

Certificate of Registration for a UK Design

Design number: 6338580

Grant date: 26 January 2024

Registration date: 10 January 2024

This is to certify that,

in pursuance of and subject to the provision of Registered Designs Act 1949, the design of which a representation or specimen is attached, had been registered as of the date of registration shown above in the name of

Vinay Kumar Singh, Dr Shiv Prakash, Saifullah Khalid

in respect of the application of such design to:

Smart Learning Headset: An EEG-Infused Headgear Design for Students

International Design Classification:

Version: 14-2023

Class: 14 RECORDING, TELECOMMUNICATION OR DATA PROCESSING
EQUIPMENT

Subclass: 02 DATA PROCESSING EQUIPMENT AS WELL AS PERIPHERAL
APPARATUS AND DEVICES

Adam Williams

Adam Williams

Comptroller-General of Patents, Designs and Trade Marks
Intellectual Property Office

The attention of the Proprietor(s) is drawn to the important notes overleaf.

JP 30.01.2024





Intellectual
Property
Office

Certificate of Registration for a UK Design

Design number: 6355122

Grant date: 11 April 2024

Registration date: 24 March 2024

This is to certify that,

in pursuance of and subject to the provision of Registered Designs Act 1949, the design of which a representation or specimen is attached, had been registered as of the date of registration shown above in the name of

Vivek Kumar Pandey, Dr Shiv Prakash, Gaurav Ojha, Dr Ram Bhushan, Dr

Pawan Kumar, Saifullah Khalid

in respect of the application of such design to:

Intrusion Detection System for Wireless Sensor Networks

International Design Classification:

Version: 14-2023

Class: 10 CLOCKS AND WATCHES AND OTHER MEASURING INSTRUMENTS, CHECKING AND SIGNALLING INSTRUMENTS

Subclass: 05 INSTRUMENTS, APPARATUS AND DEVICES FOR CHECKING, SECURITY OR TESTING

Adam Williams

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Comptroller-General of Patents, Designs and Trade Marks
Intellectual Property Office

The attention of the Proprietor(s) is drawn to the important notes overleaf.



24/30.04.2024

(12) PATENT APPLICATION PUBLICATION.

(19) INDIA

(22) Date of filing of Application : 14/09/2023

(21) Application No. 202331061770 A

(43) Publication Date : 06/10/2023

(54) Title of the invention : SYSTEMATIC APPROACH TO ANALYZE THE IMPACT OF DESIGN THINKING AS AN EFFECTIVE METHOD FOR PROBLEM SETTING AND NEED FINDING FOR ENTREPRENEURIAL TEAMS ADDRESSING WICKED PROBLEMS

(51) International classification : G06N0005040000, G06Q0010060000, B33Y0050020000, G06F0030331000, G06Q0010080000
(86) International Application No : PCT//
Filing Date : 01/01/1900
(87) International Publication No : NA
(61) Patent of Addition to Application Number : NA
Filing Date : NA
(62) Divisional to Application Number : NA
Filing Date : NA

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5) Dr. Suman Dahiya

6) Dr. Savitha Velaayutham

7) Vatsal Kumar Parasar

8) K. Bharadwaja

9) P. Anjaiah

10) N. Premalatha

11) Dr. Vishal Ratansing Patil

12) Romala Vijaya Srinivas

Name of Applicant : NA

Address of Applicant : NA

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(57) Abstract :
SYSTEMATIC APPROACH TO ANALYZE THE IMPACT OF DESIGN THINKING AS AN EFFECTIVE METHOD FOR PROBLEM SETTING AND NEED FINDING FOR ENTREPRENEURIAL TEAMS ADDRESSING WICKED PROBLEMS-A systematic approach to analyze the impact of design thinking as an effective method for problem setting and need finding for entrepreneurial teams addressing wicked problems. The system comprises components of inspiration, ideation, and implementation (Brown, 2009) serve as the foundation of this hybrid model, shapes as a non-sequential, innovative method to interpret and address complex problems, thinking, forming a hypothesis from abduction reasoning and the examination is performed using that deduction, a sequence of phases linking through ideation and then prototyping, two forces of learning that processes reality and transforming it within each tangible and intangible component and creates a streamlined and flexible framework, where the innovation may occur in a non-sequential order, dictated by the needs of the problem FIG.1

No. of Pages : 11 No. of Claims : 1

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(12) PATENT APPLICATION PUBLICATION

(21) Application No.202311058894 A

(19) INDIA

(22) Date of filing of Application :01/09/2023

(43) Publication Date : 06/10/2023

(54) Title of the invention : AI-DRIVEN HYBRID DECISION-MAKING FRAMEWORK FOR ANALYSIS AND PREDICTION OF BUSINESS VALUE MAXIMIZATION

(51) International classification :G06Q0010060000, G06N0020000000, G06N0005040000, G16H10050200000, G06N00050200000
(86) International Application No :NA
Filing Date :NA
(87) International Publication No :NA
(61) Patent of Addition to Application Number :NA
Filing Date :NA
(62) Divisional to Application Number :NA
Filing Date :NA

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(57) Abstract :
A system and method are disclosed for utilizing an AI-driven hybrid decision-making framework to analyze and predict business value maximization. The framework integrates machine learning algorithms, data analytics, and expert knowledge to provide comprehensive insights for decision-makers. The system assists in evaluating various business strategies and predicting their impact on value creation, enhancing overall decision-making processes.

No. of Pages : 13 No. of Claims : 6



US011851335B2

(12) **United States Patent**
Hodgkins et al.(10) **Patent No.:** **US 11,851,335 B2**(45) **Date of Patent:** ***Dec. 26, 2023**(54) **NICKEL-CONTAINING ORGANOMETALLIC FUNCTIONALIZED FIBROUS HIERARCHICAL ZEOLITE AND METHOD OF MAKING THE SAME**10,196,465 B2 2/2019 Han et al.
2010/0140138 A1* 6/2010 Chaumonnot B01J 35/023
2019/0004059 A1 1/2019 Stapels et al. 502/64(71) Applicants: **Saudi Arabian Oil Company**, Dhahran (SA); **King Abdullah University of Science and Technology**, Thuwal (SA)

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CA 2917133 * 7/2014
EP 2592049 A2 5/2013
WO 0020101 * 10/1999
WO 2012028695 * 11/2012
WO 2015001123 1/2015(72) Inventors: **Robert Peter Hodgkins**, Dhahran (SA); **Omer Refa Koseoglu**, Dhahran (SA); **Jean-Marie Maurice Basset**, Thuwal (SA); **Kuo-Wei Huang**, Thuwal (SA); **Anissa Bendjeriou-Sedjerari**, Thuwal (SA); **Sathiyamoorthy Murugesan**, Thuwal (SA); **Moussab Harb**, Thuwal (SA); **Manoj Kumar Gangwar**, Thuwal (SA)

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U.S. Appl. No. 17/230,500, filed Apr. 14, 2021.
U.S. Appl. No. 17/230,491, filed Apr. 14, 2021.
U.S. Appl. No. 17/230,505, filed Apr. 14, 2021.
U.S. Appl. No. 17/230,524, filed Apr. 14, 2021.
U.S. Appl. No. 17/230,532, filed Apr. 14, 2021.
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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 18 days.

This patent is subject to a terminal disclaimer

(21) Appl. No.: **17/412,733**(22) Filed: **Aug. 26, 2021**(65) **Prior Publication Data**

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(51) **Int. Cl.**
C07F 17/02 (2006.01)
C01B 39/02 (2006.01)
C01B 39/40 (2006.01)(52) **U.S. Cl.**
CPC **C01B 39/026** (2013.01); **C01B 39/40** (2013.01); **C07F 17/02** (2013.01); **C01P 2002/82** (2013.01); **C01P 2002/85** (2013.01); **C01P 2002/86** (2013.01); **C01P 2004/03** (2013.01); **C01P 2004/04** (2013.01)(58) **Field of Classification Search**
None
See application file for complete search history.(56) **References Cited**

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(57) **ABSTRACT**

A functionalized fibrous hierarchical zeolite includes a framework comprising aluminum atoms, silicon atoms, and oxygen atoms, the framework further comprising a plurality of micropores and a plurality of mesopores. The functionalized fibrous hierarchical zeolite is functionalized with at least one terminal hydroxyl. Terminal organometallic functionalities are bonded to silicon atoms of the microporous framework, the terminal organometallic functionalities comprising a nickel atom.

13 Claims, 7 Drawing Sheets
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US011565942B2

(12) **United States Patent**
Hodgkins et al.

(10) **Patent No.:** **US 11,565,942 B2**(45) **Date of Patent:** **Jan. 31, 2023**

(54) **MODIFIED ZEOLITES THAT INCLUDE PLATINUM-CONTAINING ORGANOMETALLIC MOIETIES AND METHODS FOR MAKING SUCH**

(71) Applicants: **Saudi Arabian Oil Company**, Dhahran (SA); **King Abdullah University of Science and Technology**, Thuwal (SA)

(72) Inventors: **Robert Peter Hodgkins**, Dhahran (SA); **Omer Refa Koseoglu**, Dhahran (SA); **Jean-Marie Maurice Basset**, Thuwal (SA); **Kuo-Wei Huang**, Thuwal (SA); **Anissa Bendjeriou Sedjerari**, Thuwal (SA); **Manoj K. Gangwar**, Thuwal (SA); **Sathiyamoorthy Murugesan**, Thuwal (SA)

(73) Assignees: **Saudi Arabian Oil Company**, Dhahran (SA); **King Abdullah University of Science and Technology**, Thuwal (SA)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 3 days.

(21) Appl. No.: **17/230,476**

(22) Filed: **Apr. 14, 2021**

(65) **Prior Publication Data**
US 2022/0340432 A1 Oct. 27, 2022

(51) **Int. Cl.**
C01B 33/26 (2006.01)
C01B 39/40 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC **C01B 39/40** (2013.01); **B01J 29/40** (2013.01); **B01J 35/023** (2013.01);
(Continued)

(58) **Field of Classification Search**

CPC C01B 33/26; C01B 33/28; C01B 33/2807;
C01B 33/2869; C01B 39/04; C01B 39/38;
C01B 39/40

See application file for complete search history.

(56) **References Cited**

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7,994,085 B2 8/2011 Chaumonnot et al
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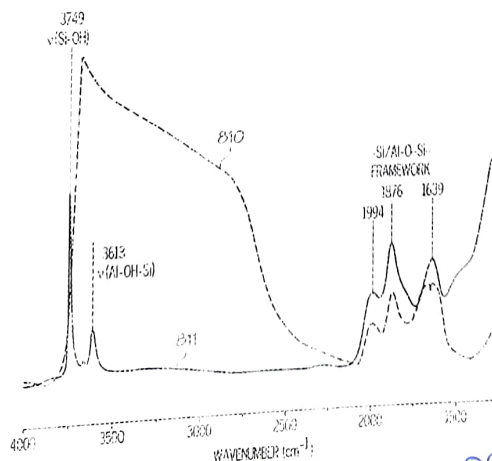
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(57) **ABSTRACT**

Disclosed herein are modified zeolites and methods for making modified zeolites. In one or more embodiments disclosed herein, a modified zeolite may include a microporous framework including a plurality of micropores having diameters of less than or equal to 2 nm. The microporous framework may include at least silicon atoms and oxygen atoms. The modified zeolite may further include organometallic moieties each bonded to bridging oxygen atoms. The organometallic moieties may include a platinum atom. The platinum atom may be bonded to a bridging oxygen atom, and the bridging oxygen atom may bridge the platinum atom of the organometallic moiety and a silicon atom of the microporous framework.

19 Claims, 9 Drawing Sheets



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(12) **United States Patent**
Hodgkins et al.

(10) Patent No.: US 11,591,230 B2**(45) Date of Patent: Feb. 28, 2023**

(54) **MODIFIED ZEOLITES THAT INCLUDE
HAFNIUM-CONTAINING
ORGANOMETALLIC MOIETIES AND
METHODS FOR MAKING SUCH**

(71) Applicants: **Saudi Arabian Oil Company**, Dhahran
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(73) Assignees: **Saudi Arabian Oil Company**, Dhahran
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(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 0 days.

(21) Appl. No.: 17/231,191

(22) Filed: Apr. 15, 2021

(65) **Prior Publication Data**
US 2022/0332593 A1 Oct. 20, 2022

(51) **Int. Cl.**
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B01J 29/40 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC **C01B 39/40** (2013.01); **B01J 29/405**
(2013.01); **B01J 35/023** (2013.01);
(Continued)

(58) **Field of Classification Search**

CPC C01B 33/26; C01B 33/28; C01B 33/2807;
C01B 33/2869; C01B 39/04; C01B 39/38;
C01B 39/40

See application file for complete search history.

(56) **References Cited**

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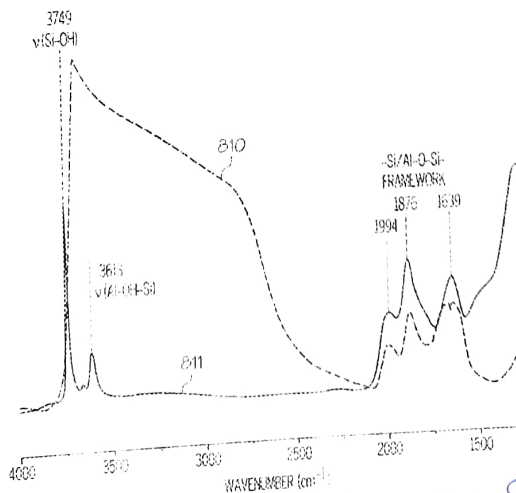
Primary Examiner — Hoa (Holly) Le

(74) Attorney, Agent, or Firm — Dinsmore & Shohl LLP

(57) **ABSTRACT**

Disclosed herein are modified zeolites and methods for
making modified zeolites. In one or more embodiments
disclosed herein, a modified zeolite may include a micropo-
rous framework including a plurality of micropores having
diameters of less than or equal to 2 nm. The microporous
framework includes at least silicon atoms and oxygen atoms.
The modified zeolite may further include organometallic
moieties each bonded to bridging oxygen atoms. The orga-
nometallic moieties include a hafnium atom. The hafnium
atom is bonded to a bridging oxygen atom, and bridging
oxygen atom bridges the hafnium atom of the organometal-
lic moiety and a silicon atom of the microporous framework.

20 Claims, 9 Drawing Sheets



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(12) **United States Patent**
Hodgkins et al.

(10) Patent No.: US 11,591,229 B2**(45) Date of Patent: Feb. 28, 2023**

(54) **MODIFIED ZEOLITES THAT INCLUDE
TITANIUM-CONTAINING
ORGANOMETALLIC MOIETIES AND
METHODS FOR MAKING SUCH**

(58) **Field of Classification Search**
CPC C01B 33/26; C01B 33/28; C01B 33/2807;
C01B 33/2869; C01B 39/04; C01B 39/38;
C01B 39/40
See application file for complete search history.

(71) Applicants: **Saudi Arabian Oil Company**, Dhahran
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(56) **References Cited**

U.S. PATENT DOCUMENTS

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7,994,085 B2 8/2011 Chaumonnot et al.
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FOREIGN PATENT DOCUMENTS

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WO 2019035045 A1 2/2019

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Chopin & Quignard, From supported homogeneous catalysts to
heterogeneous molecular catalysts, *Coordination Chemistry Reviews*
178-180 (1998) 1679-1702 (Year: 1998) *

(Continued)

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(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 0 days.

(21) Appl. No.: 17/230,500

(22) Filed: Apr. 14, 2021

(65) **Prior Publication Data**

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(51) **Int. Cl.**

C01B 39/40 (2006.01)

B01J 29/40 (2006.01)

(Continued)

(52) **U.S. Cl.**

CPC **C01B 39/40** (2013.01); **B01J 29/405**

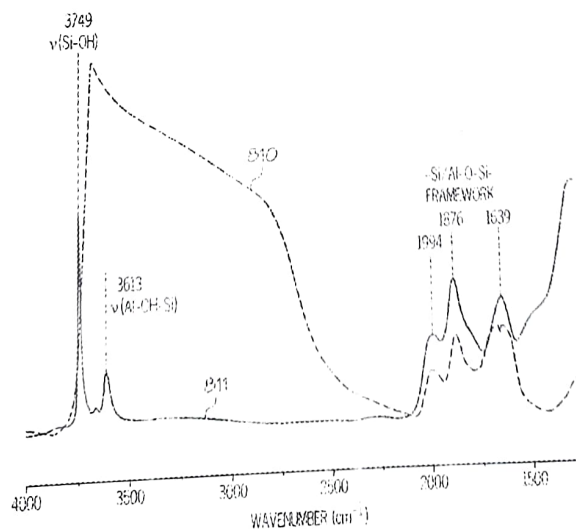
(2013.01); **B01J 35/023** (2013.01);

(Continued)

(57) **ABSTRACT**

Disclosed herein are modified zeolites and methods for
making modified zeolites. In one or more embodiments
disclosed herein, a modified zeolite may include a micropo-
rous framework comprising a plurality of micropores having
diameters of less than or equal to 2 nm. The microporous
framework may include at least silicon atoms and oxygen
atoms. The modified zeolite may further include organome-
tallic moieties each bonded to bridging oxygen atoms. The
organometallic moieties may include a titanium atom. The
titanium atom may be bonded to a bridging oxygen atom,
and the bridging oxygen atom may bridge the titanium atom
of the organometallic moiety and a silicon atom of the
microporous framework.

20 Claims, 10 Drawing Sheets



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08/04/24



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(19) United States

(12) Patent Application Publication

Hodgkins et al.

(10) Pub. No.: US 2023/0069248 A1

(43) Pub. Date:

Mar. 2, 2023

(54) PLATINUM NANOPARTICLE
FUNCTIONALIZED FIBROUS
HIERARCHICAL ZEOLITE AND METHOD
OF MAKING THE SAME

(21) Appl. No.: 17/412,773

(22) Filed Aug. 26, 2021

Publication Classification

(71) Applicants: Saudi Arabian Oil Company, Dhahran
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(51) Int. Cl.
C01B 39/48 (2006.01)

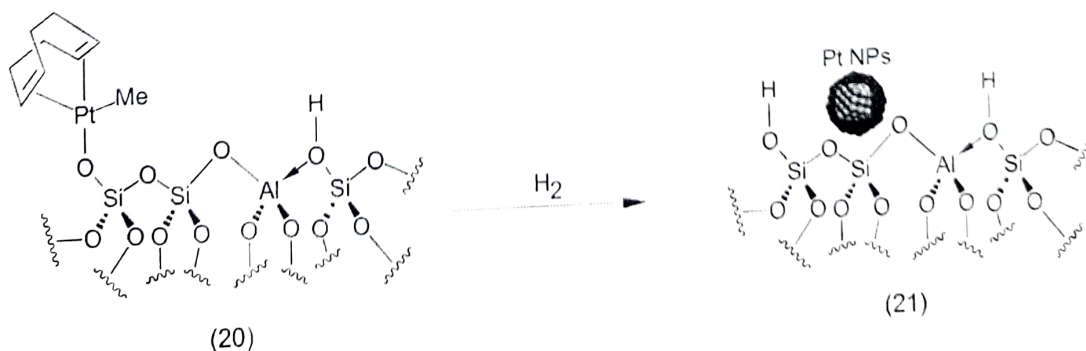
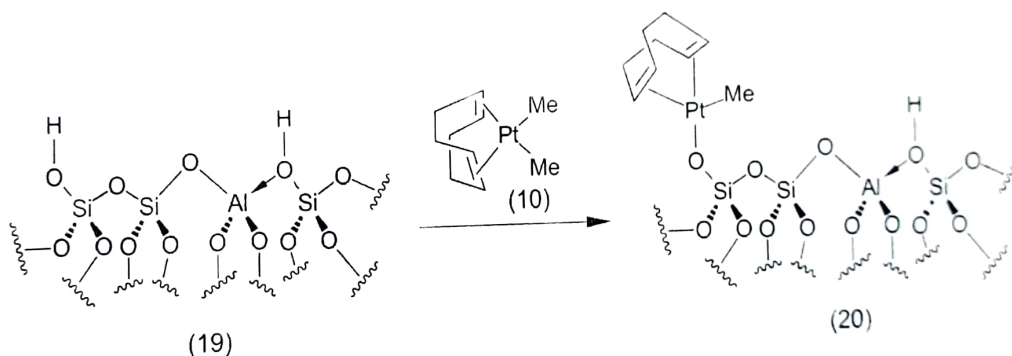
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(52) U.S. Cl.
CPC C01B 39/48 (2013.01);
C01P 2004/64 (2013.01)

(73) Assignees: Saudi Arabian Oil Company, Dhahran
(SA); King Abdullah University of
Science and Technology, Thuwal (SA)

(57) ABSTRACT

A functionalized fibrous hierarchical zeolite includes a framework comprising aluminum atoms, silicon atoms, and oxygen atoms, the framework further comprising a plurality of micropores and a plurality of mesopores. A plurality of nanoparticles comprising platinum are immobilized on the framework.



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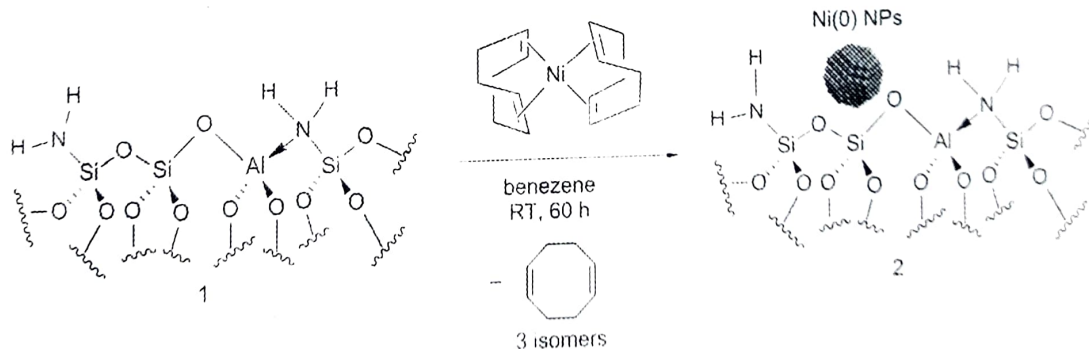
US 20230072575A1

(19) **United States**(12) **Patent Application Publication**
Hodgkins et al.(10) **Pub. No.: US 2023/0072575 A1**(43) **Pub. Date: Mar. 9, 2023**(54) **NICKEL NANOPARTICLE
FUNCTIONALIZED AMINE-MODIFIED
FIBROUS HIERARCHICAL ZEOLITE AND
METHOD OF MAKING THE SAME****Publication Classification**

- (51) **Int. Cl.**
C01B 39/02 (2006.01)
C01B 39/40 (2006.01)
- (52) **U.S. Cl.**
CPC *C01B 39/026* (2013.01); *C01B 39/40*
(2013.01); *C01P 2002/86* (2013.01); *C01P*
2004/03 (2013.01); *C01P 2002/85* (2013.01);
C01P 2004/04 (2013.01); *C01P 2004/51*
(2013.01)

(71) **Applicants:** Saudi Arabian Oil Company, Dhahran
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Science and Technology, Thuwal (SA)(72) **Inventors:** Robert Peter Hodgkins, Dhahran (SA);
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Anissa Bendjeriou-Sedjerari, Thuwal
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Thuwal (SA); Moussab Harb, Thuwal
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Thuwal (SA)(73) **Assignees:** Saudi Arabian Oil Company, Dhahran
(SA); King Abdullah University of
Science and Technology, Thuwal (SA)(21) **Appl. No.:** 17/412,817(22) **Filed:** Aug. 26, 2021(57) **ABSTRACT**

A functionalized fibrous hierarchical zeolite includes a framework comprising aluminum atoms, silicon atoms, and oxygen atoms, the framework further comprising a plurality of micropores and a plurality of mesopores. The functionalized fibrous hierarchical zeolite is functionalized with at least one amine. A plurality of nanoparticles comprising nickel are immobilized on the framework.



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US 20230082855A1

(19) **United States**(12) **Patent Application Publication**
Hodgkins et al.(10) Pub. No.: **US 2023/0082855 A1**(43) Pub. Date: **Mar. 16, 2023**(54) **PLATINUM NANOPARTICLE
FUNCTIONALIZED AMINE-MODIFIED
FIBROUS HIERARCHICAL ZEOLITE AND
METHOD OF MAKING THE SAME****Publication Classification**

(51) Int. Cl.

C01B 39/02 (2006.01)*C01B 39/40* (2006.01)*C07F 15/00* (2006.01)*C07F 17/02* (2006.01)

(52) U.S. Cl.

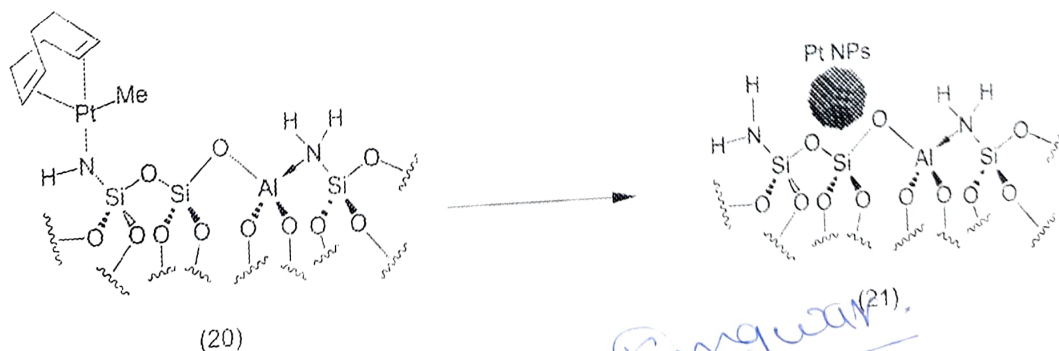
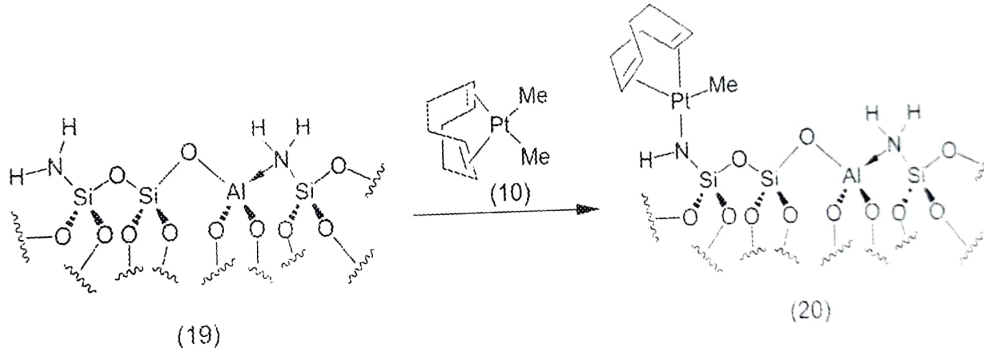
CPC *C01B 39/026* (2013.01); *C01B 39/40*(2013.01); *C07F 15/0086* (2013.01); *C07F**17/02* (2013.01); *C01P 2002/86* (2013.01);*C01P 2002/85* (2013.01); *C01P 2004/03*(2013.01); *C01P 2004/04* (2013.01)(71) Applicants: Saudi Arabian Oil Company, Dhahran
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(21) Appl. No.: 17/412,697

(22) Filed: Aug. 26, 2021

(57) **ABSTRACT**

A functionalized fibrous hierarchical zeolite includes a framework comprising aluminum atoms, silicon atoms, and oxygen atoms, the framework further comprising a plurality of micropores and a plurality of mesopores. The functionalized fibrous hierarchical zeolite is functionalized with at least one amine. A plurality of nanoparticles comprising platinum are immobilized on the framework.



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(19) **United States**(12) **Patent Application Publication**
Hodgkins et al.(10) **Pub. No.: US 2023/0085197 A1**(43) **Pub. Date: Mar. 16, 2023**(54) **PLATINUM ORGANOMETALLIC COMPLEX
FUNCTIONALIZED AMINE-MODIFIED
FIBROUS HIERARCHICAL ZEOLITE AND
METHOD OF MAKING THE SAME**(71) Applicants: **Saudi Arabian Oil Company**, Dhahran
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(21) Appl. No.: 17/412,732

(22) Filed: Aug. 26, 2021

Publication Classification(51) **Int. Cl.****C01B 39/02** (2006.01)**C01B 39/40** (2006.01)**C07F 15/00** (2006.01)(52) **U.S. Cl.**CPC **C01B 39/026** (2013.01); **C01B 39/40**
(2013.01); **C07F 15/0086** (2013.01); **C01P**
2002/86 (2013.01)

(57)

ABSTRACT

A functionalized fibrous hierarchical zeolite includes a framework comprising aluminum atoms, silicon atoms, and oxygen atoms, the framework further comprising a plurality of micropores and a plurality of mesopores. The functionalized fibrous hierarchical zeolite is functionalized with at least one terminal amine bonded to a silicon atom. Terminal organometallic functionalities are bonded to a nitrogen atom of the at least one terminal amine, the terminal organometallic functionalities comprising a platinum atom.

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(19) **United States**(12) **Patent Application Publication**
Hodgkins et al.(10) **Pub. No.: US 2023/0078677 A1**(43) **Pub. Date: Mar. 16, 2023**(54) **NON-BRØNSTED FIBROUS HIERARCHICAL
ZEOLITE AND METHOD OF MAKING THE
SAME**

(21) Appl. No.: 17/412,807

(22) Filed: Aug. 26, 2021

(71) Applicants: Saudi Arabian Oil Company, Dhahran
(SA); King Abdullah University of
Science and Technology, Thuwal (SA)**Publication Classification**(51) **Int. Cl.**
C01B 39/02 (2006.01)
C01B 39/40 (2006.01)(52) **U.S. Cl.**
CPC **C01B 39/026** (2013.01); **C01B 39/40**
(2013.01); **C01P 2002/72** (2013.01)(72) Inventors: Robert Peter Hodgkins, Dhahran (SA);
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Anissa Bendjeriou Sedjerari, Thuwal
(SA); Sathiyamoorthy Murugesan,
Thuwal (SA); Manoj Kumar
Gangwar, Thuwal (SA); Rajesh
Kumar Parsapur, Thuwal (SA)(57) **ABSTRACT**

A fibrous hierarchical zeolite includes a framework comprising aluminum atoms, silicon atoms, and oxygen atoms, the framework further comprising a plurality of micropores and a plurality of mesopores. The framework comprises no Brønsted acid activity.

(73) Assignees: Saudi Arabian Oil Company, Dhahran
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(19) **United States**(12) **Patent Application Publication** (10) **Pub. No.: US 2023/0104591 A1****Hodgkins et al.**(43) **Pub. Date:****Apr. 6, 2023**

(54) **NICKEL NANOPARTICLE
FUNCTIONALIZED FIBROUS
HIERARCHICAL ZEOLITE AND METHOD
OF MAKING THE SAME**

(21) Appl. No.: 17/412,748

(22) Filed: Aug. 26, 2021

(71) Applicants: Saudi Arabian Oil Company, Dhahran
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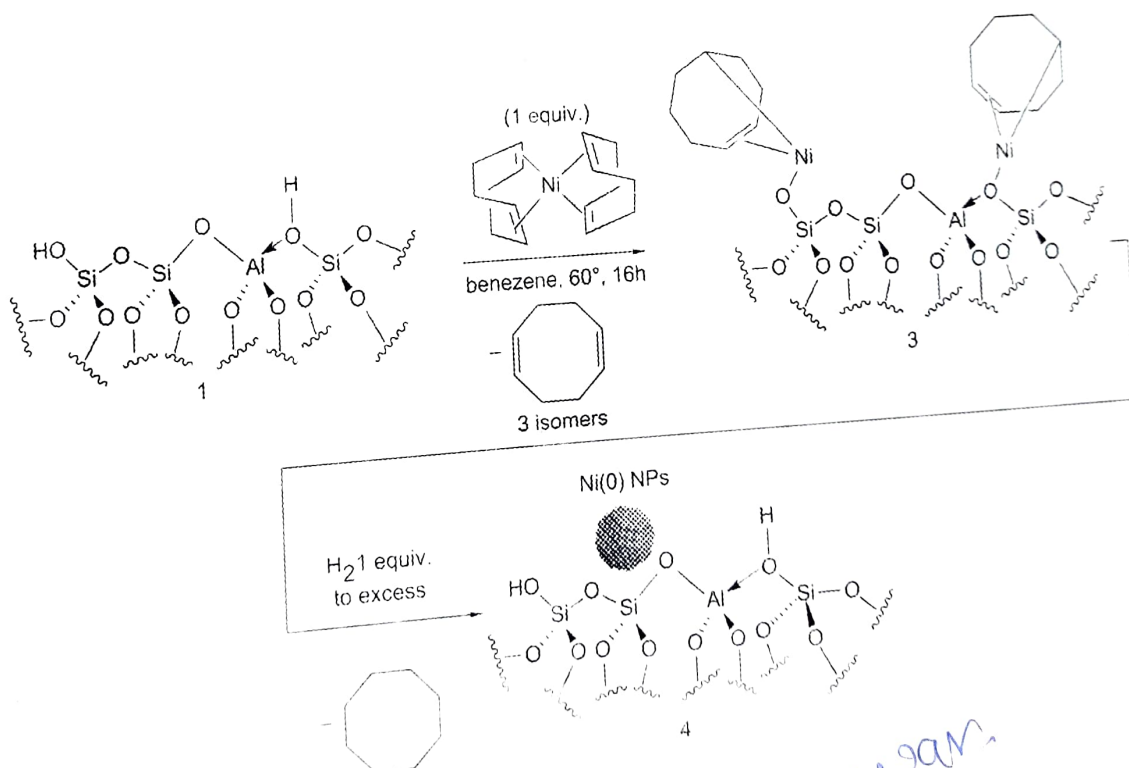
Publication Classification

(51) Int. Cl.
C07F 15/04 (2006.01)
C01B 39/38 (2006.01)

(52) U.S. Cl.
CPC C07F 15/04 (2013.01); C01B 39/38
(2013.01); B82Y 30/00 (2013.01)

ABSTRACT

A functionalized fibrous hierarchical zeolite includes a framework comprising aluminum atoms, silicon atoms, and oxygen atoms, the framework further comprising a plurality of micropores and a plurality of mesopores. A plurality of nanoparticles comprising nickel are immobilized on the framework.



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(19) **United States**(12) **Patent Application Publication**
Hodgkins et al.(10) **Pub. No.: US 2023/0159343 A1**(43) **Pub. Date: May 25, 2023**(54) **MODIFIED ZEOLITES THAT INCLUDE
TITANIUM-CONTAINING
ORGANOMETALLIC MOIETIES AND
METHODS FOR MAKING SUCH***B01J 35/02* (2006.01)*B01J 37/16* (2006.01)*B01J 37/02* (2006.01)*C01B 39/02* (2006.01)(71) Applicants: Saudi Arabian Oil Company, Dhahran
(SA); King Abdullah University of
Science and Technology, Thuwal (SA)(52) **U.S. Cl.***CPC* *C01B 39/40* (2013.01); *B01J 29/405*
(2013.01); *B01J 35/1061* (2013.01); *B01J*
35/1066 (2013.01); *B01J 35/023* (2013.01);
B01J 37/16 (2013.01); *B01J 37/0203*
(2013.01); *C01B 39/026* (2013.01); *C01P*
2004/64 (2013.01); *C01P 2002/72* (2013.01);
C01P 2004/04 (2013.01); *C01P 2004/03*
(2013.01); *C01P 2002/82* (2013.01); *C01P*
2002/86 (2013.01); *C01P 2006/16* (2013.01);
C01P 2004/62 (2013.01)(72) Inventors: Robert Peter Hodgkins, Dhahran (SA);
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(57)

ABSTRACT

(21) Appl. No.: 18/101,923

(22) Filed: Jan. 26, 2023

Related U.S. Application Data(62) Division of application No. 17/230,500, filed on Apr.
14, 2021, now Pat. No. 11,591,229.**Publication Classification**(51) **Int. Cl.**
C01B 39/40 (2006.01)
B01J 29/40 (2006.01)
B01J 35/10 (2006.01)

Disclosed herein are modified zeolites and methods for making modified zeolites. In one or more embodiments disclosed herein, a modified zeolite may include a microporous framework comprising a plurality of micropores having diameters of less than or equal to 2 nm. The microporous framework may include at least silicon atoms and oxygen atoms. The modified zeolite may further include organometallic moieties each bonded to bridging oxygen atoms. The organometallic moieties may include a titanium atom. The titanium atom may be bonded to a bridging oxygen atom, and the bridging oxygen atom may bridge the titanium atom of the organometallic moiety and a silicon atom of the microporous framework.

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(19) **United States**(12) **Patent Application Publication**
Hodgkins et al.(10) **Pub. No.: US 2023/0174383 A1**(43) **Pub. Date: Jun. 8, 2023**(54) **MODIFIED ZEOLITES THAT INCLUDE
HAFNIUM-CONTAINING
ORGANOMETALLIC MOIETIES AND
METHODS FOR MAKING SUCH***B01J 35/10* (2006.01)
B01J 37/02 (2006.01)
B01J 37/16 (2006.01)
C01B 39/02 (2006.01)
B01J 29/40 (2006.01)(71) Applicants: **Saudi Arabian Oil Company, Dhahran
(SA); King Abdullah University of
Science and Technology, Thuwal (SA)**(52) **U.S. Cl.****CPC** *C01B 39/40* (2013.01); *B01J 35/023*
(2013.01); *B01J 35/1061* (2013.01); *B01J*
35/1066 (2013.01); *B01J 37/0203* (2013.01);
B01J 37/16 (2013.01); *C01B 39/026*
(2013.01); *B01J 29/405* (2013.01); *C01P*
2006/16 (2013.01); *C01P 2002/70* (2013.01);
C01P 2002/82 (2013.01); *C01P 2002/86*
(2013.01); *C01P 2004/03* (2013.01); *C01P*
2004/04 (2013.01); *C01P 2004/62* (2013.01);
C01P 2004/64 (2013.01)(72) Inventors: **Robert Peter Hodgkins, Dhahran (SA);
Omer Refa Koseoglu, Dhahran (SA);
Jean-Marie Maurice Basset, Thuwal
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(57)

ABSTRACT(21) Appl. No.: **18/101,963**(22) Filed: **Jan. 26, 2023****Related U.S. Application Data**(62) Division of application No. 17/231,191, filed on Apr.
15, 2021, now Pat. No. 11,591,230.**Publication Classification**(51) **Int. Cl.**
C01B 39/40 (2006.01)
B01J 35/02 (2006.01)

Disclosed herein are modified zeolites and methods for making modified zeolites. In one or more embodiments disclosed herein, a modified zeolite may include a microporous framework including a plurality of micropores having diameters of less than or equal to 2 nm. The microporous framework includes at least silicon atoms and oxygen atoms. The modified zeolite may further include organometallic moieties each bonded to bridging oxygen atoms. The organometallic moieties include a hafnium atom. The hafnium atom is bonded to a bridging oxygen atom, and bridging oxygen atom bridges the hafnium atom of the organometallic moiety and a silicon atom of the microporous framework.

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US011731881B2

(12) **United States Patent**
Hodgkins et al.

(10) **Patent No.:** **US 11,731,881 B2**(45) **Date of Patent:** **Aug. 22, 2023**

(54) **MODIFIED ZEOLITES THAT INCLUDE ZIRCONIUM-CONTAINING ORGANOMETALLIC MOIETIES AND METHODS FOR MAKING SUCH**

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(73) **Assignees:** Saudi Arabian Oil Company, Dhahran (SA); King Abdullah University of Science and Technology, Thuwal (SA)

(*) **Notice:** Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 294 days.

(21) **Appl. No.:** 17/230,491

(22) **Filed:** Apr. 14, 2021

(65) **Prior Publication Data**
US 2022/0348474 A1 Nov. 3, 2022

(51) **Int. Cl.**
C01B 39/40 (2006.01)
C01B 39/02 (2006.01)
B01J 29/40 (2006.01)

(52) **U.S. Cl.**
CPC **C01B 39/026** (2013.01); **B01J 29/405** (2013.01); **C01B 39/40** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC C01B 39/04; C01B 39/40; C01B 33/26; C01B 33/28; C01B 33/2807; C01P 2006/16

See application file for complete search history.

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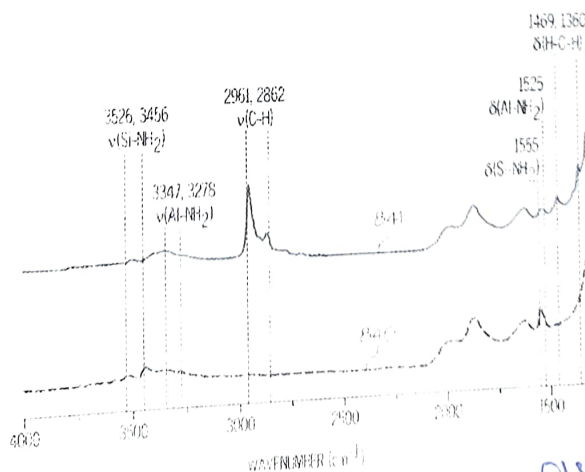
Primary Examiner Hoa (Holly) Le

(74) *Attorney, Agent, or Firm* — Dinsmore & Shohl LLP

(57) **ABSTRACT**

Disclosed herein are modified zeolites and methods for making modified zeolites. In one or more embodiments disclosed herein, a modified zeolite may include a microporous framework including a plurality of micropores having diameters of less than or equal to 2 nm. The microporous framework may include at least silicon atoms and oxygen atoms. The modified zeolite may further include organometallic moieties each bonded to a nitrogen atom of a secondary amine functional group including a nitrogen atom and a hydrogen atom. The organometallic moieties may include a zirconium atom that is bonded to the nitrogen atom of the secondary amine functional group. The nitrogen atom of the secondary amine function group may bridge the zirconium atom of the organometallic moiety and a silicon atom of the microporous framework.

20 Claims, 14 Drawing Sheets



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ORIGINAL

क्रम सं/ Serial No.: 170591



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The Patent Office, Government Of India

डिजाइन के पंजीकरण का प्रमाण पत्र

Certificate of Registration of Design

डिजाइन सं. / Design No.

412704-001

तारीख / Date

05/04/2024

पारस्परिकता तारीख / Reciprocity Date*

देश / Country

प्रमाणित किया जाता है कि संलग्न प्रति में वर्णित डिजाइन जो **IOT ENABLED AUDIO PLAYER INTEGRATED PRINTER** से संबंधित है, का पंजीकरण, श्रेणी 14-02 में 1.Dr. Dilkeshwar Pandey 2. Dr. Sanjiv Sharma 3.Mr. Amar Singh 4.Dr. Amit Kumar Gupta 5.Dr Vinod Kumar 6.Saurav Chandra 7.Dr. Ankur Bhardwaj के नाम में उपर्युक्त संख्या और तारीख में कर लिया गया है।

Certified that the design of which a copy is annexed hereto has been registered as of the number and date given above in class 14-02 in respect of the application of such design to **IOT ENABLED AUDIO PLAYER INTEGRATED PRINTER** in the name of 1.Dr. Dilkeshwar Pandey 2. Dr. Sanjiv Sharma 3.Mr. Amar Singh 4.Dr. Amit Kumar Gupta 5.Dr Vinod Kumar 6.Saurav Chandra 7.Dr. Ankur Bhardwaj.

डिजाइन अधिनियम, 2000 तथा डिजाइन नियम, 2001 के अधधीन प्रावधानों के अनुसरण में।

In pursuance of and subject to the provisions of the Designs Act, 2000 and the Designs Rules, 2001.

जारी करने की तिथि :

Date of Issue

22/05/2024



कुलत की संस्थिति

महानियंत्रक पेटेंट, डिजाइन और व्यापार चिह्न
Controller General of Patents, Designs and Trade Marks

*पारस्परिकता तारीख (यदि कोई हो) जिसकी अनुमति दी गई है तथा देश का नाम। डिजाइन का स्वत्वाधिकार पंजीकरण की तारीख से दस वर्षों के लिए होगा जिसका विस्तार, अधिनियम एवं नियम के निबंधनों के अधीन, पाँच वर्षों की अतिरिक्त अवधि के लिए किया जा सकेगा। इस प्रमाण पत्र का उपयोग विधिक कार्यवाहियों अथवा विदेश में पंजीकरण प्राप्त करने के लिए नहीं हो सकता है।

The reciprocity date (if any) which has been allowed and the name of the country. Copyright in the design will subsist for ten years from the date of Registration, and may under the terms of the Act and Rules, be extended for a further period of five years. This Certificate is not for use in legal proceedings or for obtaining registration abroad.



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सत्यमेव जयते



पेटेंट कार्यालय, भारत सरकार

The Patent Office, Government Of India

पेटेंट प्रमाण पत्र

Patent Certificate

(पेटेंट नियमावली का नियम 74)

(Rule 74 of The Patents Rules)

पेटेंट सं. / Patent No.

547594

आवेदन सं. / Application No.

202211036243

फाइल करने की तारीख / Date of Filing

24/06/2022

पेटेंटी / Patentee

1.Dr. Navneet Yadav 2.Dr. Kajal Kumar Dey 3.Prof. Raja Ram Yadav

प्रमाणित किया जाता है कि पेटेंटी को, उपरोक्त आवेदन में यथाप्रकरित **A COMPOSITION FOR MICROWAVE ASSISTED GREEN SYNTHESIS OF TRIMETALLIC AU/PT/CU NANOPARTICLES** नामक आविष्कार के लिए, पेटेंट अधिनियम, 1970 के उपबंधों के अनुसार आज तारीख जून 2022 के चौबीसवें दिन से बीस वर्ष की अवधि के लिए पेटेंट अनुदत्त किया गया है।

It is hereby certified that a patent has been granted to the patentee for an invention entitled **A COMPOSITION FOR MICROWAVE ASSISTED GREEN SYNTHESIS OF TRIMETALLIC AU/PT/CU NANOPARTICLES** as disclosed in the above mentioned application for the term of 20 years from the 24th day of June 2022 in accordance with the provisions of the Patents Act, 1970.



इकांत की दंडित

Controller of Patents

अनुदान की तारीख : 12/08/2024

टिप्पणी - इस पेटेंट के नवीकरण के लिए फीस, यदि इसे बनाए रखा जाना है, जून 2024 के चौबीसवें दिन को और उसके पश्चात प्रत्येक वर्ष में उसी दिन देय होगी।
Note. - The fees for renewal of this patent, if it is to be maintained, will fall / has fallen due on 24th day of June 2024 and on the same day in every year thereafter.



ORIGINAL

क्रम सं/ Serial No.: 177801



पेटेंट कार्यालय, भारत सरकार

The Patent Office, Government Of India

डिजाइन के पंजीकरण का प्रमाण पत्र

Certificate of Registration of Design

डिजाइन सं. / Design No.

417559-001

तारीख / Date

21/05/2024

पारस्परिकता तारीख / Reciprocity Date*

देश / Country

प्रमाणित किया जाता है कि संलग्न प्रति में वर्णित डिजाइन जो **DATA PROCESSING AND MINING DEVICE** से संबंधित है, का पंजीकरण, श्रेणी 14-02 में 1.Dr. Arvind Kumar Shukla 2. Prof. Rakesh Singh 3.Prof. Madhurendra Kumar 4.Prof. Anil Pratap Giri 5.Dr. Rajdeep Singh के नाम में उपर्युक्त संख्या और तारीख में कर लिया गया है।

Certified that the design of which a copy is annexed hereto has been registered as of the number and date given above in class 14-02 in respect of the application of such design to **DATA PROCESSING AND MINING DEVICE** in the name of 1.Dr. Arvind Kumar Shukla 2. Prof. Rakesh Singh 3.Prof. Madhurendra Kumar 4.Prof. Anil Pratap Giri 5.Dr. Rajdeep Singh.

डिजाइन अधिनियम, 2000 तथा डिजाइन नियम, 2001 के अधधीन प्रावधानों के अनुसरण में।

In pursuance of and subject to the provisions of the Designs Act, 2000 and the Designs Rules, 2001.

जारी करने की तिथि :

Date of Issue 09/08/2024



डिजाइन की पंजीकरण

महानियंत्रक पेटेंट, डिजाइन और व्यापार चिह्न
Controller General of Patents, Designs and Trade Marks

*पारस्परिकता तारीख (यदि कोई हो) जिसकी अनुमति दी गई है तथा देश का नाम। डिजाइन का स्वत्वाधिकार पंजीकरण की तारीख से दस वर्षों के लिए होगा जिसका विस्तार, अधिनियम एवं नियम के निबंधनों के अधीन, पाँच वर्षों की अतिरिक्त अवधि के लिए किया जा सकेगा। इस प्रमाण पत्र का उपयोग विधिक कार्यवाहियों अथवा विदेश में पंजीकरण प्राप्त करने के लिए नहीं हो सकता है।

The reciprocity date (if any) which has been allowed and the name of the country. Copyright in the design will subsist for ten years from the date of Registration, and may under the terms of the Act and Rules, be extended for a further period of five years. This Certificate is not for use in legal proceedings or for obtaining registration abroad.



पेटेंट कार्यालय, भारत सरकार The Patent Office, Government Of India
डिजाइन के पंजीकरण का प्रमाण पत्र | Certificate of Registration of Design

डिजाइन सं. / Design No. : 405868-001
तारीख / Date : 28/01/2024
पारस्परिकता तारीख / Reciprocity Date* :
देश / Country :

प्रमाणित किया जाता है कि संलग्न प्रति में वर्णित डिजाइन जो *SANSKRIT TO ENGLISH TRANSLATION DEVICE* से संबंधित है, का पंजीकरण, श्रेणी 14-02 में 1.Prof. Anil Pratap Giri 2. Dr. Retna Mony R 3.K. B. V. Brahma Rao 4.Dr. Arvind Kumar Shukla के नाम में उपर्युक्त संख्या और तारीख में कर लिया गया है।

Certified that the design of which a copy is annexed hereto has been registered as of the number and date given above in class 14-02 in respect of the application of such design to *SANSKRIT TO ENGLISH TRANSLATION DEVICE* in the name of 1.Prof. Anil Pratap Giri 2. Dr. Retna Mony R 3.K. B. V. Brahma Rao 4.Dr. Arvind Kumar Shukla.

डिजाइन अधिनियम, 2000 तथा डिजाइन नियम, 2001 के अध्याधीन प्रावधानों के अनुसरण में।

In pursuance of and subject to the provisions of the Designs Act, 2000 and the Designs Rules, 2001.

जारी करने की तिथि :
Date of Issue : 05/04/2024



उन्नत जी भंडा

महानियंत्रक पेटेंट, डिजाइन और व्यापार चिह्न
Controller General of Patents, Designs and Trade Marks

*पारस्परिकता तारीख (यदि कोई हो) जिसकी अनुमति दी गई है तथा देश का नाम। डिजाइन का स्वत्वाधिकार पंजीकरण की तारीख से दस वर्षों के लिए होगा जिसका विस्तार, अधिनियम एवं नियम के निबंधनों के अधीन, पाँच वर्षों की अतिरिक्त अवधि के लिए किया जा सकेगा। इस प्रमाण पत्र का उपयोग विधिक कार्यवाहियों अथवा विदेश में पंजीकरण प्राप्त करने के लिए नहीं हो सकता है।

The reciprocity date (if any) which has been allowed and the name of the country. Copyright in the design will subsist for ten years from the date of Registration, and may under the terms of the Act and Rules, be extended for a further period of five years. This Certificate is not for use in legal proceedings or for obtaining registration abroad.

Certificate of Registration for a UK Design

Design number: 6338580

Grant date: 26 January 2024

Registration date: 10 January 2024

This is to certify that,

in pursuance of and subject to the provision of Registered Designs Act 1949, the design of which a representation or specimen is attached, had been registered as of the date of registration shown above in the name of

Vinay Kumar Singh, Dr Shiv Prakash, Saifullah Khalid

in respect of the application of such design to:

Smart Learning Headset: An EEG-Infused Headgear Design for Students

International Design Classification:

Version: 14-2023

Class: 14 RECORDING, TELECOMMUNICATION OR DATA PROCESSING
EQUIPMENT

Subclass: 02 DATA PROCESSING EQUIPMENT AS WELL AS PERIPHERAL
APPARATUS AND DEVICES

Adam Williams

Adam Williams

Comptroller-General of Patents, Designs and Trade Marks
Intellectual Property Office

The attention of the Proprietor(s) is drawn to the important notes overleaf.

JP 30.01.2024





Intellectual
Property
Office

Certificate of Registration for a UK Design

Design number: 6355122

Grant date: 11 April 2024

Registration date: 24 March 2024

This is to certify that,

in pursuance of and subject to the provision of Registered Designs Act 1949, the design of which a representation or specimen is attached, had been registered as of the date of registration shown above in the name of

Vivek Kumar Pandey, Dr Shiv Prakash, Gaurav Ojha, Dr Ram Bhushan, Dr

Pawan Kumar, Saifullah Khalid

in respect of the application of such design to:

Intrusion Detection System for Wireless Sensor Networks

International Design Classification:

Version: 14-2023

Class: 10 CLOCKS AND WATCHES AND OTHER MEASURING INSTRUMENTS, CHECKING AND SIGNALLING INSTRUMENTS

Subclass: 05 INSTRUMENTS, APPARATUS AND DEVICES FOR CHECKING, SECURITY OR TESTING

Adam Williams

Adam Williams

Comptroller-General of Patents, Designs and Trade Marks
Intellectual Property Office

The attention of the Proprietor(s) is drawn to the important notes overleaf.



20/04/2024

(12) PATENT APPLICATION PUBLICATION
(19) INDIA

(21) Application No. 202311065879 A

(22) Date of filing of Application : 30/09/2023

(43) Publication Date : 20/10/2023

(54) Title of the invention : SADBHAVANA CIRCUIT

(51) International classification : G06Q0010060000, A47G0033000000, A61K0036740000, A47G0033020000, A63F0003000000
(86) International Application No : NA
Filing Date : NA
(87) International Publication No : NA
(61) Patent of Addition to Application Number : NA
Filing Date : NA
(62) Divisional to Application Number : NA
Filing Date : NA

(71) Name of Applicant :

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2) Dr. Ruchika Singh

Name of Applicant : NA

Address of Applicant : NA

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2) Dr. Ruchika Singh

Address of Applicant : Assistant Professor, Department of Geography, University of Allahabad, Prayagraj Pincode- 211002 Prayagraj

(57) Abstract :

ABSTRACT [001] Our Invention SADBHAVANA CIRCUIT is a development of cultural and religious sites in India holds profound significance, often designating them as sacred places or tirthas. These sites are intricately connected to various deities and hold religious significance for people of diverse faiths, making them prime destinations for pilgrimage and spiritual exploration. Simultaneously, India has been home to a multitude of revered saints and spiritual leaders who have tirelessly worked towards societal reform. These luminaries have actively sought to eliminate social evils and promote unity and harmony within society. Notably, Saint Gorakhnath and Kabir stand as prominent figures. The Sadbhavana Circuit initiative represents a significant undertaking, linking several historically and spiritually rich locations. This circuit connects Ayodhya (the birthplace of Lord Rama), Maghar (associated with Saint Kabir), Gorakhpur (linked to Saint Gorakhnath), and Kushinagar (the place of Lord Buddha's Mahaparinirvana). It underscores the profound influence of these saints and their spiritual teachings, emphasizing unity, equality, and societal well-being. This initiative reflects the broader theme of interconnectedness in spirituality and underscores the shared goal of fostering a harmonious society. By enhancing tourism in the Sadbhavana Circuit, we not only celebrate India's diverse spiritual and cultural heritage but also contribute to the propagation of the timeless ideals of unity, equality, and societal betterment advocated by these revered saints.

No. of Pages : 10 No. of Claims : 8

(12) PATENT APPLICATION PUBLICATION

(19) INDIA

(22) Date of filing of Application : 08/02/2024

(21) Application No. 202411008591 A

(43) Publication Date : 16/02/2024

(54) Title of the invention : AN ULTRA LOW TEMPERATURE CO-FIRED CERAMIC (ULTCC) HAVING HIGH QUALITY FACTOR (Q X F) VALUE FOR USE IN MICROWAVE DEVICES AND METHOD OF PREPARATION THEREOF.

(51) International Classification : B82Y30/00, B82Y40/00, C04B35/01, C04B35/50, C04B35/64
(86) International Application No : NA
Filing Date : NA
(87) International Publication No : NA
(61) Patent of Addition to Application Number : NA
Filing Date : NA
(62) Divisional to Application Number : NA
Filing Date : NA

(71) Name of Applicant :

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Name of Applicant : NA

Address of Applicant : NA

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(57) Abstract :
TITLE: An Ultra Low Temperature Co-fired Ceramic (ULTCC) having high quality factor (Qxf) value for use in microwave devices and method of preparation thereof. The present invention relates to an Ultra Low Temperature Co-fired Ceramic (ULTCC) having high quality factor (Qxf) value for use in microwave devices characterized in that the chemical formula of the dielectric material is as follows: $(1-x)\text{BaV}_2\text{O}_6 \cdot (x)\text{LiMgPO}_4$ wherein x lies in the range of 0.3 to 0.5, preferably 0.5; Qxf value of the dielectric material is 61,000 GHz; dielectric constant is 8.3; sintering temperature is 475-550, preferably 525; and the temperature coefficient of the resonant frequency is in the range of -40 to -30 ppm/. Further a method for preparation of the ULTCC dielectric material is also disclosed. The dielectric material shows excellent microwave dielectric properties with low dielectric constant and high quality factor for use in microwave devices. Figure 1

No. of Pages : 15 No. of Claims : 7

Preeti



US011851335B2

(12) **United States Patent**
Hodgkins et al.(10) **Patent No.:** **US 11,851,335 B2**(45) **Date of Patent:** ***Dec. 26, 2023**(54) **NICKEL-CONTAINING ORGANOMETALLIC
FUNCTIONALIZED FIBROUS
HIERARCHICAL ZEOLITE AND METHOD
OF MAKING THE SAME**10,196,465 B2 2/2019 Han et al.
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U.S. Appl. No. 17/230,485, filed Apr. 14, 2021.
U.S. Appl. No. 17/230,500, filed Apr. 14, 2021.
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Jean-Marie Maurice Basset, Thuwal
(SA); **Kuo-Wei Huang**, Thuwal (SA);
Anissa Bendjeriou-Sedjerari, Thuwal
(SA); **Sathiyamoorthy Murugesan**,
Thuwal (SA); **Moussab Harb**, Thuwal
(SA); **Manoj Kumar Gangwar**,
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TECHNOLOGY**, Thuwal (SA)(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 18 days.This patent is subject to a terminal dis-
claimer(21) Appl. No.: **17/412,733**(22) Filed: **Aug. 26, 2021**(65) **Prior Publication Data**
US 2023/0099413 A1 Mar. 30, 2023(51) **Int. Cl.**
C07F 17/02 (2006.01)
C01B 39/02 (2006.01)
C01B 39/40 (2006.01)(52) **U.S. Cl.**
CPC **C01B 39/026** (2013.01); **C01B 39/40**
(2013.01); **C07F 17/02** (2013.01); **C01P**
2002/82 (2013.01); **C01P 2002/85** (2013.01);
C01P 2002/86 (2013.01); **C01P 2004/03**
(2013.01); **C01P 2004/04** (2013.01)(58) **Field of Classification Search**
None
See application file for complete search history.(56) **References Cited**
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5,139,984 A * 8/1992 Iwamoto C10G 47/16
502/79

Primary Examiner — Sheng H Davis

(74) Attorney, Agent, or Firm — DINSMORE & SHOHL
LLP(57) **ABSTRACT**A functionalized fibrous hierarchical zeolite includes a
framework comprising aluminum atoms, silicon atoms, and
oxygen atoms, the framework further comprising a plurality
of micropores and a plurality of mesopores. The function-
alized fibrous hierarchical zeolite is functionalized with at
least one terminal hydroxyl. Terminal organometallic func-
tionalities are bonded to silicon atoms of the microporous
framework, the terminal organometallic functionalities com-
prising a nickel atom.**13 Claims, 7 Drawing Sheets**
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Assistant Professor
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Prayagraj-211002*M. K. Gangwar*
08/04/24



US011565942B2

(12) **United States Patent**
Hodgkins et al.

(10) **Patent No.:** **US 11,565,942 B2**(45) **Date of Patent:** **Jan. 31, 2023**

(54) **MODIFIED ZEOLITES THAT INCLUDE PLATINUM-CONTAINING ORGANOMETALLIC MOIETIES AND METHODS FOR MAKING SUCH**

(71) Applicants: **Saudi Arabian Oil Company**, Dhahran (SA); **King Abdullah University of Science and Technology**, Thuwal (SA)

(72) Inventors: **Robert Peter Hodgkins**, Dhahran (SA); **Omer Refa Koseoglu**, Dhahran (SA); **Jean-Marie Maurice Basset**, Thuwal (SA); **Kuo-Wei Huang**, Thuwal (SA); **Anissa Bendjeriou Sedjerari**, Thuwal (SA); **Manoj K. Gangwar**, Thuwal (SA); **Sathiyamoorthy Murugesan**, Thuwal (SA)

(73) Assignees: **Saudi Arabian Oil Company**, Dhahran (SA); **King Abdullah University of Science and Technology**, Thuwal (SA)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 3 days.

(21) Appl. No.: **17/230,476**

(22) Filed: **Apr. 14, 2021**

(65) **Prior Publication Data**
US 2022/0340432 A1 Oct. 27, 2022

(51) **Int. Cl.**
C01B 33/26 (2006.01)
C01B 39/40 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC **C01B 39/40** (2013.01); **B01J 29/40** (2013.01); **B01J 35/023** (2013.01);
(Continued)

(58) **Field of Classification Search**

CPC C01B 33/26; C01B 33/28; C01B 33/2807;
C01B 33/2869; C01B 39/04; C01B 39/38;
C01B 39/40

See application file for complete search history.

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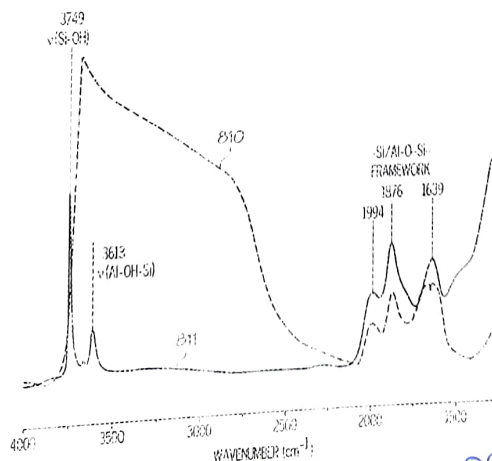
Primary Examiner — Hoa (Holly) Le

(74) *Attorney, Agent, or Firm* — Dinsmore & Shohl LLP

(57) **ABSTRACT**

Disclosed herein are modified zeolites and methods for making modified zeolites. In one or more embodiments disclosed herein, a modified zeolite may include a microporous framework including a plurality of micropores having diameters of less than or equal to 2 nm. The microporous framework may include at least silicon atoms and oxygen atoms. The modified zeolite may further include organometallic moieties each bonded to bridging oxygen atoms. The organometallic moieties may include a platinum atom. The platinum atom may be bonded to a bridging oxygen atom, and the bridging oxygen atom may bridge the platinum atom of the organometallic moiety and a silicon atom of the microporous framework.

19 Claims, 9 Drawing Sheets



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08/04/24



US011591230B2

(12) **United States Patent**
Hodgkins et al.

(10) Patent No.: US 11,591,230 B2**(45) Date of Patent: Feb. 28, 2023**

(54) **MODIFIED ZEOLITES THAT INCLUDE HAFNIUM-CONTAINING ORGANOMETALLIC MOIETIES AND METHODS FOR MAKING SUCH**

(71) Applicants: **Saudi Arabian Oil Company**, Dhahran (SA); **King Abdullah University of Science and Technology**, Thuwal (SA)

(72) Inventors: **Robert Peter Hodgkins**, Dhahran (SA); **Omer Refa Koseoglu**, Dhahran (SA); **Jean-Marie Maurice Basset**, Thuwal (SA); **Kuo-Wei Huang**, Thuwal (SA); **Anissa Bendjeriou Sedjerari**, Thuwal (SA); **Manoj K. Gangwar**, Thuwal (SA); **Sathiyamoorthy Murugesan**, Thuwal (SA)

(73) Assignees: **Saudi Arabian Oil Company**, Dhahran (SA); **King Abdullah University of Science and Technology**, Thuwal (SA)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: 17/231,191

(22) Filed: Apr. 15, 2021

(65) **Prior Publication Data**
US 2022/0332593 A1 Oct. 20, 2022

(51) **Int. Cl.**
C01B 39/40 (2006.01)
B01J 29/40 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC **C01B 39/40** (2013.01); **B01J 29/405** (2013.01); **B01J 35/023** (2013.01);
(Continued)

(58) **Field of Classification Search**

CPC C01B 33/26; C01B 33/28; C01B 33/2807; C01B 33/2869; C01B 39/04; C01B 39/38; C01B 39/40

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,523,506 A 6/1996 Benazzi et al.
7,994,085 B2 8/2011 Chaumonnot et al.
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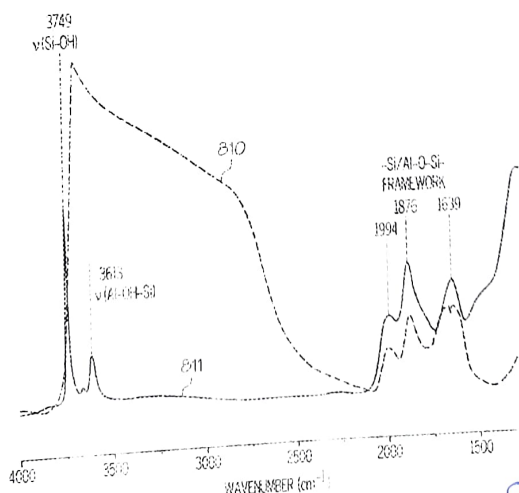
Primary Examiner — Hoa (Holly) Le

(74) Attorney, Agent, or Firm — Dinsmore & Shohl LLP

(57) **ABSTRACT**

Disclosed herein are modified zeolites and methods for making modified zeolites. In one or more embodiments disclosed herein, a modified zeolite may include a microporous framework including a plurality of micropores having diameters of less than or equal to 2 nm. The microporous framework includes at least silicon atoms and oxygen atoms. The modified zeolite may further include organometallic moieties each bonded to bridging oxygen atoms. The organometallic moieties include a hafnium atom. The hafnium atom is bonded to a bridging oxygen atom, and bridging oxygen atom bridges the hafnium atom of the organometallic moiety and a silicon atom of the microporous framework.

20 Claims, 9 Drawing Sheets



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US011591229B2

(12) United States Patent
Hodgkins et al.**(10) Patent No.: US 11,591,229 B2****(45) Date of Patent: Feb. 28, 2023****(54) MODIFIED ZEOLITES THAT INCLUDE
TITANIUM-CONTAINING
ORGANOMETALLIC MOIETIES AND
METHODS FOR MAKING SUCH****(71) Applicants:** Saudi Arabian Oil Company, Dhahran
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Omer Refa Koseoglu, Dhahran (SA);
Jean-Marie Maurice Basset, Thuwal
(SA); Kuo-Wei Huang, Thuwal (SA);
Anissa Bendjeriou Sedjerari, Thuwal
(SA); **Manoj K. Gangwar**, Thuwal
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Thuwal (SA)**(73) Assignees:** Saudi Arabian Oil Company, Dhahran
(SA); King Abdullah University of
Science and Technology, Thuwal (SA)**(*) Notice:** Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 0 days.**(21) Appl. No.: 17/230,500****(22) Filed: Apr. 14, 2021****(65) Prior Publication Data**
US 2022/0340433 A1 Oct. 27, 2022**(51) Int. Cl.**
C01B 39/40 (2006.01)
B01J 29/40 (2006.01)
(Continued)**(52) U.S. Cl.**
CPC **C01B 39/40** (2013.01); **B01J 29/405**
(2013.01); **B01J 35/023** (2013.01);
(Continued)**(58) Field of Classification Search**
CPC C01B 33/26; C01B 33/28; C01B 33/2807;
C01B 33/2869; C01B 39/04; C01B 39/38;
C01B 39/40
See application file for complete search history.**(56) References Cited**

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(Continued)

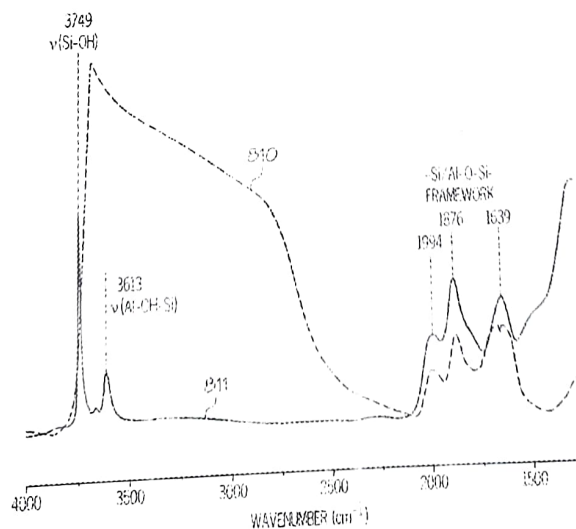
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heterogeneous molecular catalysts, *Coordination Chemistry Reviews*
178-180 (1998) 1679-1702 (Year: 1998) *

(Continued)

Primary Examiner — Hoa (Holly) Le**(74) Attorney, Agent, or Firm** — Dinsmore & Shohl LLP**(57) ABSTRACT**Disclosed herein are modified zeolites and methods for
making modified zeolites. In one or more embodiments
disclosed herein, a modified zeolite may include a micropo-
rous framework comprising a plurality of micropores having
diameters of less than or equal to 2 nm. The microporous
framework may include at least silicon atoms and oxygen
atoms. The modified zeolite may further include organome-
tallic moieties each bonded to bridging oxygen atoms. The
organometallic moieties may include a titanium atom. The
titanium atom may be bonded to a bridging oxygen atom,
and the bridging oxygen atom may bridge the titanium atom
of the organometallic moiety and a silicon atom of the
microporous framework.**20 Claims, 10 Drawing Sheets**Dr. Manoj Kumar Gangwar
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US 20230069248A1

(19) United States

(12) Patent Application Publication

Hodgkins et al.

(10) Pub. No.: US 2023/0069248 A1

(43) Pub. Date:

Mar. 2, 2023

(54) PLATINUM NANOPARTICLE
FUNCTIONALIZED FIBROUS
HIERARCHICAL ZEOLITE AND METHOD
OF MAKING THE SAME

(21) Appl. No.: 17/412,773

(22) Filed Aug. 26, 2021

Publication Classification

(71) Applicants: Saudi Arabian Oil Company, Dhahran
(SA); King Abdullah University of
Science and Technology, Thuwal (SA)

(51) Int. Cl.
C01B 39/48 (2006.01)

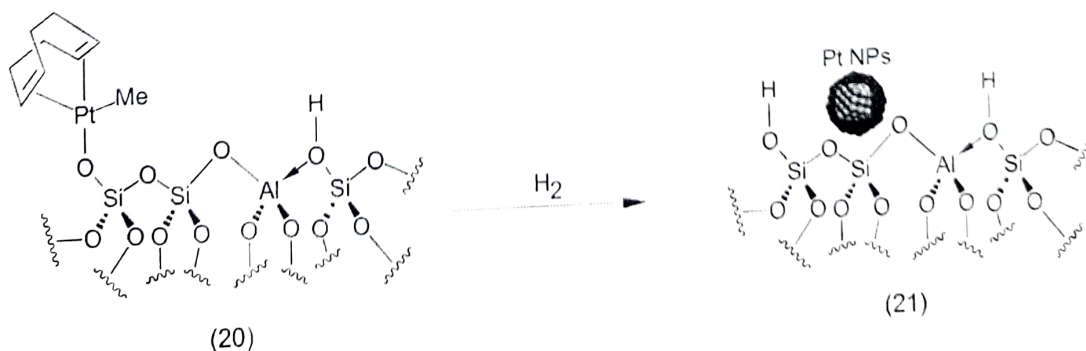
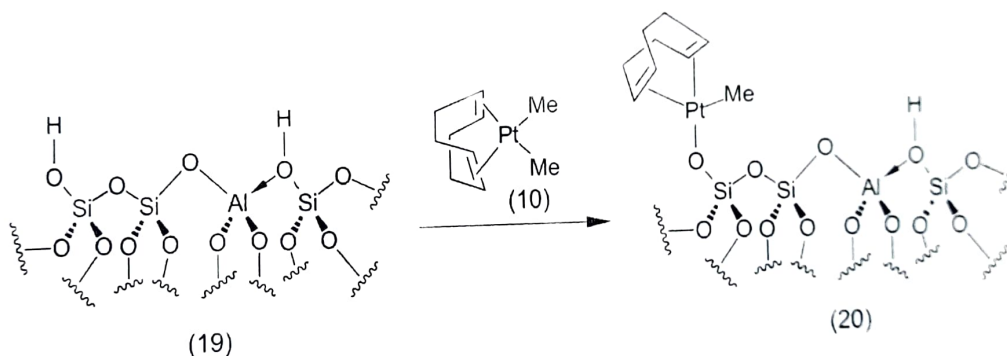
(72) Inventors: Robert Peter Hodgkins, Dhahran (SA);
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Jean-Marie Maurice Basset, Thuwal
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Thuwal (SA); Manoj Kumar Gangwar,
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(52) U.S. Cl.
CPC C01B 39/48 (2013.01);
C01P 2004/64 (2013.01)

(73) Assignees: Saudi Arabian Oil Company, Dhahran
(SA); King Abdullah University of
Science and Technology, Thuwal (SA)

(57) ABSTRACT

A functionalized fibrous hierarchical zeolite includes a framework comprising aluminum atoms, silicon atoms, and oxygen atoms, the framework further comprising a plurality of micropores and a plurality of mesopores. A plurality of nanoparticles comprising platinum are immobilized on the framework.



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US 20230072575A1

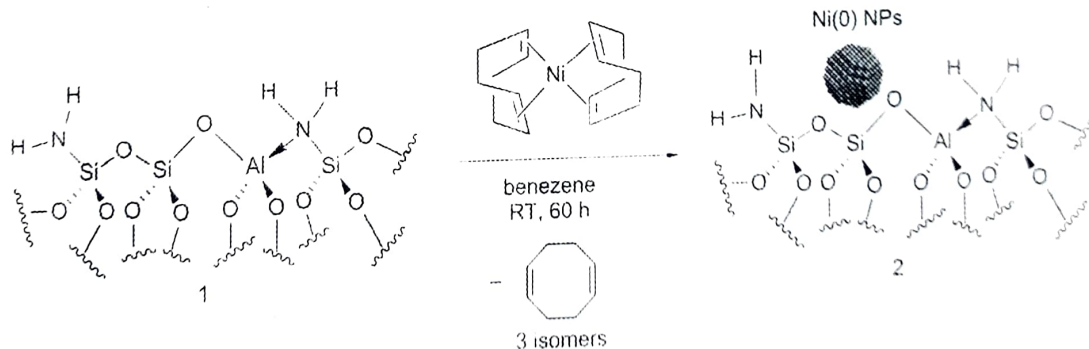
(19) **United States**(12) **Patent Application Publication**
Hodgkins et al.(10) **Pub. No.: US 2023/0072575 A1**(43) **Pub. Date: Mar. 9, 2023**(54) **NICKEL NANOPARTICLE
FUNCTIONALIZED AMINE-MODIFIED
FIBROUS HIERARCHICAL ZEOLITE AND
METHOD OF MAKING THE SAME****Publication Classification**

(51) **Int. Cl.**
C01B 39/02 (2006.01)
C01B 39/40 (2006.01)

(52) **U.S. Cl.**
CPC *C01B 39/026* (2013.01); *C01B 39/40*
(2013.01); *C01P 2002/86* (2013.01); *C01P*
2004/03 (2013.01); *C01P 2002/85* (2013.01);
C01P 2004/04 (2013.01); *C01P 2004/51*
(2013.01)

(71) **Applicants:** Saudi Arabian Oil Company, Dhahran
(SA); King Abdullah University of
Science and Technology, Thuwal (SA)(72) **Inventors:** Robert Peter Hodgkins, Dhahran (SA);
Omer Refa Koseoglu, Dhahran (SA);
Jean-Marie Maurice Basset, Thuwal
(SA); Kuo-Wei Huang, Thuwal (SA);
Anissa Bendjeriou-Sedjerari, Thuwal
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Thuwal (SA); Moussab Harb, Thuwal
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Thuwal (SA)(73) **Assignees:** Saudi Arabian Oil Company, Dhahran
(SA); King Abdullah University of
Science and Technology, Thuwal (SA)(21) **Appl. No.: 17/412,817**(22) **Filed: Aug. 26, 2021**(57) **ABSTRACT**

A functionalized fibrous hierarchical zeolite includes a framework comprising aluminum atoms, silicon atoms, and oxygen atoms, the framework further comprising a plurality of micropores and a plurality of mesopores. The functionalized fibrous hierarchical zeolite is functionalized with at least one amine. A plurality of nanoparticles comprising nickel are immobilized on the framework.



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(19) **United States**(12) **Patent Application Publication**
Hodgkins et al.(10) Pub. No.: **US 2023/0082855 A1**(43) Pub. Date: **Mar. 16, 2023**(54) **PLATINUM NANOPARTICLE
FUNCTIONALIZED AMINE-MODIFIED
FIBROUS HIERARCHICAL ZEOLITE AND
METHOD OF MAKING THE SAME****Publication Classification**

(51) Int. Cl.

C01B 39/02 (2006.01)*C01B 39/40* (2006.01)*C07F 15/00* (2006.01)*C07F 17/02* (2006.01)

(52) U.S. Cl.

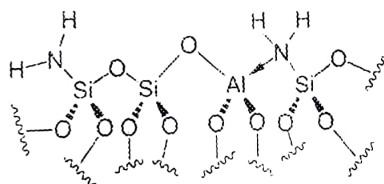
CPC *C01B 39/026* (2013.01); *C01B 39/40*(2013.01); *C07F 15/0086* (2013.01); *C07F**17/02* (2013.01); *C01P 2002/86* (2013.01);*C01P 2002/85* (2013.01); *C01P 2004/03*(2013.01); *C01P 2004/04* (2013.01)(71) Applicants: Saudi Arabian Oil Company, Dhahran
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Science and Technology, Thuwal (SA)(72) Inventors: Robert Peter Hodgkins, Dhahran (SA);
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(21) Appl. No.: 17/412,697

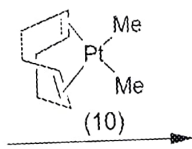
(22) Filed: Aug. 26, 2021

(57) **ABSTRACT**

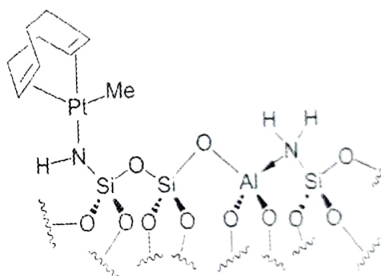
A functionalized fibrous hierarchical zeolite includes a framework comprising aluminum atoms, silicon atoms, and oxygen atoms, the framework further comprising a plurality of micropores and a plurality of mesopores. The functionalized fibrous hierarchical zeolite is functionalized with at least one amine. A plurality of nanoparticles comprising platinum are immobilized on the framework.



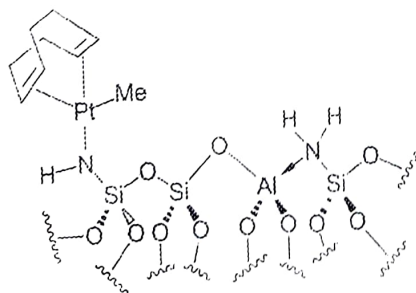
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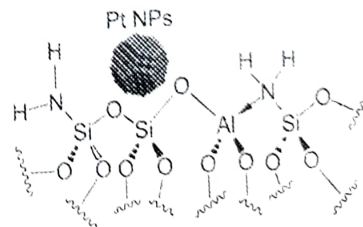
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(19) **United States**(12) **Patent Application Publication**
Hodgkins et al.(10) **Pub. No.: US 2023/0085197 A1**(43) **Pub. Date: Mar. 16, 2023**(54) **PLATINUM ORGANOMETALLIC COMPLEX
FUNCTIONALIZED AMINE-MODIFIED
FIBROUS HIERARCHICAL ZEOLITE AND
METHOD OF MAKING THE SAME**(71) Applicants: **Saudi Arabian Oil Company**, Dhahran
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Science and Technology**, Thuwal (SA)(72) Inventors: **Robert Peter Hodgkins**, Dhahran (SA);
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Anissa Bendjeriou Sedjerari, Thuwal
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(21) Appl. No.: 17/412,732

(22) Filed: Aug. 26, 2021

Publication Classification(51) **Int. Cl.**
C01B 39/02 (2006.01)
C01B 39/40 (2006.01)
C07F 15/00 (2006.01)
(52) **U.S. Cl.**
CPC **C01B 39/026** (2013.01); **C01B 39/40**
(2013.01); **C07F 15/0086** (2013.01); **C01P**
2002/86 (2013.01)(57) **ABSTRACT**

A functionalized fibrous hierarchical zeolite includes a framework comprising aluminum atoms, silicon atoms, and oxygen atoms, the framework further comprising a plurality of micropores and a plurality of mesopores. The functionalized fibrous hierarchical zeolite is functionalized with at least one terminal amine bonded to a silicon atom. Terminal organometallic functionalities are bonded to a nitrogen atom of the at least one terminal amine, the terminal organometallic functionalities comprising a platinum atom.

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(19) **United States**(12) **Patent Application Publication**
Hodgkins et al.(10) **Pub. No.: US 2023/0078677 A1**(43) **Pub. Date: Mar. 16, 2023**(54) **NON-BRØNSTED FIBROUS HIERARCHICAL
ZEOLITE AND METHOD OF MAKING THE
SAME**

(21) Appl. No.: 17/412,807

(22) Filed: Aug. 26, 2021

(71) Applicants: Saudi Arabian Oil Company, Dhahran
(SA); King Abdullah University of
Science and Technology, Thuwal (SA)**Publication Classification**(51) **Int. Cl.**
C01B 39/02 (2006.01)
C01B 39/40 (2006.01)(52) **U.S. Cl.**
CPC **C01B 39/026** (2013.01); **C01B 39/40**
(2013.01); **C01P 2002/72** (2013.01)(72) Inventors: Robert Peter Hodgkins, Dhahran (SA);
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Jean-Marie Maurice Basset, Thuwal
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Anissa Bendjeriou Sedjerari, Thuwal
(SA); Sathiyamoorthy Murugesan,
Thuwal (SA); Manoj Kumar
Gangwar, Thuwal (SA); Rajesh
Kumar Parsapur, Thuwal (SA)(57) **ABSTRACT**

A fibrous hierarchical zeolite includes a framework comprising aluminum atoms, silicon atoms, and oxygen atoms, the framework further comprising a plurality of micropores and a plurality of mesopores. The framework comprises no Brønsted acid activity.

(73) Assignees: Saudi Arabian Oil Company, Dhahran
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(19) **United States**(12) **Patent Application Publication** (10) **Pub. No.: US 2023/0104591 A1**

Hodgkins et al.

(43) **Pub. Date:****Apr. 6, 2023**

(54) **NICKEL NANOPARTICLE
FUNCTIONALIZED FIBROUS
HIERARCHICAL ZEOLITE AND METHOD
OF MAKING THE SAME**

(21) Appl. No.: 17/412,748

(22) Filed: Aug. 26, 2021

(71) Applicants: Saudi Arabian Oil Company, Dhahran
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(72) Inventors: Robert Peter Hodgkins, Dhahran (SA);
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(73) Assignees: Saudi Arabian Oil Company, Dhahran
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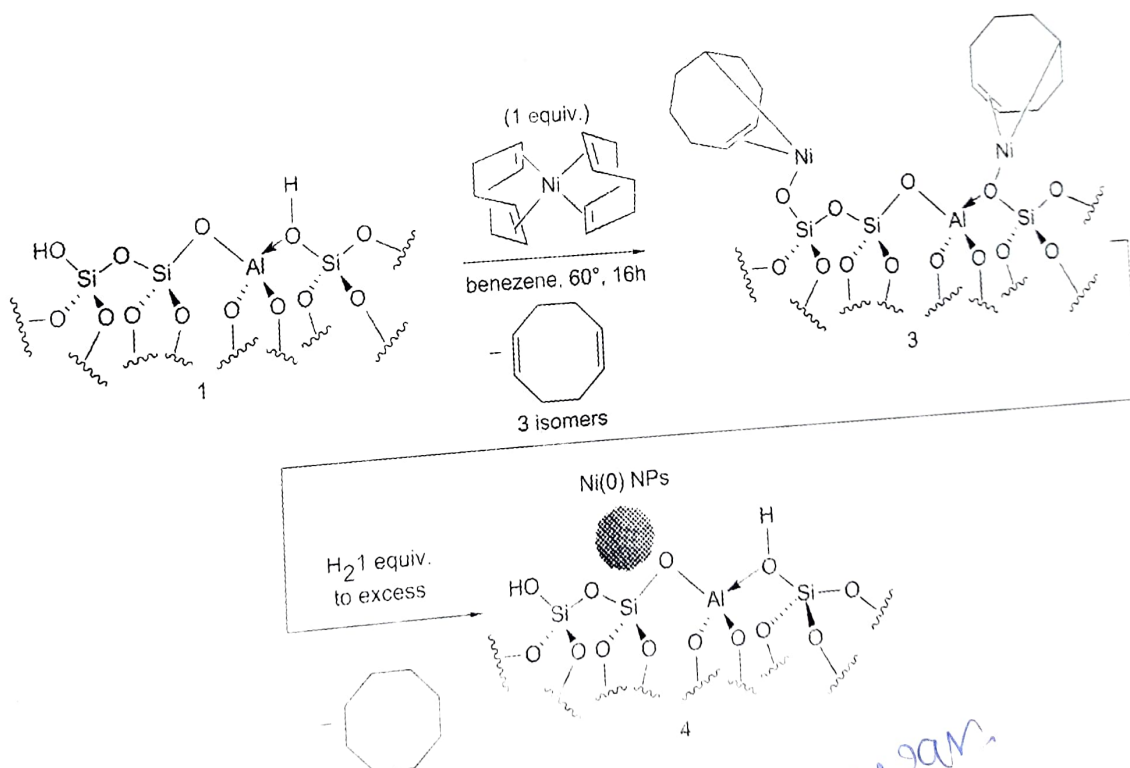
Publication Classification

(51) Int. Cl.
C07F 15/04 (2006.01)
C01B 39/38 (2006.01)

(52) U.S. Cl.
CPC C07F 15/04 (2013.01); C01B 39/38
(2013.01); B82Y 30/00 (2013.01)

ABSTRACT

A functionalized fibrous hierarchical zeolite includes a framework comprising aluminum atoms, silicon atoms, and oxygen atoms, the framework further comprising a plurality of micropores and a plurality of mesopores. A plurality of nanoparticles comprising nickel are immobilized on the framework.



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(19) **United States**(12) **Patent Application Publication**
Hodgkins et al.(10) **Pub. No.: US 2023/0159343 A1**(43) **Pub. Date: May 25, 2023**(54) **MODIFIED ZEOLITES THAT INCLUDE
TITANIUM-CONTAINING
ORGANOMETALLIC MOIETIES AND
METHODS FOR MAKING SUCH***B01J 35/02* (2006.01)*B01J 37/16* (2006.01)*B01J 37/02* (2006.01)*C01B 39/02* (2006.01)(71) Applicants: Saudi Arabian Oil Company, Dhahran
(SA); King Abdullah University of
Science and Technology, Thuwal (SA)(52) **U.S. Cl.***CPC* *C01B 39/40* (2013.01); *B01J 29/405*
(2013.01); *B01J 35/1061* (2013.01); *B01J*
35/1066 (2013.01); *B01J 35/023* (2013.01);
B01J 37/16 (2013.01); *B01J 37/0203*
(2013.01); *C01B 39/026* (2013.01); *C01P*
2004/64 (2013.01); *C01P 2002/72* (2013.01);
C01P 2004/04 (2013.01); *C01P 2004/03*
(2013.01); *C01P 2002/82* (2013.01); *C01P*
2002/86 (2013.01); *C01P 2006/16* (2013.01);
C01P 2004/62 (2013.01)(72) Inventors: Robert Peter Hodgkins, Dhahran (SA);
Omer Refa Koseoglu, Dhahran (SA);
Jean-Marie Maurice Basset, Thuwal
(SA); Kuo-Wei Huang, Thuwal (SA);
Anissa Bendjeriou Sedjerari, Thuwal
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(57)

ABSTRACT

(21) Appl. No.: 18/101,923

(22) Filed: Jan. 26, 2023

Related U.S. Application Data(62) Division of application No. 17/230,500, filed on Apr.
14, 2021, now Pat. No. 11,591,229.**Publication Classification**(51) **Int. Cl.**
C01B 39/40 (2006.01)
B01J 29/40 (2006.01)
B01J 35/10 (2006.01)

Disclosed herein are modified zeolites and methods for making modified zeolites. In one or more embodiments disclosed herein, a modified zeolite may include a microporous framework comprising a plurality of micropores having diameters of less than or equal to 2 nm. The microporous framework may include at least silicon atoms and oxygen atoms. The modified zeolite may further include organometallic moieties each bonded to bridging oxygen atoms. The organometallic moieties may include a titanium atom. The titanium atom may be bonded to a bridging oxygen atom, and the bridging oxygen atom may bridge the titanium atom of the organometallic moiety and a silicon atom of the microporous framework.

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(19) **United States**(12) **Patent Application Publication**
Hodgkins et al.(10) **Pub. No.: US 2023/0174383 A1**(43) **Pub. Date: Jun. 8, 2023**(54) **MODIFIED ZEOLITES THAT INCLUDE
HAFNIUM-CONTAINING
ORGANOMETALLIC MOIETIES AND
METHODS FOR MAKING SUCH***B01J 35/10* (2006.01)
B01J 37/02 (2006.01)
B01J 37/16 (2006.01)
C01B 39/02 (2006.01)
B01J 29/40 (2006.01)(71) Applicants: **Saudi Arabian Oil Company, Dhahran
(SA); King Abdullah University of
Science and Technology, Thuwal (SA)**(52) **U.S. Cl.****CPC** *C01B 39/40* (2013.01); *B01J 35/023*
(2013.01); *B01J 35/1061* (2013.01); *B01J*
35/1066 (2013.01); *B01J 37/0203* (2013.01);
B01J 37/16 (2013.01); *C01B 39/026*
(2013.01); *B01J 29/405* (2013.01); *C01P*
2006/16 (2013.01); *C01P 2002/70* (2013.01);
C01P 2002/82 (2013.01); *C01P 2002/86*
(2013.01); *C01P 2004/03* (2013.01); *C01P*
2004/04 (2013.01); *C01P 2004/62* (2013.01);
C01P 2004/64 (2013.01)(72) Inventors: **Robert Peter Hodgkins, Dhahran (SA);
Omer Refa Koseoglu, Dhahran (SA);
Jean-Marie Maurice Basset, Thuwal
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Anissa Bendjeriou Sedjerari, Thuwal
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Thuwal (SA)**(73) Assignees: **Saudi Arabian Oil Company, Dhahran
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(57)

ABSTRACT(21) Appl. No.: **18/101,963**(22) Filed: **Jan. 26, 2023****Related U.S. Application Data**(62) Division of application No. 17/231,191, filed on Apr.
15, 2021, now Pat. No. 11,591,230.**Publication Classification**(51) **Int. Cl.**
C01B 39/40 (2006.01)
B01J 35/02 (2006.01)

Disclosed herein are modified zeolites and methods for making modified zeolites. In one or more embodiments disclosed herein, a modified zeolite may include a microporous framework including a plurality of micropores having diameters of less than or equal to 2 nm. The microporous framework includes at least silicon atoms and oxygen atoms. The modified zeolite may further include organometallic moieties each bonded to bridging oxygen atoms. The organometallic moieties include a hafnium atom. The hafnium atom is bonded to a bridging oxygen atom, and bridging oxygen atom bridges the hafnium atom of the organometallic moiety and a silicon atom of the microporous framework.

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US011731881B2

(12) **United States Patent**
Hodgkins et al.

(10) **Patent No.:** **US 11,731,881 B2**(45) **Date of Patent:** **Aug. 22, 2023**

(54) **MODIFIED ZEOLITES THAT INCLUDE ZIRCONIUM-CONTAINING ORGANOMETALLIC MOIETIES AND METHODS FOR MAKING SUCH**

(71) **Applicants:** Saudi Arabian Oil Company, Dhahran (SA); King Abdullah University of Science and Technology, Thuwal (SA)

(72) **Inventors:** Robert Peter Hodgkins, Dhahran (SA); Omer Refa Koscoglu, Dhahran (SA); Jean-Marie Maurice Basset, Thuwal (SA); Kuo-Wei Huang, Thuwal (SA); Anissa Bendjeriou Sedjerari, Thuwal (SA); Sathiyamoorthy Murugesan, Thuwal (SA); **Manoj K. Gangwar, Thuwal (SA)**

(73) **Assignees:** Saudi Arabian Oil Company, Dhahran (SA); King Abdullah University of Science and Technology, Thuwal (SA)

(*) **Notice:** Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 294 days.

(21) **Appl. No.:** 17/230,491

(22) **Filed:** Apr. 14, 2021

(65) **Prior Publication Data**
US 2022/0348474 A1 Nov. 3, 2022

(51) **Int. Cl.**
C01B 39/40 (2006.01)
C01B 39/02 (2006.01)
B01J 29/40 (2006.01)

(52) **U.S. Cl.**
CPC **C01B 39/026** (2013.01); **B01J 29/405** (2013.01); **C01B 39/40** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC C01B 39/04; C01B 39/40; C01B 33/26; C01B 33/28; C01B 33/2807; C01P 2006/16

See application file for complete search history.

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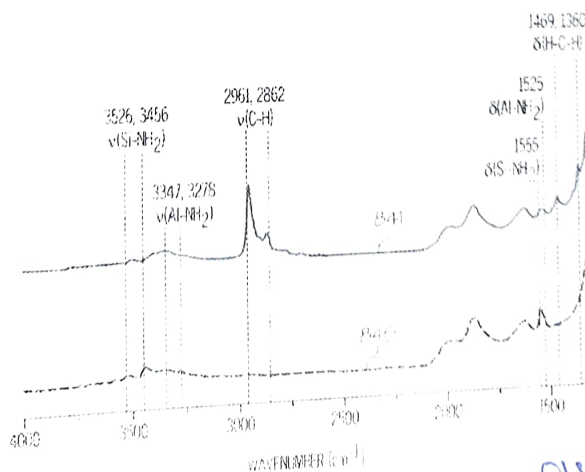
Primary Examiner Hoa (Holly) Le

(74) *Attorney, Agent, or Firm* — Dinsmore & Shohl LLP

(57)

ABSTRACT

Disclosed herein are modified zeolites and methods for making modified zeolites. In one or more embodiments disclosed herein, a modified zeolite may include a microporous framework including a plurality of micropores having diameters of less than or equal to 2 nm. The microporous framework may include at least silicon atoms and oxygen atoms. The modified zeolite may further include organometallic moieties each bonded to a nitrogen atom of a secondary amine functional group including a nitrogen atom and a hydrogen atom. The organometallic moieties may include a zirconium atom that is bonded to the nitrogen atom of the secondary amine functional group. The nitrogen atom of the secondary amine function group may bridge the zirconium atom of the organometallic moiety and a silicon atom of the microporous framework.

20 Claims, 14 Drawing Sheets

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Intellectual
Property
Office

Certificate of Registration for a UK Design

Design number: 6308751

Grant date: 20 November 2023

Registration date: 08 September 2023

This is to certify that,

in pursuance of and subject to the provision of Registered Designs Act 1949, the design of which a representation or specimen is attached, had been registered as of the date of registration shown above in the name of

Dr. Shikha Banerjee, Dr. Sunita Minz, Dr. Poonam Pandey, Dr. Devi Prasad

Singh, Dr. Saummya Tiwari

in respect of the application of such design to:

Electronic Teaching Device

International Design Classification:

Version: 14-2023

Class: 19 STATIONERY AND OFFICE EQUIPMENT, ARTISTS' AND
TEACHING MATERIALS

Subclass: 07 TEACHING MATERIALS AND APPARATUS

Version: 14-2023

Class: 14 RECORDING, TELECOMMUNICATION OR DATA PROCESSING
EQUIPMENT

Subclass: 02 DATA PROCESSING EQUIPMENT AS WELL AS PERIPHERAL
APPARATUS AND DEVICES

Adam Williams

Comptroller-General of Patents, Designs and Trade Marks
Intellectual Property Office

The attention of the Proprietor(s) is drawn to the important notes overleaf.



Intellectual Property Office is an operating name of the Patent Office

www.gov.uk/ipa

(12) PATENT APPLICATION PUBLICATION.

(19) INDIA

(22) Date of filing of Application : 14/09/2023

(21) Application No. 202331061770 A

(43) Publication Date : 06/10/2023

(54) Title of the invention : SYSTEMATIC APPROACH TO ANALYZE THE IMPACT OF DESIGN THINKING AS AN EFFECTIVE METHOD FOR PROBLEM SETTING AND NEED FINDING FOR ENTREPRENEURIAL TEAMS ADDRESSING WICKED PROBLEMS

(51) International classification : G06N0005040000, G06Q0010060000, B33Y0050020000, G06F0030331000, G06Q0010080000
(86) International Application No : PCT//
Filing Date : 01/01/1900
(87) International Publication No : NA
(61) Patent of Addition to Application Number : NA
Filing Date : NA
(62) Divisional to Application Number : NA
Filing Date : NA

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4) Dr. Archana Singh

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6) Dr. Savitha Velaayutham

7) Vatsal Kumar Parasar

8) K. Bharadwaja

9) P. Anjaiah

10) N. Premalatha

11) Dr. Vishal Ratansing Patil

12) Romala Vijaya Srinivas

Name of Applicant : NA

Address of Applicant : NA

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(57) Abstract :
SYSTEMATIC APPROACH TO ANALYZE THE IMPACT OF DESIGN THINKING AS AN EFFECTIVE METHOD FOR PROBLEM SETTING AND NEED FINDING FOR ENTREPRENEURIAL TEAMS ADDRESSING WICKED PROBLEMS-A systematic approach to analyze the impact of design thinking as an effective method for problem setting and need finding for entrepreneurial teams addressing wicked problems. The system comprises components of inspiration, ideation, and implementation (Brown, 2009) serve as the foundation of this hybrid model, shapes as a non-sequential, innovative method to interpret and address complex problems, thinking, forming a hypothesis from abduction reasoning and the examination is performed using that deduction, a sequence of phases linking through ideation and then prototyping, two forces of learning that processes reality and transforming it within each tangible and intangible component and creates a streamlined and flexible framework, where the innovation may occur in a non-sequential order, dictated by the needs of the problem FIG.1

No. of Pages : 11 No. of Claims : 1

The Patent Office Journal No. 40/2023 Dated 06/10/2023

67334

(12) PATENT APPLICATION PUBLICATION

(21) Application No.202311058894 A

(19) INDIA

(22) Date of filing of Application :01/09/2023

(43) Publication Date : 06/10/2023

(54) Title of the invention : AI-DRIVEN HYBRID DECISION-MAKING FRAMEWORK FOR ANALYSIS AND PREDICTION OF BUSINESS VALUE MAXIMIZATION

(51) International classification :G06Q0010060000, G06N0020000000, G06N0005040000, G16H10050200000, G06N00050200000
(86) International Application No :NA
Filing Date :NA
(87) International Publication No :NA
(61) Patent of Addition to Application Number :NA
Filing Date :NA
(62) Divisional to Application Number :NA
Filing Date :NA

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4)Dr. Subodh Kumar Dwivedi
5)S Shireesha
6)Kaushik V S
7)Dr. C Sowmya Dhanalakshmi
8)Dr. Kamal Kant
9)Dr. Abhishek Dwivedi
10)Dinesh E
11)Dr. B Amarnath Reddy
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(57) Abstract :
A system and method are disclosed for utilizing an AI-driven hybrid decision-making framework to analyze and predict business value maximization. The framework integrates machine learning algorithms, data analytics, and expert knowledge to provide comprehensive insights for decision-makers. The system assists in evaluating various business strategies and predicting their impact on value creation, enhancing overall decision-making processes.

No. of Pages : 13 No. of Claims : 6

पेटेंट कार्यालय
शासकीय जर्नल

**OFFICIAL JOURNAL
OF
THE PATENT OFFICE**

निर्गमन सं. 43/2022
ISSUE NO. 43/2022

शुक्रवार
FRIDAY

दिनांक: 28/10/2022
DATE: 28/10/2022

पेटेंट कार्यालय का एक प्रकाशन
PUBLICATION OF THE PATENT OFFICE

The Patent Office Journal No. 43/2022 Dated 28/10/2022

68696

(12) PATENT APPLICATION PUBLICATION

(19) INDIA

(22) Date of filing of Application : 25/10/2022

(21) Application No. 202211060701 A

(43) Publication Date : 28/10/2022

(54) Title of the invention : MULTIWALLED CARBON NANOTUBE MEMBRANE BASED AIR FILTER

(51) International classification : B01D0020280000, B01D0039000000, B82Y0030000000, G01N0033487000, B82Y0015000000

(86) International Application No : NA
Filing Date : NA

(87) International Publication No : NA

(61) Patent of Addition to Application Number : NA
Filing Date : NA

(62) Divisional to Application Number : NA
Filing Date : NA

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4) Dr. Rajiv Giri

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(57) Abstract :

The present invention relates to the multi-walled carbon nanotubes (MWCNTs) membrane-based air filter, with an effective and long-lasting FPMs, PAHs- BAP, and HM filters using a high surface area, nano porous, thermally stable MWCNTs membrane. The said nanomembranes are made up of randomly distributed MWCNTs, resulting in large surface areas and better filtration performance for a wide range of particle sizes (FPMs0.3), PAHs, and HM (Ni and Cd), within pressure differentials, light weight, thin, high thermal stable, nanopore size, packing density, porosity.

No. of Pages : 60 No. of Claims : 5



पेटेंट कार्यालय, भारत सरकार

The Patent Office, Government Of India

पेटेंट प्रमाण पत्र

Patent Certificate

(पेटेंट नियमावली का नियम 74)

(Rule 74 of The Patents Rules)

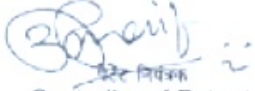
पेटेंट सं. / Patent No. : 461617
आवेदन सं. / Application No. : 202211060701
फाइल करने की तारीख / Date of Filing : 25/10/2022
पेटेंटी / Patentee : Banaras Hindu University
आविष्कारकों का नाम / Name of Inventor(s) : 1. Prof. Anchal Srivastava 2. Pramod Kumar Vishwakarma
3. Sumit Kumar Pandey 4. Dr. Rajiv Giri

प्रमाणित किया जाता है कि पेटेंटी को, उपरोक्त आवेदन में यथाप्रकटित *MULTIWALLED CARBON NANOTUBE MEMBRANE BASED AIR FILTER* नामक आविष्कार के लिए, पेटेंट अधिनियम, 1970 के उपबंधों के अनुसार आज तारीख अक्टूबर 2022 के पच्चीसवें दिन से बीस वर्ष की अवधि के लिए पेटेंट अनुदत्त किया गया है।

It is hereby certified that a patent has been granted to the patentee for an invention entitled *MULTIWALLED CARBON NANOTUBE MEMBRANE BASED AIR FILTER* as disclosed in the above mentioned application for the term of 20 years from the 25th day of October 2022 in accordance with the provisions of the Patents Act, 1970.



अनुदान की तारीख : 23/10/2023
Date of Grant :


पेटेंट नियंत्रक
Controller of Patents

टिप्पणी - इस पेटेंट के नवीकरण के लिए फीस, यदि इसे बनाए रखा जाना है, अक्टूबर 2024 के पच्चीसवें दिन को और उसके पश्चात प्रत्येक वर्ष से उसी दिन देय होगी।

Note. - The fees for renewal of this patent, if it is to be maintained, will fall / has fallen due on 25th day of October 2024 and on the same day in every year thereafter.



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सत्यमेव जयते

क्रम सं/SL No : 011171698



पेटेंट कार्यालय, भारत सरकार

The Patent Office, Government Of India

पेटेंट प्रमाण पत्र

Patent Certificate

(पेटेंट नियमावली का नियम 74)

(Rule 74 of The Patents Rules)

पेटेंट सं. / Patent No.

455623

आवेदन सं. / Application No.

201911012319

फाइल करने की तारीख / Date of Filing

29/03/2019

पेटेंटी / Patentee

DR. AMMATUL FATIMA

प्रमाणित किया जाता है कि पेटेंटी को, उपरोक्त आवेदन में यथाप्रकरित **INVENTION OF COOKIES FORTIFIED WITH SPIRULINA ALGAE** नामक आविष्कार के लिए, पेटेंट अधिनियम, 1970 के उपबंधों के अनुसार आज तारीख मार्च 2019 के उन्नीसवें दिन से बीस वर्ष की अवधि के लिए पेटेंट अनुदत्त किया गया है।

It is hereby certified that a patent has been granted to the patentee for an invention entitled **INVENTION OF COOKIES FORTIFIED WITH SPIRULINA ALGAE** as disclosed in the above mentioned application for the term of 20 years from the 29th day of March 2019 in accordance with the provisions of the Patents Act, 1970.



(Signature)

Controller of Patents

अनुदान की तारीख : 29/09/2023
Date of Grant :

टिप्पणी - इस पेटेंट के नवीकरण के लिए फीस, यदि इसे बनाए रखा जाना है, मार्च 2021 के उन्नीसवें दिन को और उसके पश्चात प्रत्येक वर्ष में उसी दिन देय होगी।

Note - The fees for renewal of this patent, if it is to be maintained, will fall / has fallen due on 29th day of March 2021 and on the same day in every year thereafter.

(12) PATENT APPLICATION PUBLICATION

(21) Application No.202211070192 A

(19) INDIA

(22) Date of filing of Application :05/12/2022

(43) Publication Date : 13/10/2023

(54) Title of the invention : ECO-FRIENDLY SYNTHETIC BEADS FOR REMOVAL OF HEXAVALENT CHROMIUM FROM WASTEWATER AND METHOD OF SYNTHESIS THEREOF

(51) International classification	:C02F0001280000, C02F0101220000, C02F0001400000, C02F0003100000, C10L0005440000	(71)Name of Applicant : 1)INDIAN INSTITUTE OF TECHNOLOGY (BANARAS HINDU UNIVERSITY), VARANASI Address of Applicant :Varanasi-221005, Uttar Pradesh, India Varanasi ----- Name of Applicant : NA Address of Applicant : NA
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Filing Date	:NA	2)VEER SINGH Address of Applicant :chool of Biochemical Engineering, Indian Institute of Technology, Banaras Hindu University, Varanasi-221005, Uttar Pradesh, India Varanasi -----
(87) International Publication No	: NA	3)MOHAN PRASAD SINGH Address of Applicant :Centre of Biotechnology, University of Allahabad, Prayagraj – 211002, Uttar Pradesh, India Prayagraj ---- -----
(61) Patent of Addition to Application Number	:NA	
Filing Date	:NA	
(62) Divisional to Application Number	:NA	
Filing Date	:NA	

(57) Abstract :

ABSTRACT “ECO-FRIENDLY SYNTHETIC BEADS FOR REMOVAL OF HEXAVALENT CHROMIUM FROM WASTEWATER AND METHOD OF SYNTHESIS THEREOF” The present invention relates to eco-friendly synthetic beads prepared from biological waste for removal of hexavalent chromium from wastewater. These synthetic beads remove total hexavalent chromium contamination from water. The beads are prepared from the mixed biomass of rice husk, Pleurotus florida biomass and Citrus limetta peels biomass. The preparation method of these beads is very simple and these beads showed high Cr (VI) removal efficiency. The prepared beads are small in size and eco-friendly. These beads also remain stable in the water solution during water treatment. These beads are easily separable from aqueous solution after Cr (VI) removal. Figures 1 (a) and 1(b) on sheet no. 1 of the drawings may accompany the abstract when published.

No. of Pages : 14 No. of Claims : 7



US 20230407302A1

(19) **United States**(12) **Patent Application Publication**
Hussain et al.(10) **Pub. No.: US 2023/0407302 A1**(43) **Pub. Date: Dec. 21, 2023**(54) **NOVEL EFFICACIOUS MICRORNA-30C ANALOGS REDUCE APOLIPOPROTEIN B SECRETION IN HUMAN LIVER CELLS**(71) Applicants: **New York University**, New York, NY (US); **The Research Foundation for the State University of New York**, Albany, NY (US); **The United States Government as represented by the Department of Veterans Affairs**, Washington, DC (US)(72) Inventors: **Mahmood Hussain**, Woodbury, NY (US); **Jia Sheng**, Schenectady, NY (US); **Pradeep Kumar Yadav**, Varanasi (IN); **Phensinee Haruehanroengra**, Billerica, MA (US)(21) Appl. No.: **18/164,699**(22) Filed: **Feb. 6, 2023****Related U.S. Application Data**

(60) Provisional application No. 63/306,726, filed on Feb. 4, 2022.

Publication Classification(51) **Int. Cl.**
C12N 15/113 (2006.01)(52) **U.S. Cl.**
CPC **C12N 15/113** (2013.01); **C12N 2310/141** (2013.01); **C12N 2310/321** (2013.01); **C12N 2310/351** (2013.01); **C12N 2310/315** (2013.01)(57) **ABSTRACT**

Provided are potent miR-30c analogs that can be delivered to hepatoma cells without the aid of viral vectors and lipid emulsions. The miR-30c analogs contain an unmodified active sense strand and a modified passenger strand to enhance the stability and uptake of miR-30c by hepatoma cells. The miR-30c analogs are for use in treatment of hyperlipidemias and cardiovascular diseases.

Specification includes a Sequence Listing.

(D)

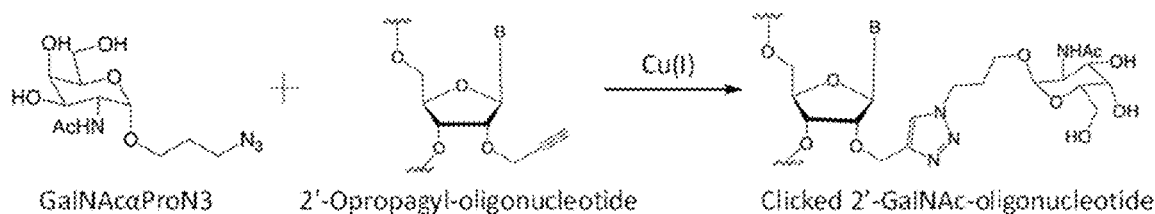


Figure 1

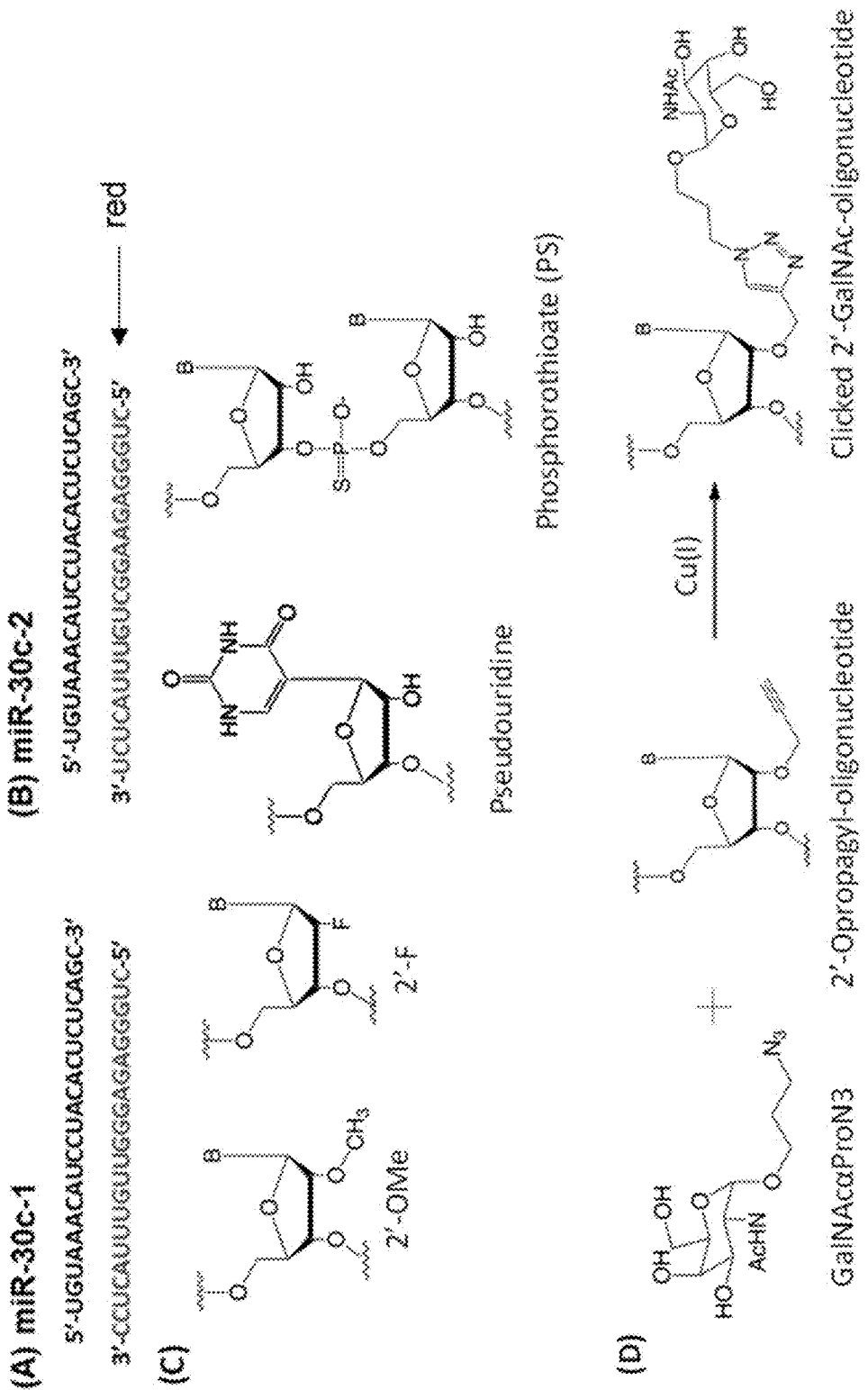


Figure 2

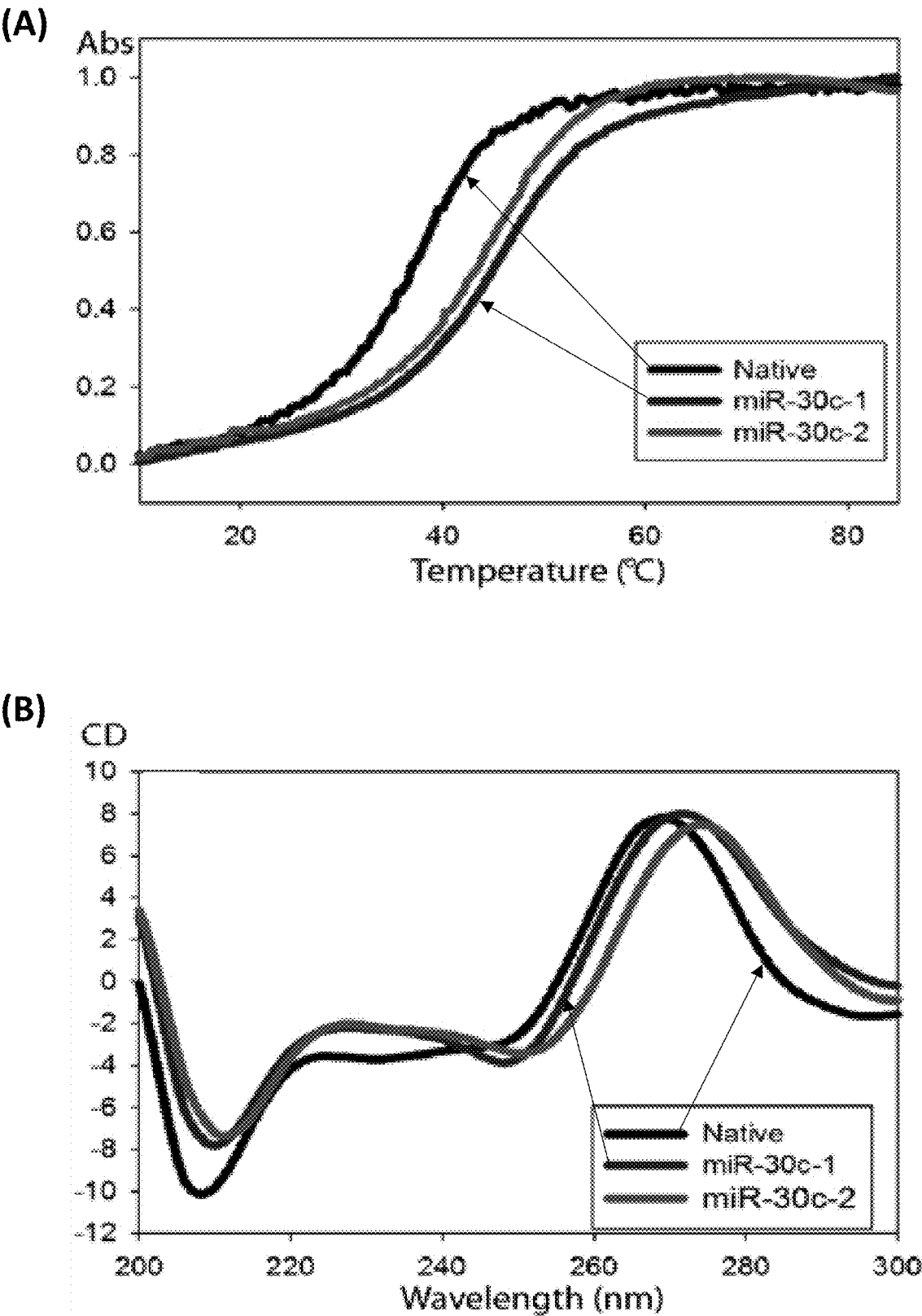


Figure 3

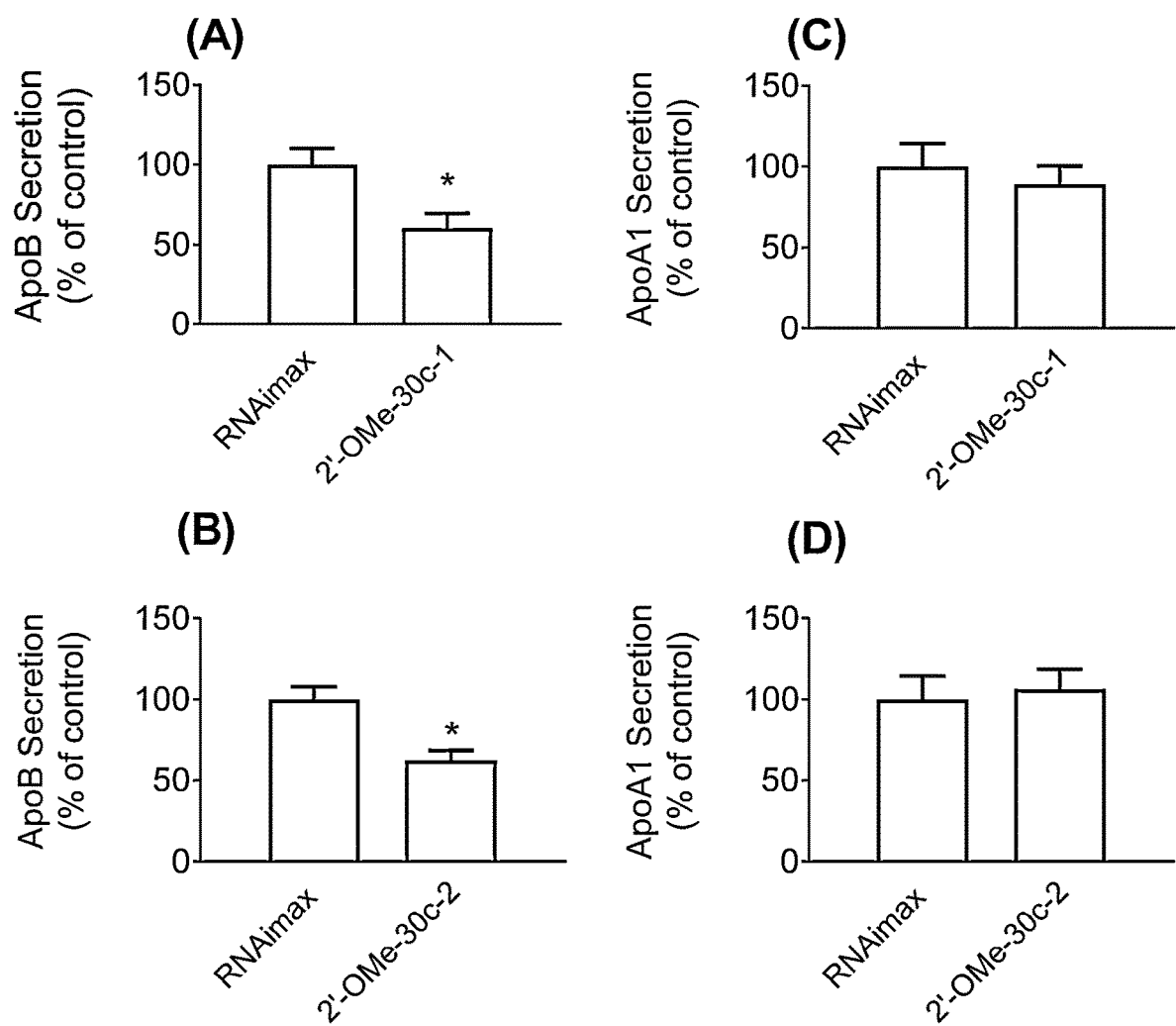
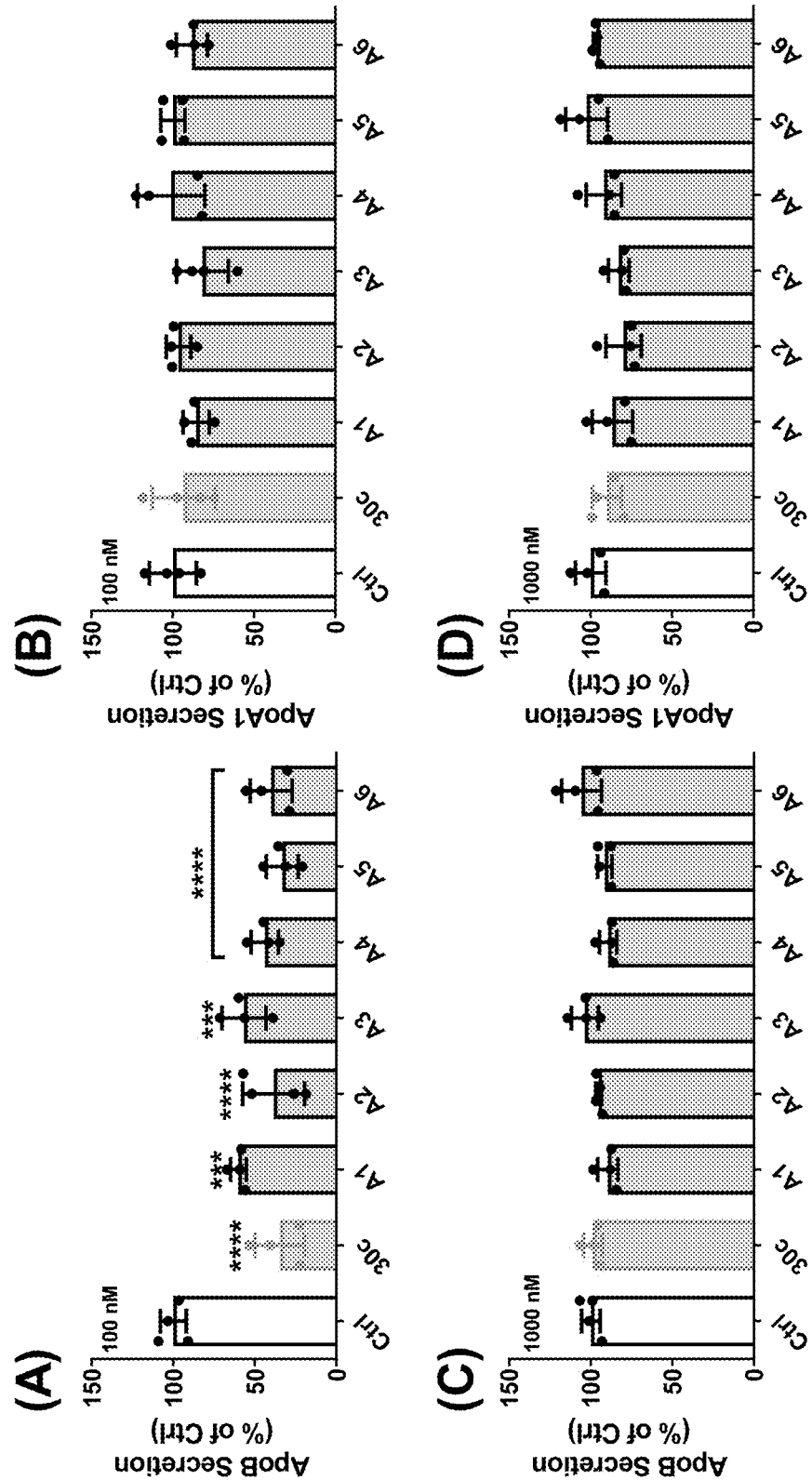


Figure 4



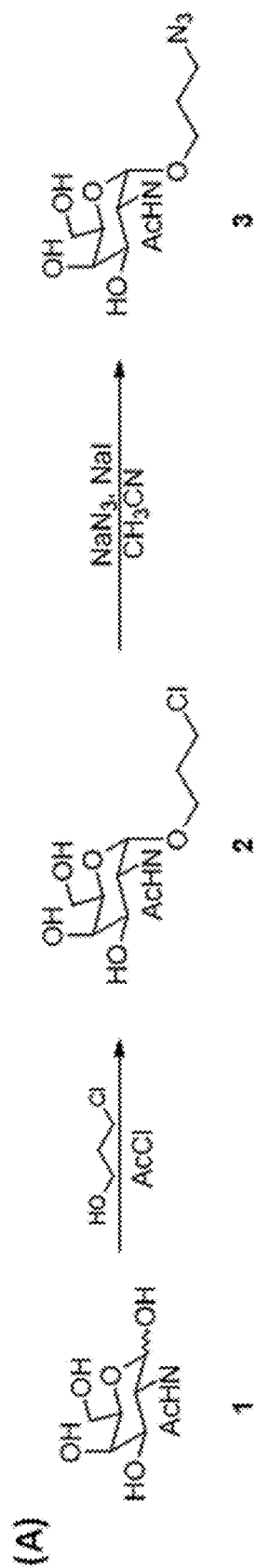
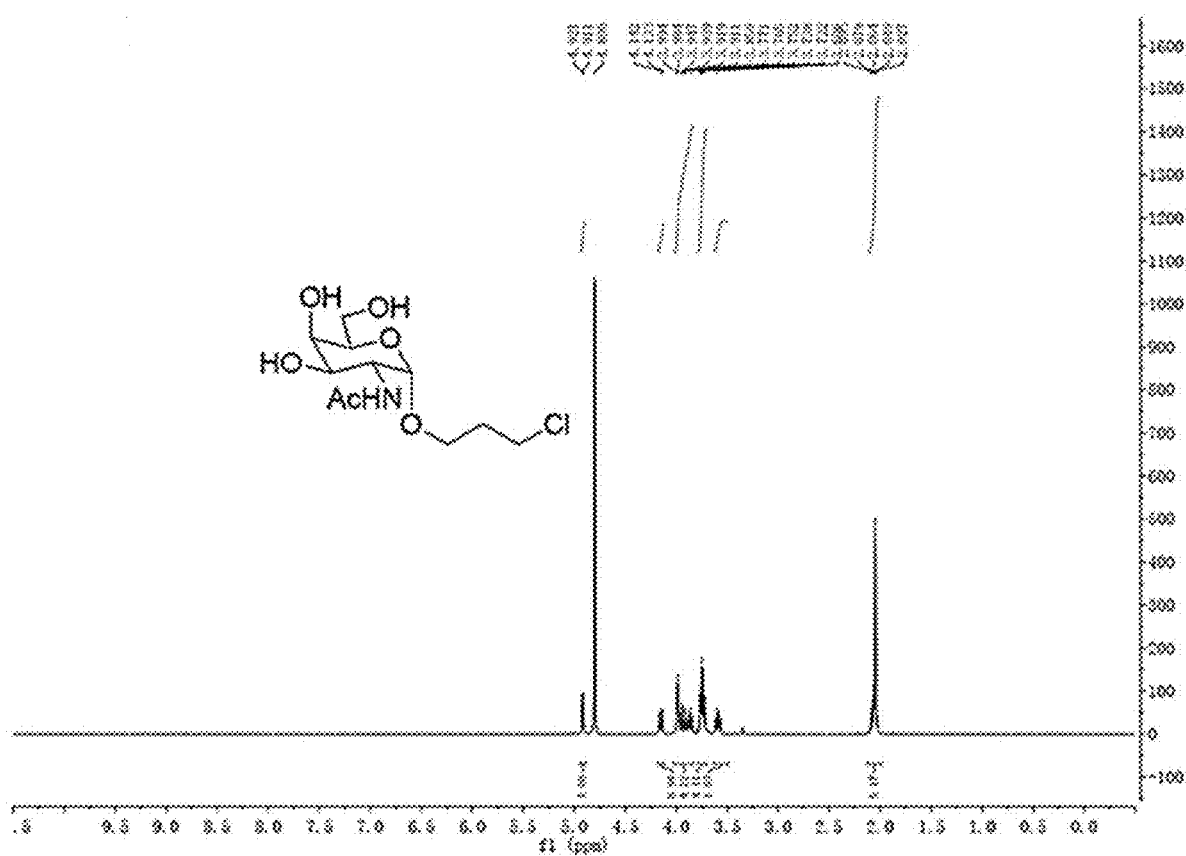
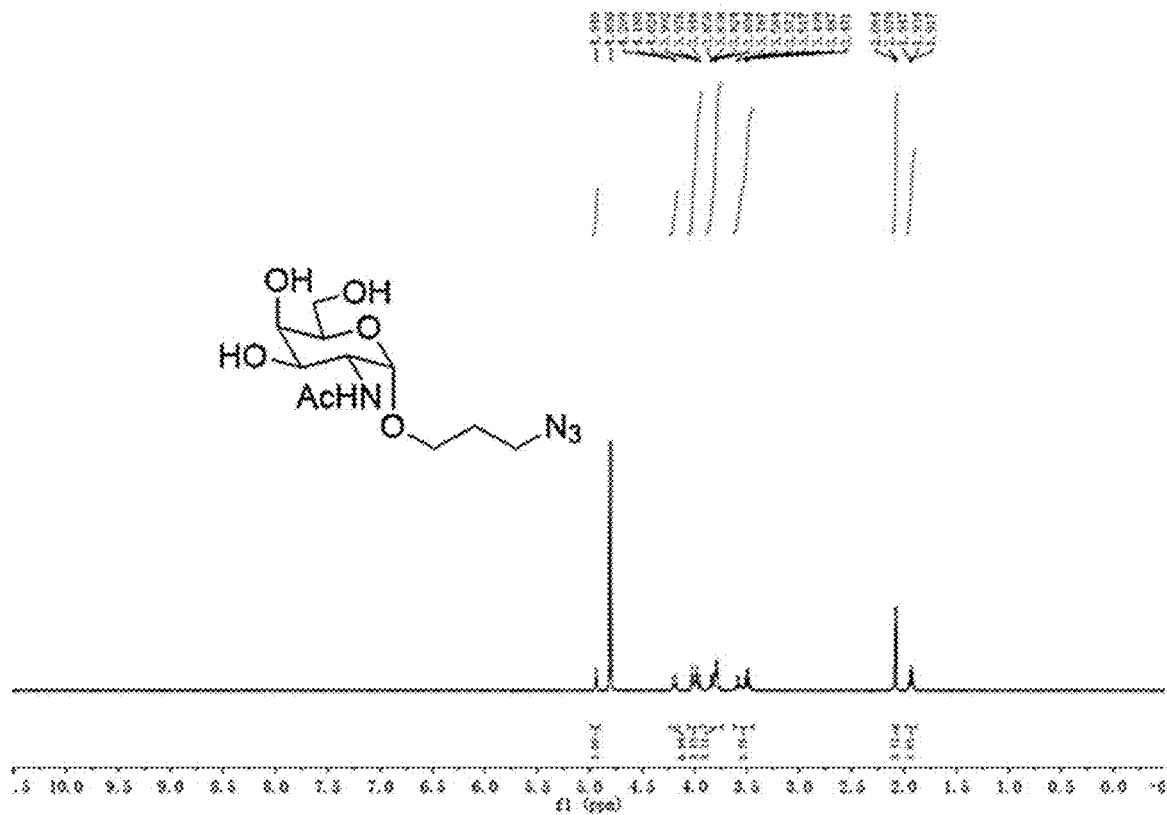


Figure 5

Figure 5 (continued)

(B) ^1H NMR of 3-Chloropropyl GalNAc (2)

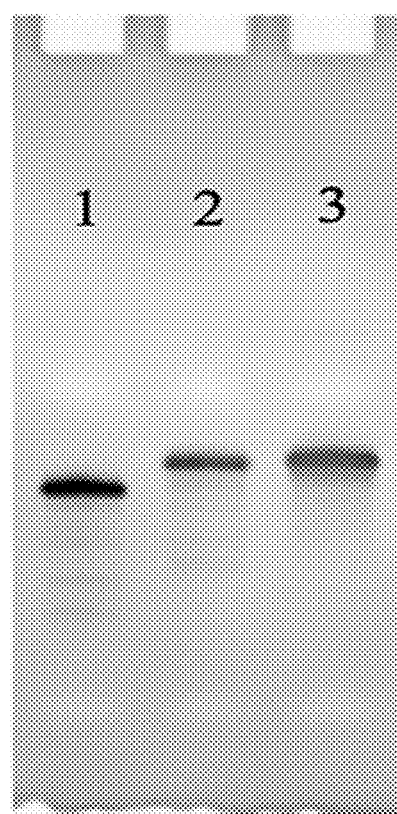
(C)



¹H NMR of **GaINAcαProN3 (3)**

Figure 5 (continued)

(D)



Oligonucleotide
analysis

Figure 6

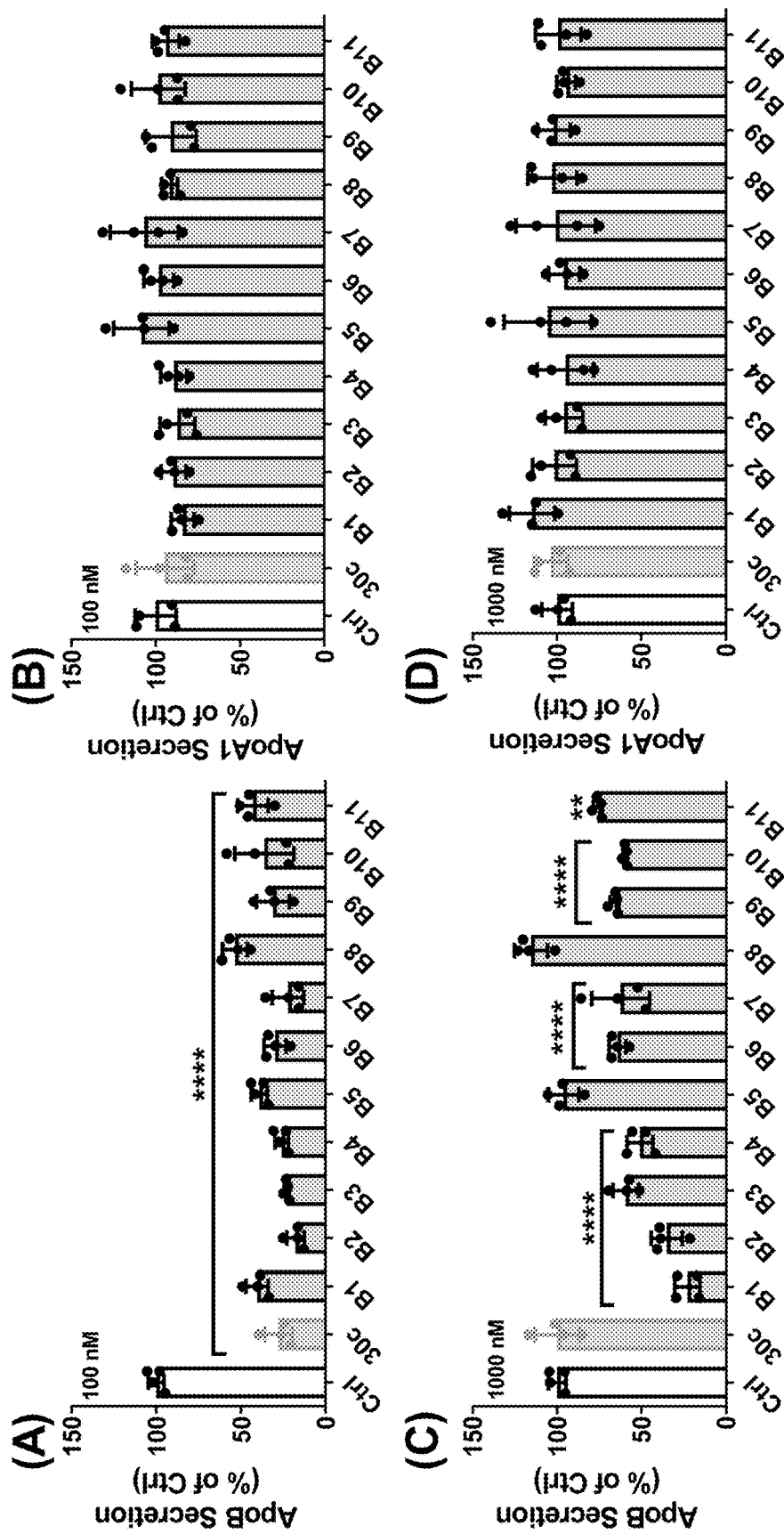


Figure 7

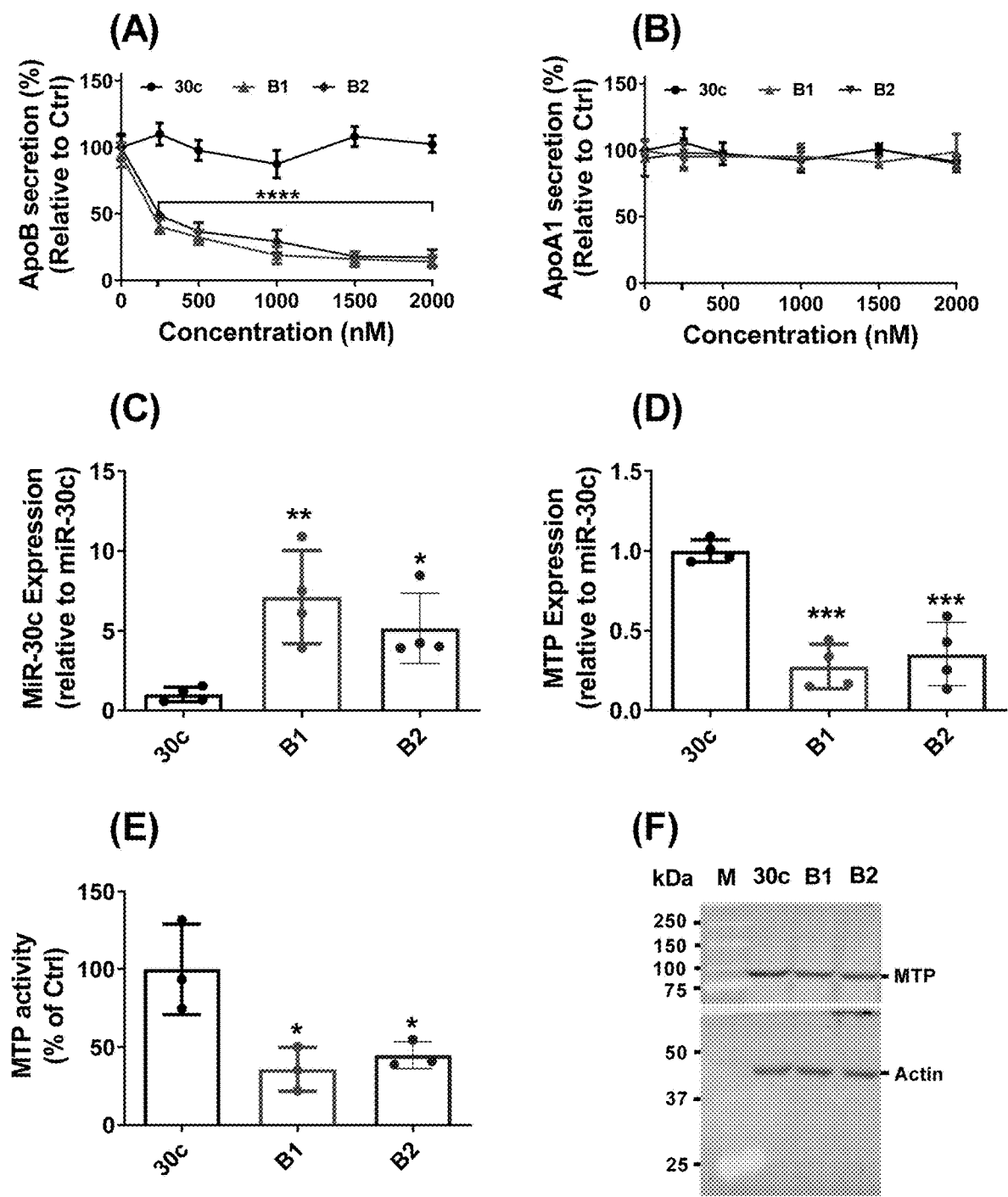
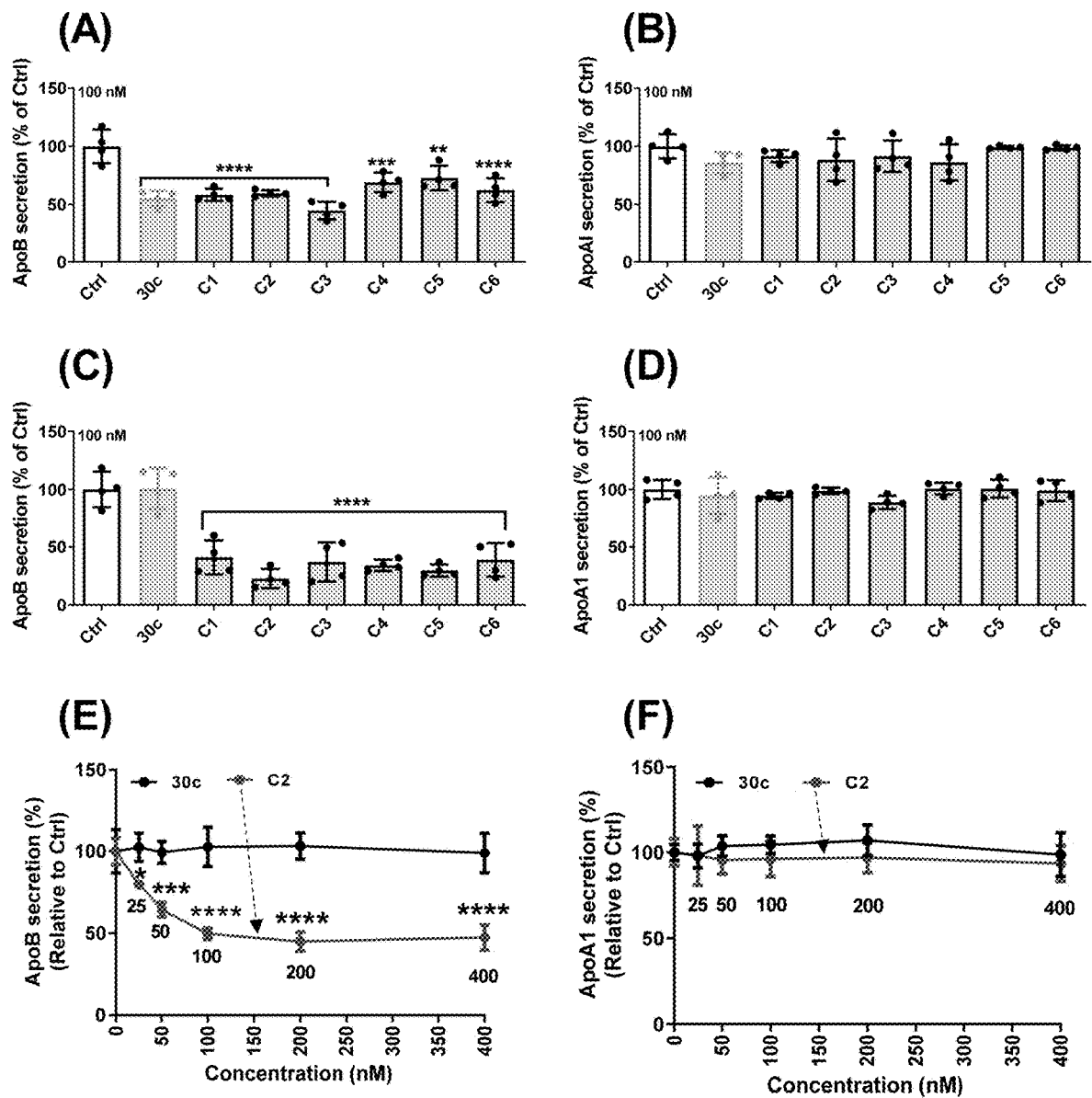


Figure 8



**NOVEL EFFICACIOUS MICRORNA-30C
ANALOGS REDUCE APOLIPOPROTEIN B
SECRETION IN HUMAN LIVER CELLS**

**CROSS REFERENCE TO RELATED
APPLICATION**

[0001] This application claims priority to U.S. provisional application No. 63/306,726, filed Feb. 4, 2022, the entire disclosure of which is incorporated herein by reference.

**STATEMENT REGARDING FEDERALLY
SPONSORED RESEARCH**

[0002] This invention was made with government support under grant numbers DK121490, HL137202, and HD094778, awarded by the National Institutes of Health, grant number BX004113 awarded by the United States Department of Veterans Affairs, and grant numbers CHE1845486 and MCB1715234 awarded by the National Science Foundation. The government has certain rights in the invention.

SEQUENCE LISTING

[0003] The instant application contains a Sequence Listing which has been submitted in .xml format and is hereby incorporated by reference in its entirety. Said .xml file is named "058636_00575_ST26_2.xml", was created on Apr. 18, 2023, and is 267,332 bytes in size.

RELATED INFORMATION

[0004] Atherosclerosis, hardening of the arteries after lipid deposition, is the leading cause of morbidity and mortality in the US and worldwide. High plasma cholesterol levels are a major risk factor for atherosclerosis. Cholesterol in the circulation is carried primarily by apolipoprotein B (apoB) containing lipoproteins. Remarkable advances have been made in lowering plasma cholesterol and reducing death by 30%-40% through treatments with statins and proprotein convertase *subtilis*/kexin type 9 inhibitors (1-4). Despite the availability of these drugs, an unmet need for new lipid lowering therapies remains, because some patients do not achieve the desirable cholesterol lowering with statins (5); a substantial proportion of patients experience unmanageable adverse effects (6,7); and statins and PCSK9 antibodies are not useful in treating patients with homozygous familial hypercholesterolemia and low density lipoprotein receptor null mutations (8,9). Therefore, a need exists to identify safer methods of lowering plasma lipids that can be used independently of or in combination with statins and other available drugs.

[0005] Statins, inhibitors of hydroxyl-methyl-glutaryl-coenzyme A reductase, lower plasma lipids by increasing the hepatic expression of low-density lipoprotein receptors and decreasing cholesterol synthesis. A complementary approach involves inhibiting the assembly and secretion of lipoproteins to limit their entry into the circulation. Lipoprotein assembly requires two proteins: the structural protein apoB and the chaperone microsomal triglyceride transfer protein (MTP). MTP physically interacts with and transfers lipids in the endoplasmic reticulum to nascent apoB, and assists in the formation and maturation of lipoprotein particles for secretion (10,11). MTP has long been a drug target for lowering plasma lipids, as its biochemical activity of transferring lipids can be easily measured in laboratory

settings. Several pharmaceutical companies have developed drugs that potently inhibit MTP activity and lower plasma lipids (12,13). However, these drugs increase hepatic lipids and plasma transaminases (14-16). One MTP inhibitor, lomitapide, has been approved for the treatment of homozygous familial hypercholesterolemia on a restricted protocol and carries label warnings for hepatic steatosis (17,18). Hence, a need remains for agents that can reduce levels of MTP and plasma lipids without causing steatosis.

[0006] MicroRNAs (miRs) are endogenous gene products ~22 nucleotides in length that regulate gene expression at the post-transcriptional level. They interact with the 3'-untranslated regions of target mRNAs and decrease protein synthesis by enhancing mRNA degradation and/or interfering with translation (19,20). Currently, several miR-based drugs are in clinical trials for the treatment of atherosclerosis, heart failure, diabetes, and hepatitis C viral infection, and are expected to be possible treatments in the future (21,22). A major hurdle in the development of miR therapeutics involving chemical modifications is the loss of mRNA silencing. Consequently, several methods of delivery have been devised, including viral vectors and neutral lipid emulsions (21).

[0007] MiR-30c is a small (23 nucleotide), double stranded, non-coding RNA. The 5'-physiologically active sense strand interacts with different mRNAs and subsequently modulates the synthesis of various proteins (23,24). MiR-30c is derived from the products of two genes (MIR30C1 and MIR30C2) in humans and mice (23). The primary transcripts of these genes, pri-miR-30c-1 and pri-miR-30c-2, show 56.7% and 58.5% similarity, respectively, between humans and mice. These transcripts are processed in the nucleus and exported to the cytoplasm as pre-miR-30c-1 and pre-miR-30c-2. Pre-miR-30c-1 is highly similar between humans and mice (98.87% similarity); in contrast, pre-miR-30c-2 is 82.1% similar between both species. These pre-miRs are further processed in the cytoplasm, thus resulting in the production of mature miR-30c with identical 5'-strands (miR-30c-5p) that are conserved in humans and mice. The 3'-strands (miR-30c-3p) derived from the two genes are slightly different, but are conserved in humans and mice.

[0008] It has been reported that overexpression of miR-30c significantly reduces MTP activity, whereas overexpression of its corresponding anti-miR elevates MTP activity in Huh-7 human hepatoma cells and human primary hepatocytes (25-27). Furthermore, miR-30c significantly reduces apoB secretion, whereas anti-miR-30c increases apoB secretion without affecting apolipoprotein A1 (apoA1) secretion in these cells. Mechanistic studies revealed that miR-30c decreases MTP activity by interacting with and degrading RNA at the post-transcriptional level (25,28,29). MiR-interacts with MTP mRNA involving both the seed and supplementary sites (26).

[0009] To investigate whether miR-30c regulates MTP activity and plasma lipids in vivo, we intravenously transduced male C57BL/6 mice with lentiviruses for the expression of control, miR-30c, or anti-miR-30c and then fed them a Western diet (25). MiR-30c decreased hepatic MTP expression, plasma cholesterol, and hepatic lipoprotein production. Despite reductions in plasma cholesterol, increases in hepatic lipids and plasma transaminases in miR-30c expressing mice were not detected. Because viral therapy is formidable, we intravenously injected miR-30c analogs

complexed with lipid emulsions (28). These emulsions enabled delivery of miR-30c to the liver and diminished diet-induced hypercholesterolemia in the mice. Furthermore, we found that miR-30c mimic significantly reduces hypercholesterolemia and atherosclerosis in Apoe^{-/-} mice (28). Subsequent studies demonstrated that miR-30c also decreases plasma cholesterol in diabetic ob/ob and db/db mice and in Western-diet fed Ldlr^{-/-} mice, but has no effect on plasma triglycerides, glucose, and transaminases (29). These studies have indicated that the hepatic expression of miR-30c decreases plasma cholesterol, hepatic lipid synthesis, and atherosclerosis without causing steatosis seen with MTP inhibitors. In the studies summarized above (25,28, 29), miR-30c was injected intravenously as lentiviruses or complexed with lipid emulsions. Because these approaches can be expensive and difficult for therapeutic interventions, there remains a need for improved compositions for use in to reducing apoB secretion without affecting apoA1 secretion and hepatic lipid accumulation in a viral vector and liposome free manner. The present disclosure is pertinent to this need.

BRIEF SUMMARY

[0010] The present disclosure provides, among other aspects, viral vector and liposome free compositions comprising new and potent miR-30c analogs, and methods of using the potent miR-30c analogs and compositions. The miR-30c analogs are in some embodiments provided as a double stranded polynucleotide complex. The double stranded polynucleotide complex comprises a first strand which optionally comprises no nucleotide modifications and a second strand comprising nucleotide modifications that forms the double stranded polynucleotide complex with the first strand. The second modified second strands include the following:

						SEQ ID NO:
miR30c-C1	C1	miR-30c-1-3p	(pC) •U•gGgAgAgGgUuGuUuAcUc•C			1
miR30c-C2	C2	miR-30c-1-3p	(pC) •UgGgAgAgGgUuGuUuAc•U•c•C			2
miR30c-C3	C3	miR-30c-1-3p	(pc) •U•gGgAgAgGgUuGuUuAc•U•c•C			3
miR30c-C4	C4	miR-30c-1-3p	GgGaGaGgGuUgUuUaCuC (pC) •u			4
miR30c-C5	C5	miR-30c-1-3p	GgGaGaGgGuUgUuUaCu•C• (pC) •u			5
miR30c-C6	C6	miR-30c-1-3p	C•u•GgGaGaGgGuUgUuUaCuC (pC) u			6

wherein upper case letters signify a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification; lower case letters signify a 2'-O-methyl (2'-OMe) ribosugar modification; pC signifies 2'-a GalNAc clicked cytidine, and the • symbol signifies a phosphorothioate linkage. In one example the second strand comprises the C2 strand. In embodiments, the described complex that comprises the C2 strand exhibits one or more improved properties relative to a complex that comprises the C1, C3, C4, C5, or C6 strand.

[0011] The disclosure also provides a method for inhibiting apoB secretion from cells by introducing into the cells a described double stranded polynucleotide complex in a composition that does not include any viral expression vector or liposomal components. In embodiments the

described method does not reduce apoA1 secretion, or reduces apoA1 secretion less than a control value obtained from introducing into the cells a double stranded polynucleotide complex that does comprise the C2 strand.

BRIEF DESCRIPTION OF THE FIGURES

[0012] FIG. 1. MiR-30c sequences and representative RNA modifications. (A and B) The two double stranded mature miR-30c sequences derived from two independent genes are shown. The two passenger strands, miR-30c-1 and miR-30c-2, are in red. The common miR-30c-5p strand is in black. (C) Different chemically modified nucleotides used in the synthesis of modified miR-30c passenger strands. (D) Synthesis of GalNAc cytidine.

[0013] FIG. 2. Thermal stability and circular dichroism spectra of modified miR-30c duplexes. (A) Melting temperature and (B) CD spectra of native miR-30c, and 2'-OMe modified miR-30c-1-3p and miR-30c-2-3p duplexed with native miR-30c-strand.

[0014] FIG. 3. Activity of 2'-OMe modified miR-30c-1 and miR-30c-2 in Huh-7 cells. Human hepatoma cells (Huh-7) were reverse transfected with 100 nM of 2"-OMe modified miR-30c analogs complexed with Lipofectamine RNAiMax transfection at a ratio of 3:1. For the control, cells were treated only with Lipofectamine RNAiMax (no mimics). Forty-eight hours after transfection with 2'-OMe-30c-1 and 2'-OMe-30c-2 analogs, media were collected and used to measure apoB (A and B) and apoA1 (C and D) concentrations. Data are representative of three independent experiments. Significance was determined at p<0.05 (*) with Student's t test.

[0015] FIG. 4. Effects of different miR-30c series A analogs on apoB secretion in Huh-7 cells. (A) ApoB secretion in Huh-7 cells transfected with control (Ctrl) and different miR-30c analogs (100 nM), as described in Table 1, with

Lipofectamine RNAiMax. MiR-30c (30c) was used a positive control. (B) ApoA1 secretion in Huh-7 cells transfected with control (Ctrl) and different miR-30c analogs (100 nM) with Lipofectamine RNAiMax. (C) ApoB secretion in Huh-7 cells transfected with Ctrl and different miR-30c analogs (1000 nM) without Lipofectamine RNAiMax. (D) ApoA1 secretion in Huh-7 cells transfected with Ctrl and different miR-30c analogs without Lipofectamine RNAiMax. The apoB and apoA1 concentrations were measured by ELISA in the collected media. Data are representative of four independent experiments. Significance was determined at p<0.0001 (****) and p<0.001 (***) with ANOVA.

[0016] FIG. 5. Synthesis of 3-chloropropyl GalNAc 2 and GalNAc α ProN3 3. (A) 3-Chloropropyl GalNAc 2 and GalNAc α ProN3 3 were synthesized as described in the methods. (B and C) ^1H NMR spectra of 3-chloropropyl GalNAc 2 and GalNAc α ProN3 3 are shown. (D) Analytical 15% polyacrylamide 8 M urea gel electrophoresis of anti-sense-oligonucleotide (ASO) in lane 1, post-clicked GalNAc-ASO in lane 2, and reference GalNAc-ASO in lane 3.

[0017] FIG. 6. Effects of various GalNAc-modified miR-30c analogs on apoB secretion in Huh-7 human hepatoma cells. (A) ApoB secretion and (B) apoA1 secretion in Huh-7 cells transfected with control (Ctrl) and different miR-30c series B analogs (Table 2) with Lipofectamine RNAiMax. MiR-30c (30c) was used as a positive control. (C) ApoB and (D) apoA1 secretion in Huh-7 cells transfected with Ctrl and different miR-30c analogs without Lipofectamine RNAiMax. The apoB and apoA1 concentrations in the media were measured with ELISA. Data are representative of four independent experiments. Significance was determined at $p < 0.0001$ (****) and $p < 0.001$ (***) with ANOVA.

[0018] FIG. 7. Effects of GalNAc-modified B1 and B2 analogs on apoB secretion and MTP activity in Huh-7 cells. (A) ApoB and (B) apoA1 secretion (%) in the culture medium of Huh-7 cells transfected with increasing amounts of miR-30c, or B1 or B2 analog without Lipofectamine RNAiMax. Non-transfected cells were used as controls. Data are representative of two independent experiments. (C-F) cells were exposed to 250 nM of miR-30c or B1 without transfection reagent. After 48 h, the cells were used to measure (C) miR-30c levels, (D) MTP mRNA, (E) MTP activity, and (F) MTP protein. Data are representative of three independent experiments. Western blot analysis is from one representative experiment. After transfer, the blot was cut into two parts; the top was used to detect MTP, and the bottom was used to detect β -actin as a loading control. Significance was determined at $p < 0.05$ (*) and $p < 0.0001$ (****) with Student's t test and ANOVA.

[0019] FIG. 8. Effects of various phosphorothioate-linked miR-30c analogs on apoB secretion in Huh-7 human hepatoma cells. (A) ApoB and (B) apoA1 secretion in Huh-7 cells transfected with Ctrl and different synthetic miR-30c series C analogs (Table 3) with Lipofectamine RNAiMax. MiR-30c (30c) was used as a positive control. (C) ApoB and (D) apoA1 secretion in Huh-7 cells transfected with Ctrl and different miR-30c analogs without Lipofectamine RNAiMax. Data are representative of three independent experiments. Relative (E) apoB and (F) apoA1 secretion (%) in culture medium of Huh-7 cells transfected with increasing amounts of miR-30c or analog without Lipofectamine/RNAiMax. Non-transfected cells were used as a control. Data are representative of two independent experiments. Significance was determined at $p < 0.0001$ (****), $p < 0.001$ (***), and $p < 0.01$ (**) with ANOVA.

DETAILED DESCRIPTION

[0020] Unless defined otherwise herein, all technical and scientific terms used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this disclosure pertains. The disclosure includes the following abbreviations: ApoA1, apolipoprotein A1; ApoB, apolipoprotein B; CD, circular dichroism; Ctrl, control; DMEM, Dulbecco's modified Eagle's medium; FBS, fetal

bovine serum; GalNAc, N-acetyl-galactosamine; MTP, microsomal triglyceride transfer protein; TLC, thin layer chromatography;

[0021] Unless specified to the contrary, it is intended that every maximum numerical limitation given throughout this description includes every lower numerical limitation, as if such lower numerical limitations were expressly written herein. Every minimum numerical limitation given throughout this specification will include every higher numerical limitation, as if such higher numerical limitations were expressly written herein. Every numerical range given throughout this specification will include every narrower numerical range that falls within such broader numerical range, as if such narrower numerical ranges were all expressly written herein.

[0022] The disclosure includes all polynucleotide sequences described herein expressly and by reference, and every polynucleotide sequence referred to herein includes its complementary sequence, and its reverse complement. All segments of polynucleotides from 10 nucleotides to the entire length of the polynucleotides, inclusive, and including numbers and ranges of numbers there between are included. All nucleotide sequences associated with any database accession numbers are incorporated herein by reference as they exist in the database as of the date of the filing of this application or patent. The disclosure includes all polynucleotide sequences described herein expressly or by reference that are between 80.0% and 99.9% identical to the described sequences.

[0023] As used in the specification and the appended claims, the singular forms "a" "and" and "the" include plural referents unless the context clearly dictates otherwise. Ranges may be expressed herein as from "about" one particular value, and/or to "about" another particular value. When such a range is expressed, another embodiment includes from the one particular value and/or to the other particular value. Similarly, when values are expressed as approximations, by the use of the antecedent "about" or "approximately" it will be understood that the particular value forms another embodiment. The term "about" and "approximately" in relation to a numerical value encompass variations of $\pm 10\%$, $\pm 5\%$, or $\pm 1\%$.

[0024] In embodiments, a therapeutically effective amount of a described double stranded RNA complex in is administered to an individual in need thereof.

[0025] A double stranded RNA complex includes two strands that anneal to one another under stringent or semi-stringent conditions. The strand that is optionally not modified may be fully complementary to the modified strand, or double stranded RNA complex may comprise mismatches between the strands.

[0026] In embodiments, the double stranded polynucleotide complex comprises one strand which optionally comprises no modifications, and a second strand comprising modifications and can form the double stranded polynucleotide complex with the first strand. The second strand comprises a sequence selected from the group sequences consisting of the following sequences:

					SEQ ID NO:
miR30c-C1	C1	miR-30c-1-3p	(pC) •U•gGgAgAgGgUuGuUuAcUc•C		1
miR30c-C2	C2	miR-30c-1-3p	(pC) •UgGgAgAgGgUuGuUuAc•U•c•C		2
miR30c-C3	C3	miR-30c-1-3p	(pc) •U•gGgAgAgGgUuGuUuAc•U•c•C		3
miR30c-C4	C4	miR-30c-1-3p	GgGaGaGgGuUgUuUaCuC (pC) •u		4
miR30c-C5	C5	miR-30c-1-3p	GgGaGaGgGuUgUuUaCu•C (pC) •u		5
miR30c-C6	C6	miR-30c-1-3p	C•u•GgGaGaGgGuUgUuUaCuC (pC) u		6

wherein upper case letters signify a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification; lower case letters signify a 2'-O-methyl (2'-OMe) ribosugar modification; pC signifies 2'-a GalNAc clicked cytidine, and the symbol signifies a phosphorothioate linkage. A modified strand is referred to herein from time to time using the C1, C2, C3, C5, C6 and C6 designations as described above.

[0027] In embodiments, one or both strands in the described RNA complex may comprise additional modifications. In embodiments, such modifications include, in addition to the modifications described above, modified ribonucleotides or deoxyribonucleotide, and thus include RNA/DNA hybrids. In non-limiting examples, modified ribonucleotides may comprise methylations and/or substitutions of the 2' position of the ribose moiety with an —O—alkyl group containing 1-6 saturated or unsaturated carbon atoms, or with an —O-aryl group having 3-6 carbon atoms, wherein such alkyl or aryl group may be unsubstituted or may be substituted, e.g., with halo, hydroxy, trifluoromethyl, cyano, nitro, acyl, acyloxy, alkoxy, carboxyl, carbalkoxyl, or amino groups; or with a hydroxy, an amino or a halo group. In embodiments modified nucleotides comprise methylcytidine and/or pseudo-uridine. The nucleotides may be linked by phosphodiester linkages or by a synthetic linkage, i.e., a linkage other than a phosphodiester linkage. Examples of inter-nucleoside linkages in the polynucleotide agents that can be used in the disclosure include, but are not limited to, phosphodiester, alkylphosphonate, phosphorothioate, phosphorodithioate, phosphate ester, alkylphosphonothioate, phosphoramidate, carbamate, carbonate, morpholino, phosphate triester, acetamidate, carboxymethyl ester, or combinations thereof

[0028] The term “therapeutically effective amount” as used herein refers to an amount of a described RNA complex to achieve, in a single dose or multiple doses, the intended purpose of treatment. The amount desired or required will vary depending its mode of administration, patient specifics and the like. Appropriate effective amounts can be determined by one of ordinary skill in the art informed by the instant disclosure using routine experimentation. In embodiments, a therapeutically effective amount of a described RNA complex is administered to an individual in need thereof. In embodiments, a described RNA complex is administered to an individual in an expression vector and viral vector free manner, i.e., the RNA complex is administered as an RNA complex without expression of the RNA within a cell and without any lipids. In embodiments, a described RNA complex alone is administered to an indi-

vidual. In embodiments, a composition wherein a described RNA complex is the only RNA complex in the composition is administered.

[0029] In embodiments, an agent described herein is administered as a double stranded polynucleotide complex without a liposomal component, and without an expression vector that encodes either stand of the complex, such expression vectors including but not limited to viral vectors.

[0030] In embodiments, introducing a described double stranded polynucleotide complex into cells inhibits and/or prevents apoB secretion from cells. In embodiments, introducing a described double stranded polynucleotide complex into cells does not reduce apoA1 secretion, or reduces apoA1 secretion less than a control value obtained from introducing into cells a double stranded polynucleotide complex that does not contain a modified strand, or contains different modifications than those described herein.

[0031] In embodiments, the cells into which the described double stranded polynucleotide complex is introduced comprise human liver cells, which may include hepatoma cells. In embodiments, the cells are within a human individual. In embodiments, the human individual needs treatment or prophylaxis of a cardiovascular and/or circulatory disorder, such as atherosclerosis. In embodiments, the individual is in need of plasma lipid reduction. In embodiments, the individual has homozygous familial hypercholesterolemia or low density lipoprotein receptor null mutations.

[0032] The following Examples are intended to illustrate but not limit the disclosure.

EXAMPLES

[0033] Modified miR-30c Duplexes have Increased Thermal Stability and are Physiologically Active

[0034] RNA interference-based therapy is becoming a feasible and attractive approach for treating life-threatening diseases that are not easily treatable through conventional small drug molecules. The success of small interfering RNA (siRNA)-based therapy has been due to improvements in the stability, potency, specificity, delivery, and safety of modified siRNAs (30-32). Building on prior advances made in siRNA delivery technology, we synthesized novel analogs of miR-30c to assess whether these approaches might be extended to miRs. Strategically, we decided to modify only the antisense strand (passenger strands, miR-30c-1-3p and miR-30c-2-3p) while leaving the active sense strand (guide strand, miR-30c-5p) untouched to avoid hindering its ability to interact with the RNA-induced silencing complex and recognition of target mRNAs. As shown in FIG. 1A-B, two versions of double stranded mature miR-30c sequences

(miR-30c-1 and miR-30c-2) are derived from the products of two independent genes, MIRC1 and MIRC2, contain an identical guide strand (sense, miR-30c-5p, 5'-UGUAAA-CAUCCUACACUCACAGC-3' (SEQ ID NO:7)) but slightly different passenger strands (antisense strands, red, miR-30c-1-3p, 5'-CUGGGAGAGGGUUGUUUACUCC-3' (SEQ ID NO:8) and miR-30c-2-3p, black, 5'-CUGG-GAGAAGGCUGUUUACUCU-3' (SEQ ID NO:9)). First, we synthesized modified miR-30c-1-3p and miR-30c-2-3p passenger strands by using all 2'-OMe nucleosides (FIG. 1C), then annealed these antisense strands with a sense unmodified or native miR-30c-5p strand to study the biophysical properties of the annealed duplexes. For a control, we annealed unmodified miR-30c-1-3p with native miR-30c-5p. Duplexes of miR-30c-5p with native miR-30c-3p, modified miR-30c-1-3p, or modified miR-30c-2-3p showed similar denaturation curves (FIG. 2A). However, the overall thermal stability of duplexes with modified miR-30c-3p strands increased by $\sim 7^\circ \text{C}$, thus indicating enhanced stability of the duplexes. The circular dichroism (CD) spectra showed similar conformations for both native and modified duplexes. These duplexes had a strong positive peak in the range of 260-270 nm (FIG. 2B). Thus, the annealing of miR-30c anti-sense strand containing modified base pairs does not affect its interaction with the miR-30c sense strand in duplex formation and the double helix conformation.

[0035] These data indicated that the synthesis of miR-30c-3p with modified nucleotides does not affect either the ability of these modified passenger strands to bind the sense strand or the stability of the dsRNA. Therefore, we evaluated the efficacy of these miRs in reducing apoB secretion in Huh-7 human hepatoma cells (FIG. 3) by adding them to the media and analyzing their effects on apoB secretion. The duplexes had no effect on apoB secretion when added to cells without transfection reagent. These negative results might have been because the duplexes failed to be delivered to the cells or were not physiologically active. To determine the reasons for their inactivity, we introduced native miR-30c-5p complexed with 2"-OMe modified miR-30c-1-3p (2"-OMe-30c-1) or miR-30c-2-3p (2"-OMe-30c-2) analogs into cells with Lipofectamine RNAiMax reagent. Both modified complexes significantly reduced apoB secretion (FIG. 3A, 3B) without affecting apoA1 secretion (FIG. 3C, 3D), thus indicating that the modified miRs were physiologically active when introduced as lipid complexes. The inability of these complexes to reduce apoB secretion in the absence of lipid-mediated delivery was probably because the RNAs were unable to enter the cells. These data provided crucial preliminary evidence that miR-30c-3p modifications are tolerable if delivered to cells and suggested the feasibility of synthesis of more potent miR-30c analogs by modifying the antisense strands of miR-30c.

[0036] Next, we introduced pseudouridine (ψ) (FIG. 1C) in place of the natural uracil and synthesized six different series A (A1-A6) strands (Table 1). Pseudouridine stabilizes the tertiary structure of tRNA, and the synthetic replacement of all uracil with pseudouridine renders mRNA non-immunogenic and increases its stability (33,34). All analogs were transfected into Huh-7 cells using Lipofectamine RNAiMax reagent (FIG. 4A). For the positive control, we used commercial native miR-30c. For the negative control, we used an unrelated commercially available miR (Ctrl). Compared with the Ctrl, miR-30c and all A-series analogs significantly decreased apoB secretion (FIG. 4A), but apoA1 secretion

was unaffected (FIG. 4B). These studies indicated that when delivered to cells, these new synthetic analogs were able to diminish apoB secretion similarly to miR-30c, as compared with Ctrl miR. Next, we asked whether any of these analogs might affect apoB secretion without lipid emulsions. For this purpose, we provided higher concentrations of analogs to cells without Lipofectamine RNAiMax. These analogs and native miR-30c had no effect on apoB and apoA1 secretion (FIGS. 4C and 4D). These studies indicated that these analogs were unable to penetrate cells on their own to reduce apoB secretion; however, they were able to reduce apoB secretion when introduced into cells with Lipofectamine RNAiMax.

MiR-30c-3p Analogs Modified with N-Acetyl-Galactosamine Reduce apoB Secretion without the Use of Lipid Emulsions

[0037] In recent years, the asialoglycoprotein receptor ligand N-acetyl-galactosamine (GalNAc) has been used to deliver anti-sense and siRNA oligonucleotides to liver cells (35-41). Therefore, we introduced one GalNAc modified nucleotide at both ends as well as more than one GalNAc modified residue in the antisense strands. First, we synthesized 3-chloropropyl GalNAc (FIG. 5A, 2) and 3-azidopropyl 2-acetamido-2-deoxy- α -D-galactopyranoside (GalNAc α ProN3; FIG. 5A, 3). Their correct synthesis was confirmed by ^1H NMR spectra (FIG. 5B, 5C) and 15% polyacrylamide analytical 8 M urea gel electrophoresis (FIG. 5D). Second, the GalNAcProN3 was attached to 2'-(O-propargyl)-cytosine through click chemistry (42,43). Third, GalNAc-cytidine (pC) was used during the synthesis of miR-30c-3p strands (Table 2). During these syntheses, we also incorporated (2'-deoxy-2'-fluoro ribosugar modified nucleosides to increase the biological stability (44) of these RNA strands (Table 2). Fourth, these analogs were transfected into cells with Lipofectamine RNAiMax. All analogs potentially inhibited apoB secretion in Huh-7 cells (FIG. 6A) and therefore were biologically active. ApoA1 secretion was unaffected by these analogs (FIG. 6B). Fifth, we evaluated the efficacy of these series B analogs in reducing apoB secretion when provided to cells without Lipofectamine RNAiMax. Similarly to miR-30c, compounds B5 and B8 had no effect on apoB secretion with respect to the Ctrl (FIG. 6C). However, all other analogs reduced apoB secretion from 40% to 80%. None of these analogs affected apoA1 secretion (FIG. 6D). The most potent analogs inhibiting apoB secretion were B1 and B2 (FIG. 6C). Both these analogs contain one copy of GalNAc at either the 5'- or 3'-end. Introduction of multiple GalNAc modified nucleotides, as in B5 and B8, resulted in a loss of biological activity. Thus, analogs with one GalNAc at either end are suitable for cellular delivery without liposomes.

The GalNAc Modified miR-30c Analogs Significantly Reduce MTP Activity

[0038] Because analogs B1 and B2 potentially inhibited apoB secretion, we performed concentration dependent studies to assess their potency. Both analogs showed a concentration dependent decrease in apoB secretion with an IC₅₀ of 250 nM, but miR-30c had no effect (FIG. 7A). Under similar conditions, different concentrations of miR-30c, B1, and B2 had no effect on apoA1 secretion (FIG. 7B). Next, we exposed cells to 250 nM of B1 and B2 to assess the delivery of miR-30c to cells and its effects on MTP. The levels of miR-30c compared with control miR-30c transcripts were significantly higher (~ 7 -fold) in the B1-exposed

cells and (~5-fold) in the B2-exposed cells (FIG. 7C). We previously showed that miR-30c diminishes apoB secretion by reducing MTP activity (23-25,28,29). Therefore, we asked whether the analogs B1 and B2 might affect MTP transcripts, protein and activity. Both analogs B1 and B2, compared to miR-30c, reduced MTP mRNA and activity by more than 50% (FIG. 7D, 7E). Western blot analysis also showed a similar decrease in MTP protein (FIG. 7F). These studies suggest that analogs B1 and B2 are likely to reduce apoB secretion in Huh-7 cells by lowering MTP expression similarly to native miR-30c.

Modified miR-30c Analogs with GalNAc and Phosphorothioate at the 5'- or 3'-End have Elevated Potency

[0039] In FIG. 7A, a significant reduction in apoB secretion was observed with 250 nM of analogs B1 and B2. Because our long-term goal is to develop analogs as potential therapeutic drugs, we focused on producing analogs that are more efficacious. Recent studies have suggested that the placement of phosphorothioate linkages improves both the specificity and silencing activity of siRNAs (37,40). Therefore, we synthesized new series C analogs of compounds B1 and B2 by using phosphorothioate linkages (Table 3). These analogs were transfected into cells with Lipofectamine RNAiMax and were found to inhibit apoB secretion (FIG. 8A) without affecting apoA1 secretion (FIG. 8B) in Huh-7 cells, thus suggesting that they are physiologically active. Next, we evaluated their efficacy when they were provided to cells without Lipofectamine RNAiMax. All analogs potentially inhibited apoB secretion (FIG. 8C), but had no significant effect on apoA1 secretion (FIG. 8D). In all cases, >50% inhibition of apoB secretion was seen with 100 nM concentrations of these analogs (FIG. 8C). A comparison of the data in FIG. 8A and FIG. 8C suggested that these analogs might be more potent when delivered without lipid emulsions. Next, we verified the effects of different concentrations of the most potent analog, C2, on apoB secretion in Huh-7 cells (FIG. 8E). The analog C2 yielded a concentration dependent decrease in apoB secretion, with an IC₅₀ value of 20 nM. At higher concentrations, the maximum reduction in apoB secretion was ~60% (FIG. 8E). At all concentrations, analog C2 had no effect on apoA1 secretion (FIG. 8F). These studies indicated that the addition of phosphorothioate linkages increases the efficacy of different analogs in decreasing apoB secretion and that analog C2 is a potent inhibitor of apoB secretion.

Discussion

[0040] Previous work has shown that miR-30c is a good candidate to lower plasma lipids without causing hepatosteatosis, but requires additional agents. This disclosure describes development of potent miR-30c analogs that are expected to be useful as therapeutic agents for lowering plasma lipid levels, among other uses as described herein. The successful synthesis of an azido-modified GalNAc moiety (GalNAcαProN3) allowed us to selectively attach the GalNAc molecule at any location of the RNA oligonucleotide modified with an alkyne group. This synthesis design provided the flexibility to explore the most effective modified passenger strand of miR-30c with the best cell-penetrating capacity. This design could also be extended to other miR systems. By introducing a variety of chemical modifications and phosphorothioate linkages, we improved the efficacy of the miR-30c analogs. Addition of GalNAc residues at either end circumvented the need for lipid

emulsions for delivery to hepatoma cells. Mechanistic studies showed that these analogs reduced MTP mRNA and thus behaved similarly to native miR-30c. Furthermore, these analogs had no effect on apoA1 secretion; therefore, the decreased apoB was a specific response to these analogs and was not secondary to cellular toxicity. These studies provide evidence that the passenger strand of miR-30c can be modified to enhance cellular delivery without lipid emulsions. This system therefore has certain advantages relative to delivery with lipid emulsions.

[0041] In summary, the disclosure demonstrates successful synthesis of various miR-30c analogs that potently inhibit MTP activity and apoB secretion. The disclosure demonstrates that modification of miR-30c in the passenger strand can improve its stability and delivery into hepatoma cells.

EXPERIMENTAL PROCEDURES

[0042] Synthesis of Chemically Modified Novel miR-30c-3p Analogs

[0043] Anhydrous solvents were used and redistilled through standard procedures. All solid reagents were dried under a high vacuum line before use. Air sensitive reactions were performed under argon. Analytical thin layer chromatography (TLC) plates pre-coated with silica gel F254 (Aldrich, #717185) were used for monitoring reactions. The ¹H NMR spectra were measured on a Bruker Ascend 500 MHz spectrometer. Chemical shift values are reported in ppm. High-resolution mass spectroscopy was achieved with a quadrupole time of flight spectrometer at the University at Albany, SUNY.

[0044] Native RNAs were custom synthesized by Integrated DNA Technologies. We used an automated RNA/DNA synthesizer (ASM800, BIOSSET Ltd.) to synthesize modified antisense oligonucleotides at 1 micromole scale with commercial phosphoramidites and reagents from Chemgenes. The modified and native phosphoramidites were dissolved in anhydrous acetonitrile to obtain a concentration of 0.07 M. Trichloroacetic acid (3%) in dichloromethane was used for detritylation, and the coupling step was performed with 5-ethylthio-1H-tetrazole (0.25 M in acetonitrile) for 12 min. The unreacted 5'-OH was capped with CapA solution (80% tetrahydrofuran/10% acetic anhydride/10% 2,6-Lutidine) and CapB solution (16% N-methyl imidazole in tetrahydrofuran). Oxidation on the phosphate backbone was performed with 20 mM iodine solution in pyridine/tetrahydrofuran/water. Phosphorothioate backbones were synthesized with sulfurization reagent (3-((dimethylamino-methylidene)amino)-3H-1,2,4-dithiazole-3-thione, instead of the iodine solution in the oxidation step. All the reagents were of oligo-synthesizer grade from Chemgenes.

[0045] The synthesis of modified miR-30c passenger strands was performed with the dimethoxyltrityl-off mode of the RNA/DNA synthesizer. The protection on bases was removed, and the oligonucleotides were cleaved from the solid support with concentrated aqueous ammonium hydroxide at room temperature for 18 hours. The resulting RNA solution was dried with a speed vacuum concentrator, and the pellet was redissolved with 100 μL dimethylsulfoxide and incubated with 125 μL of triethylamine trihydrofluoride (Aldrich, #344648) at 65° C. for 2.5 hours. The RNA was precipitated by addition of 25 μL of 3 M sodium acetate solution and 1 mL ethanol and subsequent cooling of

the mixture at -80°C . for 3 hours before centrifugation. The RNAs were dissolved in RNase free water and desalted again prior to storage at -20°C . in RNase free water. The purity of modified-RNA samples was confirmed by analytical denaturing gel electrophoresis (15% polyacrylamide with 8 M urea) and electrospray ionization mass spectrometry.

Annealing of Modified miR-30c-3p Strands with Native miR-30c-5p Strand and UV Thermal Denaturation Studies
[0046] The modified miR-30c-3p RNAs were annealed with native miR-30c-5p in sodium phosphate buffer (10 mM, pH 6.5) containing 100 mM NaCl. The solutions were heated at 95°C . for 3 min, then cooled to room temperature at a rate of $1^{\circ}\text{C}/\text{min}$, and stored overnight at 4°C . before use. For thermal denaturation studies, data points were acquired at 260 nm by heating and cooling from 5°C . to 85°C . (two cycles, four ramps) at a rate of $0.5^{\circ}\text{C}/\text{min}$, with a Cary-300 UV-visible spectrometer equipped with a temperature controller system. The thermodynamic parameters of each duplex strand were obtained by fitting the melting curves in Meltwin software (45).

Circular Dichroism Spectroscopy

[0047] Circular dichroism spectra were recorded at room temperature on a JASCO-815 spectropolarimeter over a wavelength range of 200-300 nm with a 1 cm path length quartz cuvette with a scanning speed of 100 nm/min, bandwidth of 1.0 nm, and digital integration time of 1.0 s. Each spectrum was averaged from four scans and baseline-corrected against the buffer.

Synthesis of GalNAc α ProN3, 3

[0048] Published protocols (46) were followed to synthesize 3-chloropropyl GalNAc 2 and GalNAc α ProN3 3.

Synthesis of 3-Chloropropyl GalNAc 2.

[0049] To a solution of N-acetyl-D-galactosamine (330 mg, 1.5 mmol) in 3-chloropropanol (5 mL), acetyl chloride (0.13 mL, 1.8 mmol) was added at 0°C . The reaction mixture was heated at 70°C . for 15 h. The solution was concentrated, and the residue was purified by silica gel chromatography, thus yielding 3-chloropropyl GalNAc 2 (200 mg, 45%) as a white solid. TLC R_f =0.5 (20% MeOH in CH_2Cl_2). ^1H NMR (500 MHz, D_2O) δ 4.92 (d, J =4.0 Hz, 1H), 4.15 (dd, J =4.4, 12.8 Hz, 1H), 4.00-3.84 (m, 4H), 3.77-3.72 (m, 4H), 3.62-3.56 (m, 1H), 2.10-2.02 (m, 5H).

[0050] GalNAc α ProN3 3. 3-chloropropyl GalNAc 2 (200 mg, 0.671 mmol) was dissolved in CH_3CN (6 mL) by heating the solution. NaN_3 (436 mg, 6.71 mmol) and NaI (101 mg, 0.671 mmol) were added. The resulting mixture was stirred at 60°C . for h. The solution was concentrated, and the residue was purified by silica gel chromatography, thus yielding GalNAc α ProN3 3 (110 mg, 54%) as a white solid. TLC R_f =0.4 (20% MeOH in CH_2Cl_2). ^1H NMR (500 MHz, D_2O) δ 4.94 (m, 1H), 4.21-4.18 (m, 1H), 4.03-3.94 (m, 3H), 3.85-3.78 (m, 3H), 3.59-3.47 (m, 3H), 2.08 (d, 3H), 1.95-1.91 (m, 2H).

Synthesis of 2'-GalNAc-Modified RNA Strands

[0051] The propargyl modified RNA oligonucleotides were first synthesized according to the solid phase synthesis procedure with commercially available 2'-(O-propargyl)-phosphoramidite building blocks from Chemgenes. GalNAc

modified RNA strands were produced through mixture of the propargyl-RNA (1 equivalent) with 100 equivalents of azido-modified GalNAc (GalNAc α ProN3) in a 1.5 mL microcentrifuge tube. In a separate tube, 22 equivalents of copper(I) bromide (CuBr) (100 mM in 25% tBuOH/75% dimethylsulfoxide) and 20% acetonitrile were mixed and transferred to the RNA solution. The mixture was shaken at room temperature for 12 h. The RNA was then precipitated with 3 M sodium acetate and ethanol after storage at -80°C . for 3 hours. The RNA was pelleted by centrifugation at 14,000 rpm (Eppendorf 5424) for 15 minutes. The RNA pellet was resuspended in 500 μL RNase-free water, and the solution was further desalted with SepPak C18 cartridges (WatersTM). The elution fractions with RNA were combined and concentrated with an oligonucleotide concentrator speed vacuum. The resulting click reaction products were monitored with analytical gel electrophoresis with 15% polyacrylamide containing 8 M urea.

Cell Culture Studies

[0052] The Huh-7 cells were maintained in Dulbecco's modified Eagle's medium (DMEM) containing 10% fetal bovine serum (FBS) and 1% L-glutamine in 75 cm² culture flasks with vent caps (Corning®, #430641U) at 37°C . and 5% CO_2 in a humidified incubator. Two types of studies were performed to assess the ability of different analogs to decrease apoB secretion. First, analogs were introduced into cells with Lipofectamine RNAiMax transfection reagent. Second, cells were exposed to different analogs without the use of any transfection reagent. In both of these experiments, Huh-7 cells were seeded at a concentration of 100,000 cells/well in a six-well plate in 2 mL of the aforementioned medium. The next day, 1 mL of fresh Opti-MEMTM I reduced serum medium (Gibco) (for transfection experiments) or DMEM containing 10% FBS (for non-liposome mediated transfection) was added to the cells. The Huh-7 cells in the Opti-MEMTM I reduced serum medium were transfected with commercially available non-specific control miR (Ctrl), miR-30c mimic (positive control), or our experimental novel synthetic miR-30c analogs with Lipofectamine RNAiMax reagent (Invitrogen) according to the manufacturer's protocol. Briefly, each miR was mixed with RNAiMax at a ratio of 3:1 and incubated for 30 minutes at room temperature. This mixture was then added to cells. In experiments testing liposome independent delivery of miR analogs, cells in DMEM (10% FBS) were exposed to these analogs without Lipofectamine RNAiMax reagent. On day 2, in both cases, 1 mL of fresh DMEM (10% FBS) was added to the cells. At 72 h after the start of transfection, the media were changed, and 1 mL of fresh DMEM (10% FBS) was added to the cells. After overnight incubation, the media were collected for apoB and apoA1 measurements. Cells were washed and collected in the presence of protease inhibitor cocktail (Sigma-Aldrich, #P2714) for protein estimation and determination of the activity of MTP as previously described (47).

ApoB and apoA1 Measurements

[0053] The apoB levels in the collected media were determined with a human apoB ELISA development kit (MABTECH Inc, #3715-1H-6) in 96-well ELISA plates (Thermo Fisher Scientific, #07-200-640) with 3,3',5,5' tetramethylbenzidine substrate (Thermo Fisher Scientific, #4041). The apoB concentration was calculated with apoB standard provided by the manufacturer in parallel in the

same plate. The medium apoB values were normalized to the total protein in the respective wells. Total cellular protein concentrations were quantified with a Coomassie (Bradford) protein assay kit (Thermo Fisher Scientific, #23200). The apoB concentrations in the media of control miR (Ctrl)-transfected cells were set at 100%. ApoB secretion by cells exposed to miR-30c mimic or newly synthesized miR-30c analogs is presented as a percentage of this value.

[0054] The apoA1 levels in the collected media were determined with a human apolipoprotein A-I/ApoA1 Duo-Set ELISA kit (R&D Systems, #DY3664) in 96-well ELISA plates (Thermo Fisher Scientific, #7-200-640). Substrate (#DY999) and stop (#DY994) solutions were from R&D Systems. The apoA1 concentration was calculated with an apoA1 standard curve prepared in parallel with standards provided by the manufacturer (R&D Systems, #DY3664). ApoA1 levels in the media were normalized to total protein in the respective wells. The concentrations of apoA1 in the control miR (Ctrl)-transfected cells were set to 100%, and those in miR-30c mimic treated cells were normalized to this value.

Measurement of miR-30c and MTP Transcript Levels

[0055] For miR-30c quantification by quantitative RT-PCR, cDNA was synthesized from RNA isolated from cells with a TaqMan MicroRNA Reverse Transcription kit (Applied Biosystems, #4366597). The miR-30c and U6-specific primers were purchased from Thermo Fisher Scientific. For quantitative RT-PCR, TaqMan™ Universal Master Mix II (Applied Biosystems, #4440043) was used. For miR-30c quantification, the Ct method with normalization to U6 was used, and the data are presented as fold changes.

[0056] For MTP quantification by quantitative RT-PCR, cDNA was synthesized from isolated RNA with a High-Capacity cDNA Reverse Transcription Kit (Thermo Fisher Scientific, #4368813). The human MTP and β -actin-specific primers were purchased from Integrated DNA Technologies (MTP primers, 5'-TGTGGCCTTACTATGGAGGAA-3' (SEQ ID NO:32) and 5'-AAGGAGCGTAGGTCTTTGCAG-3' (SEQ ID NO:10); β -actin primers, 5'-AGAGCTACGAGCTGCCTGAC-3' (SEQ ID NO:11) and 5'-AGCACTGTGTTGGCGTACAG-3' (SEQ ID NO:12)). For quantitative RT-PCR, PowerTrack SYBR Green Master Mix (Thermo Fisher Scientific, #A46109) was used. For MTP quantification, the Ct method with normalization to β -actin was used, and data are presented as fold change with respect to controls.

MTP Protein Levels and Activity Measurements

[0057] Transfected Huh-7 cells were washed with ice-cold phosphate buffered saline and scraped from the wells in ice cold buffer K (1 mM Tris-HCl, 1 mM EGTA and 1 mM $MgCl_2$, pH 7.6) containing protease inhibitor cocktail (Sigma-Aldrich, #P2714). Cells were manually lysed through 20 passes through a BD PrecisionGlide™ 25G needle, and the total protein concentrations were measured with a Coomassie (Bradford) protein assay kit (Thermo Fisher Scientific, #23200). Proteins (25 μ g) were resolved by SDS-PAGE (10%). A polyclonal rabbit primary antibody to human MTP (Abcam, #ab63467) and a monoclonal rabbit antibody to β -actin (Cell Signaling Technology, #8457) were used at 1:1000 dilution. Anti-rabbit IgG, HRP-linked secondary antibody (Cell Signaling Technology, #7074) was used at 1:2000 dilution. The blots were developed with a ChemiDoc™-Touch Imaging system (Bio-Rad). To deter-

mine the MTP activity, 50 μ g of total proteins was used. Fluorescently labeled triglyceride transfer assays were performed as previously described (25,28,29,47).

Statistical Analysis

[0058] We performed statistical analysis in GraphPad Prism versions 8 and 9. All data are represented as mean \pm SD. The symbols *, **, and *** represent significance at $p < 0.05$, $p < 0.01$, and $p < 0.001$, respectively.

Supplemental Example

Studies in Human Hepatoma Huh-7 Cells:

[0059] It is known that ablation of ApoB secretion results in hepatosteatosis. However, we have previously shown that miR-30c reduces apoB secretion without causing steatosis. Data presented before showed that analog C2 reduces ApoB secretion without affecting ApoA1 secretion. Therefore, we investigated whether analog C2 causes steatosis or not. Huh-7 cells were treated with or without analog C2 and media was collected to measure ApoB and ApoA1 levels. Cells were washed with phosphate buffer saline (PBS) and lipids were extracted using isopropanol to measure triglyceride and cholesterol.

Studies in Human Primary Hepatocytes:

[0060] To extend our studies about the efficacy of different miR-30c analogs beyond human hepatoma Huh-7 cells, we purchased human primary hepatocytes (H1000.H15B+; Lot No. HC4-25) from Sekisui XenoTech. Cells were thawed using Sekisui XenoTech's thawing protocol and OptiThaw Hepatocyte Kit. After seeding in collagen-coated plates, cells were treated with the analog C2. After 72 h, media was collected to measure ApoB and apoA1 levels using ELISA.

[0061] To determine whether analog C2 increases cellular lipid levels, cells were washed with PBS. To each well, 500 μ l of isopropanol was added and plate was incubated overnight at 4° C. Next day the supernatants were collected, dried and resuspended in 100 μ l of isopropanol followed by the lipid measurements. Total triglycerides and cholesterol were measured using commercial kits (Pointe Scientific). To each well, 500 μ l of 0.1N NaOH was added to determine the protein concentration for normalization.

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Tables:

[0108]

TABLE 1

MIR-30c analogs and sequences. Underlined upper case letters, native nucleosides; lower case letters, 2'-O-methyl (2'-OME) ribosugar modifications; ψ, pseudouridine.				
Compound	Short form	Strand	Sequence (5' to 3')	SEQ ID NO:
Ctrl	Ctrl	Sense	<u>UCACAACCUCCUAGAAAGAGUAGA</u>	13
miR30c	30c	miR-30c-5p	<u>UGUAAACAUCCUACACUCUCAGC</u>	14
miR30c-A1	A1	miR-30c-1-3p	<u>C</u> ugggagaggg <u>u</u> uguuuacuc <u>C</u>	15
miR30c-A2	A2	miR-30c-1-3p	<u>C</u> ψgggagagggwψψψacψc <u>C</u>	16
miR30c-A3	A3	miR-30c-1-3p	<u>C</u> ψggg <u>A</u> gaggψψψψψ <u>A</u> Cψ <u>C</u> C	17
miR30c-A4	A4	miR-30c-2-3p	<u>C</u> ugggagaaggcuguuuacuc <u>U</u>	18
miR30c-A5	A5	miR-30c-2-3p	cψgggagaaggcψψψψψacψc <u>U</u>	19
miR30c-A6	A6	miR-30c-2-3p	<u>C</u> ψggg <u>A</u> g <u>A</u> gg <u>C</u> ψψψψψ <u>A</u> Cψ <u>C</u> <u>U</u>	20

TABLE 2

MIR-30c analogs and sequences containing GalNAc modification. Upper case letters, 2'-deoxy-2'-fluoro (2'-F) ribosugar modified nucleosides; lower case letters, 2'-O-methyl (2'-OMe) ribosugar modified nucleosides; (pC), 2'-GalNAc clicked cytidines.				
Compound	Short form	Strand	Sequence (5' to 3')	SEQ ID NO:
miR30c-B1	B1	miR-30c-1-3p	(pC) UgGgAgAgGgUuGuUuAcUcC	21
miR30c-B2	B2	miR-30c-1-3p	CuGgGaGaGgGuUgUuUaCuC (pC) u	22
miR30c-B3	B3	miR-30c-1-3p	(pC) uGgGaGaGgGuUgUuUaCuC (pC) u	23
miR30c-B4	B4	miR-30c-2-3p	(pC) UgGgAgAaGgCuGuUuAcUcU	24
miR30c-B5	B5	miR-30c-1-3p	CuGgGaGaGgGuUgUuUa (pC) U (pC) (pC) u	25
miR30c-B6	B6	miR-30c-1-3p	(pC) UgGgAgAgGgUuGuUuA (pC) U (pC) (pC) u	26
miR30c-B7	B7	miR-30c-2-3p	CuGgGaGaGgG (pC) uGuUuA (pC) u (pC) U	27
miR30c-B8	B8	miR-30c-2-3p	(pC) UgGgAgAaGg (pC) UgUuUa (pC) U (pC) u	28
miR30c-B9	B9	miR-30c-1-3p	(pC) (pC) (pC) UgGgAgAgGgUuGuUuAcUcC	29
miR30c-B10	B10	miR-30c-2-3p	(pC) (pC) (pC) UgGgAgAaGgCuGuUuAcUcU	30
miR30c-B11	B11	miR-30c-2-3p	(pC) (pC) (pC) ugggagaaggcuguuuacucu	31

TABLE 3

MIR-30c analogs and sequences containing GalNAc and different phosphorothioate linkages. Upper case letters, 2'-deoxy-2'-fluoro (2'-F) ribosugar modifications; lower case letters, 2'-O-methyl (2'-OMe) ribosugar modifications; (pC), 2'-GalNAc clicked cytidine; "*" symbol, phosphorothioate linkages.				
Compound	Short form	Strand	Sequence (5' to 3')	SEQ ID NO:
miR30c-C1	C1	miR-30c-1-3p	(pC) *U*gGgAgAgGgUuGuUuAcUc*C	1
miR30c-C2	C2	miR-30c-1-3p	(pC) *UgGgAgAgGgUuGuUuAc*U*c*C	2
miR30c-C3	C3	miR-30c-1-3p	(pC) *U*gGgAgAgGgUuGuUuAc*U*c*C	3
miR30c-C4	C4	miR-30c-1-3p	GgGaGaGgGuUgUuUaCuC (pC) *u	4
miR30c-C5	C5	miR-30c-1-3p	GgGaGaGgGuUgUuUaCuC* (pC) *u	5
miR30c-C6	C6	miR-30c-1-3p	C*uGgGaGaGgGuUgUuUaCuC (pC) u	6

SEQUENCE LISTING

Sequence total quantity: 32

SEQ ID NO: 1 moltype = RNA length = 22

FEATURE Location/Qualifiers

source 1..22

mol_type = other RNA

organism = synthetic construct

modified_base 1

mod_base = OTHER

note = 2'-a GalNAc clicked cytidine

modified_base 1..3

mod_base = OTHER

note = Residues are connected through a phosphorothioate linkage

-continued

```

modified_base      2
                    mod_base = OTHER
                    note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar
                        modification
modified_base      4
                    mod_base = OTHER
                    note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar
                        modification
modified_base      3
                    mod_base = gm
modified_base      5
                    mod_base = gm
modified_base      6
                    mod_base = OTHER
                    note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar
                        modification
modified_base      7
                    mod_base = gm
modified_base      8
                    mod_base = OTHER
                    note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar
                        modification
modified_base      9
                    mod_base = gm
modified_base     10
                    mod_base = OTHER
                    note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar
                        modification
modified_base     11
                    mod_base = gm
modified_base     12
                    mod_base = OTHER
                    note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar
                        modification
modified_base     13
                    mod_base = um
modified_base     14
                    mod_base = OTHER
                    note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar
                        modification
modified_base     15
                    mod_base = um
modified_base     16
                    mod_base = OTHER
                    note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar
                        modification
modified_base     17
                    mod_base = um
modified_base     18
                    mod_base = OTHER
                    note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar
                        modification
modified_base     19
                    mod_base = cm
modified_base     20
                    mod_base = OTHER
                    note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar
                        modification
modified_base     21
                    mod_base = cm
modified_base     22
                    mod_base = OTHER
                    note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar
                        modification
modified_base     21^22
                    mod_base = OTHER
                    note = Residues are connected through a phosphorothioate
                        linkage

SEQUENCE: 1
ctgggagagg gttgtttact cc                                     22

SEQ ID NO: 2          moltype = RNA length = 22
FEATURE              Location/Qualifiers
source               1..22
                    mol_type = other RNA
                    organism = synthetic construct

```


-continued

modified_base	1^2 mod_base = OTHER note = Residues are connected through a phosphorothioate linkage
modified_base	19...22 mod_base = OTHER note = Residues are connected through a phosphorothioate linkage
modified_base	1 mod_base = OTHER note = 2'-a GalNAc clicked cytidine
modified_base	2 mod_base = OTHER note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification
modified_base	3 mod_base = gm
modified_base	4 mod_base = OTHER note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification
modified_base	5 mod_base = gm
modified_base	6 mod_base = OTHER note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification
modified_base	7 mod_base = gm
modified_base	8 mod_base = OTHER note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification
modified_base	9 mod_base = gm
modified_base	10 mod_base = OTHER note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification
modified_base	11 mod_base = gm
modified_base	12 mod_base = OTHER note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification
modified_base	13 mod_base = um
modified_base	14 mod_base = OTHER note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification
modified_base	15 mod_base = um
modified_base	16 mod_base = OTHER note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification
modified_base	17 mod_base = um
modified_base	18 mod_base = OTHER note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification
modified_base	19 mod_base = cm
modified_base	20 mod_base = OTHER note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification
modified_base	21 mod_base = cm
modified_base	22 mod_base = OTHER note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification

SEQUENCE: 2

-continued

```
ctgggagagg gttgtttact cc 22

SEQ ID NO: 3      moltype = RNA length = 22
FEATURE          Location/Qualifiers
source           1..22
                 mol_type = other RNA
                 organism = synthetic construct
modified_base    1..3
                 mod_base = OTHER
                 note = Residues are connected through a phosphorothioate
                 linkage
modified_base    19..22
                 mod_base = OTHER
                 note = Residues are connected through a phosphorothioate
                 linkage
modified_base    1
                 mod_base = OTHER
                 note = 2'-a GalNAc clicked cytidine
modified_base    2
                 mod_base = OTHER
                 note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar
                 modification
modified_base    3
                 mod_base = gm
modified_base    4
                 mod_base = OTHER
                 note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar
                 modification
modified_base    5
                 mod_base = gm
modified_base    6
                 mod_base = OTHER
                 note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar
                 modification
modified_base    7
                 mod_base = gm
modified_base    8
                 mod_base = OTHER
                 note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar
                 modification
modified_base    9
                 mod_base = gm
modified_base    10
                 mod_base = OTHER
                 note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar
                 modification
modified_base    11
                 mod_base = gm
modified_base    12
                 mod_base = OTHER
                 note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar
                 modification
modified_base    13
                 mod_base = um
modified_base    14
                 mod_base = OTHER
                 note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar
                 modification
modified_base    15
                 mod_base = um
modified_base    16
                 mod_base = OTHER
                 note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar
                 modification
modified_base    17
                 mod_base = um
modified_base    18
                 mod_base = OTHER
                 note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar
                 modification
modified_base    19
                 mod_base = cm
modified_base    20
                 mod_base = OTHER
                 note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar
                 modification
```

-continued

modified_base	21	
	mod_base = cm	
modified_base	22	
	mod_base = OTHER	
	note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar	
	modification	
SEQUENCE: 3		
ctgggagagg gttgtttact cc		22
SEQ ID NO: 4	moltype = RNA length = 21	
FEATURE	Location/Qualifiers	
source	1..21	
	mol_type = other RNA	
	organism = synthetic construct	
modified_base	20^21	
	mod_base = OTHER	
	note = Residues are connected through a phosphorothioate	
	linkage	
modified_base	1	
	mod_base = OTHER	
	note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar	
	modification	
modified_base	2	
	mod_base = gm	
modified_base	3	
	mod_base = OTHER	
	note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar	
	modification	
modified_base	4	
	mod_base = OTHER	
	note = Residue is 2'-O-methylated	
modified_base	5	
	mod_base = OTHER	
	note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar	
	modification	
modified_base	6	
	mod_base = OTHER	
	note = Residue is 2'-O-methylated	
modified_base	7	
	mod_base = OTHER	
	note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar	
	modification	
modified_base	8	
	mod_base = gm	
modified_base	9	
	mod_base = OTHER	
	note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar	
	modification	
modified_base	10	
	mod_base = um	
modified_base	11	
	mod_base = OTHER	
	note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar	
	modification	
modified_base	12	
	mod_base = gm	
modified_base	13	
	mod_base = OTHER	
	note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar	
	modification	
modified_base	14	
	mod_base = um	
modified_base	15	
	mod_base = OTHER	
	note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar	
	modification	
modified_base	16	
	mod_base = OTHER	
	note = Residue is 2'-O-methylated	
modified_base	17	
	mod_base = OTHER	
	note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar	
	modification	
modified_base	18	
	mod_base = um	
modified_base	19	

-continued

	mod_base = OTHER
	note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification
modified_base	20
	mod_base = OTHER
	note = 2'-a GalNAc clicked cytidine
modified_base	21
	mod_base = um
SEQUENCE: 4	
gggagagggt tgtttactcc t	21
SEQ ID NO: 5	moltype = RNA length = 21
FEATURE	Location/Qualifiers
source	1..21
	mol_type = other RNA
	organism = synthetic construct
modified_base	18..21
	mod_base = OTHER
	note = Residues are connected through a phosphorothioate linkage
modified_base	1
	mod_base = OTHER
	note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification
modified_base	2
	mod_base = gm
modified_base	3
	mod_base = OTHER
	note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification
modified_base	4
	mod_base = OTHER
	note = Residue is 2'-O-methylated
modified_base	5
	mod_base = OTHER
	note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification
modified_base	6
	mod_base = OTHER
	note = Residue is 2'-O-methylated
modified_base	7
	mod_base = OTHER
	note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification
modified_base	8
	mod_base = gm
modified_base	9
	mod_base = OTHER
	note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification
modified_base	10
	mod_base = um
modified_base	11
	mod_base = OTHER
	note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification
modified_base	12
	mod_base = gm
modified_base	13
	mod_base = OTHER
	note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification
modified_base	14
	mod_base = um
modified_base	15
	mod_base = OTHER
	note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification
modified_base	16
	mod_base = OTHER
	note = Residue is 2'-O-methylated
modified_base	17
	mod_base = OTHER
	note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification
modified_base	18

-continued

modified_base	19	mod_base = um	
		mod_base = OTHER	
		note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification	
modified_base	20		
		mod_base = OTHER	
		note = 2'-a GalNAc clicked cytidine	
modified_base	21		
		mod_base = um	
SEQUENCE: 5			
gggagagggt	tgtttactcc	t	21
SEQ ID NO: 6		moltype = RNA	length = 23
FEATURE		Location/Qualifiers	
source		1..23	
		mol_type = other RNA	
		organism = synthetic construct	
modified_base	1..3		
		mod_base = OTHER	
		note = Residues are connected through a phosphorothioate linkage	
modified_base	1		
		mod_base = OTHER	
		note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification	
modified_base	2		
		mod_base = um	
modified_base	3		
		mod_base = OTHER	
		note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification	
modified_base	4		
		mod_base = gm	
modified_base	5		
		mod_base = OTHER	
		note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification	
modified_base	6		
		mod_base = OTHER	
		note = Residue is 2'-O-methylated	
modified_base	7		
		mod_base = OTHER	
		note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification	
modified_base	8		
		mod_base = OTHER	
		note = Residue is 2'-O-methylated	
modified_base	9		
		mod_base = OTHER	
		note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification	
modified_base	10		
		mod_base = gm	
modified_base	11		
		mod_base = OTHER	
		note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification	
modified_base	12		
		mod_base = um	
modified_base	13		
		mod_base = OTHER	
		note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification	
modified_base	14		
		mod_base = gm	
modified_base	15		
		mod_base = OTHER	
		note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification	
modified_base	16		
		mod_base = um	
modified_base	17		
		mod_base = OTHER	
		note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification	

-continued

modified_base	18	
	mod_base = OTHER	
	note = Residue is 2'-O-methylated	
modified_base	19	
	mod_base = OTHER	
	note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar	
	modification	
modified_base	20	
	mod_base = um	
modified_base	21	
	mod_base = OTHER	
	note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar	
	modification	
modified_base	22	
	mod_base = OTHER	
	note = 2'-a GalNAc clicked cytidine	
modified_base	23	
	mod_base = um	
SEQUENCE: 6		
ctgggagagg gttgtttact cct		23
SEQ ID NO: 7	moltype = RNA length = 23	
FEATURE	Location/Qualifiers	
source	1..23	
	mol_type = other RNA	
	organism = synthetic construct	
SEQUENCE: 7		
tgtaaaccatc ctacactctc agc		23
SEQ ID NO: 8	moltype = RNA length = 22	
FEATURE	Location/Qualifiers	
source	1..22	
	mol_type = other RNA	
	organism = synthetic construct	
SEQUENCE: 8		
ctgggagagg gttgtttact cc		22
SEQ ID NO: 9	moltype = RNA length = 22	
FEATURE	Location/Qualifiers	
source	1..22	
	mol_type = other RNA	
	organism = synthetic construct	
SEQUENCE: 9		
ctgggagaag gctgtttact ct		22
SEQ ID NO: 10	moltype = DNA length = 21	
FEATURE	Location/Qualifiers	
source	1..21	
	mol_type = other DNA	
	organism = synthetic construct	
SEQUENCE: 10		
aaggagcgta ggtctttgca g		21
SEQ ID NO: 11	moltype = DNA length = 20	
FEATURE	Location/Qualifiers	
source	1..20	
	mol_type = other DNA	
	organism = synthetic construct	
SEQUENCE: 11		
agagctacga gctgcctgac		20
SEQ ID NO: 12	moltype = DNA length = 20	
FEATURE	Location/Qualifiers	
source	1..20	
	mol_type = other DNA	
	organism = synthetic construct	
SEQUENCE: 12		
agcactgtgt tggcgtagac		20
SEQ ID NO: 13	moltype = RNA length = 24	
FEATURE	Location/Qualifiers	
source	1..24	
	mol_type = other RNA	
	organism = synthetic construct	
SEQUENCE: 13		
tcacaacctc ctagaaagag taga		24

SEQ ID NO: 14	moltype = RNA length = 23	
FEATURE	Location/Qualifiers	
source	1..23	
	mol_type = other RNA	
	organism = synthetic construct	
SEQUENCE: 14		
tgtaaacatc ctacactctc agc		23
SEQ ID NO: 15	moltype = RNA length = 22	
FEATURE	Location/Qualifiers	
source	1..22	
	mol_type = other RNA	
	organism = synthetic construct	
modified_base	2	
	mod_base = um	
modified_base	3	
	mod_base = gm	
modified_base	4	
	mod_base = gm	
modified_base	5	
	mod_base = gm	
modified_base	6	
	mod_base = OTHER	
	note = Residue is 2'-O-methylated	
modified_base	7	
	mod_base = gm	
modified_base	8	
	mod_base = OTHER	
	note = Residue is 2'-O-methylated	
modified_base	9	
	mod_base = gm	
modified_base	10	
	mod_base = gm	
modified_base	11	
	mod_base = gm	
modified_base	12	
	mod_base = um	
modified_base	13	
	mod_base = um	
modified_base	14	
	mod_base = gm	
modified_base	15	
	mod_base = um	
modified_base	16	
	mod_base = um	
modified_base	17	
	mod_base = um	
modified_base	18	
	mod_base = OTHER	
	note = Residue is 2'-O-methylated	
modified_base	19	
	mod_base = cm	
modified_base	20	
	mod_base = um	
modified_base	21	
	mod_base = cm	
SEQUENCE: 15		
ctgggagagg gttgtttact cc		22
SEQ ID NO: 16	moltype = RNA length = 22	
FEATURE	Location/Qualifiers	
source	1..22	
	mol_type = other RNA	
	organism = synthetic construct	
modified_base	2	
	mod_base = p	
modified_base	3	
	mod_base = gm	
modified_base	4	
	mod_base = gm	
modified_base	5	
	mod_base = gm	
modified_base	6	
	mod_base = OTHER	
	note = Residue is 2'-O-methylated	

-continued

modified_base	7	
		mod_base = gm
modified_base	8	
		mod_base = OTHER
		note = Residue is 2'-O-methylated
modified_base	9	
		mod_base = gm
modified_base	10	
		mod_base = gm
modified_base	11	
		mod_base = gm
modified_base	12	
		mod_base = p
modified_base	13	
		mod_base = p
modified_base	14	
		mod_base = gm
modified_base	15	
		mod_base = p
modified_base	16	
		mod_base = p
modified_base	17	
		mod_base = p
modified_base	18	
		mod_base = OTHER
		note = Residue is 2'-O-methylated
modified_base	19	
		mod_base = cm
modified_base	20	
		mod_base = p
modified_base	21	
		mod_base = cm
SEQUENCE: 16		
cngggagagg	gnngnnnacn	cc
		22
SEQ ID NO: 17		
moltype = RNA length = 22		
FEATURE		
Location/Qualifiers		
1..22		
source		
mol_type = other RNA		
organism = synthetic construct		
modified_base	2	
		mod_base = p
modified_base	3	
		mod_base = gm
modified_base	4	
		mod_base = gm
modified_base	5	
		mod_base = gm
modified_base	7	
		mod_base = gm
modified_base	9	
		mod_base = gm
modified_base	10	
		mod_base = gm
modified_base	11	
		mod_base = gm
modified_base	12	
		mod_base = p
modified_base	13	
		mod_base = p
modified_base	14	
		mod_base = gm
modified_base	15	
		mod_base = p
modified_base	16	
		mod_base = p
modified_base	17	
		mod_base = p
modified_base	20	
		mod_base = p
SEQUENCE: 17		
cngggagagg	gnngnnnacn	cc
		22
SEQ ID NO: 18		
moltype = RNA length = 22		
FEATURE		
Location/Qualifiers		
1..22		
source		

-continued

	mol_type = other RNA	
	organism = synthetic construct	
modified_base	2	
	mod_base = um	
modified_base	3	
	mod_base = gm	
modified_base	4	
	mod_base = gm	
modified_base	5	
	mod_base = gm	
modified_base	6	
	mod_base = OTHER	
	note = Residue is 2'-O-methylated	
modified_base	7	
	mod_base = gm	
modified_base	8	
	mod_base = OTHER	
	note = Residue is 2'-O-methylated	
modified_base	9	
	mod_base = OTHER	
	note = Residue is 2'-O-methylated	
modified_base	10	
	mod_base = gm	
modified_base	11	
	mod_base = gm	
modified_base	12	
	mod_base = cm	
modified_base	13	
	mod_base = um	
modified_base	14	
	mod_base = gm	
modified_base	15	
	mod_base = um	
modified_base	16	
	mod_base = um	
modified_base	17	
	mod_base = um	
modified_base	18	
	mod_base = OTHER	
	note = Residue is 2'-O-methylated	
modified_base	19	
	mod_base = cm	
modified_base	20	
	mod_base = um	
modified_base	21	
	mod_base = cm	
SEQUENCE: 18		
ctgggagaag gctgtttact ct		22
SEQ ID NO: 19	moltype = RNA length = 22	
FEATURE	Location/Qualifiers	
source	1..22	
	mol_type = other RNA	
	organism = synthetic construct	
modified_base	1	
	mod_base = cm	
modified_base	2	
	mod_base = p	
modified_base	3	
	mod_base = gm	
modified_base	4	
	mod_base = gm	
modified_base	5	
	mod_base = gm	
modified_base	6	
	mod_base = OTHER	
	note = Residue is 2'-O-methylated	
modified_base	7	
	mod_base = gm	
modified_base	8	
	mod_base = OTHER	
	note = Residue is 2'-O-methylated	
modified_base	9	
	mod_base = OTHER	
	note = Residue is 2'-O-methylated	
modified_base	10	

-continued

modified_base	11	mod_base = gm	
modified_base	12	mod_base = gm	
modified_base	13	mod_base = cm	
modified_base	14	mod_base = p	
modified_base	15	mod_base = gm	
modified_base	16	mod_base = p	
modified_base	17	mod_base = p	
modified_base	18	mod_base = p	
modified_base	19	mod_base = OTHER	
		note = Residue is 2'-O-methylated	
modified_base	20	mod_base = cm	
modified_base	21	mod_base = p	
modified_base	22	mod_base = cm	
SEQUENCE: 19			
cngggagaag gcngnnnacn	ct		22
SEQ ID NO: 20		moltype = RNA length = 22	
FEATURE		Location/Qualifiers	
source	1..22		
		mol_type = other RNA	
		organism = synthetic construct	
modified_base	2	mod_base = p	
modified_base	3	mod_base = gm	
modified_base	4	mod_base = gm	
modified_base	7	mod_base = gm	
modified_base	10	mod_base = gm	
modified_base	13	mod_base = p	
modified_base	11	mod_base = gm	
modified_base	14	mod_base = gm	
modified_base	15	mod_base = p	
modified_base	16	mod_base = p	
modified_base	17	mod_base = p	
modified_base	20	mod_base = p	
modified_base	5	mod_base = gm	
SEQUENCE: 20			
cngggagaag gcngnnnacn	ct		22
SEQ ID NO: 21		moltype = RNA length = 22	
FEATURE		Location/Qualifiers	
source	1..22		
		mol_type = other RNA	
		organism = synthetic construct	
modified_base	1	mod_base = OTHER	
		note = 2'-a GalNAc clicked cytidine	
modified_base	2	mod_base = OTHER	
		note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification	
modified_base	3	mod_base = gm	
modified_base	4		

-continued

	mod_base = OTHER
	note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar
	modification
modified_base	5
	mod_base = gm
modified_base	6
	mod_base = OTHER
	note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar
	modification
modified_base	7
	mod_base = gm
modified_base	8
	mod_base = OTHER
	note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar
	modification
modified_base	9
	mod_base = gm
modified_base	10
	mod_base = OTHER
	note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar
	modification
modified_base	11
	mod_base = gm
modified_base	12
	mod_base = OTHER
	note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar
	modification
modified_base	13
	mod_base = um
modified_base	14
	mod_base = OTHER
	note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar
	modification
modified_base	15
	mod_base = um
modified_base	16
	mod_base = OTHER
	note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar
	modification
modified_base	17
	mod_base = um
modified_base	18
	mod_base = OTHER
	note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar
	modification
modified_base	19
	mod_base = cm
modified_base	20
	mod_base = OTHER
	note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar
	modification
modified_base	21
	mod_base = cm
modified_base	22
	mod_base = OTHER
	note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar
	modification
SEQUENCE: 21	
ctgggagagg gttgtttact cc	22
SEQ ID NO: 22	moltype = RNA length = 23
FEATURE	Location/Qualifiers
source	1..23
	mol_type = other RNA
	organism = synthetic construct
modified_base	1
	mod_base = OTHER
	note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar
	modification
modified_base	2
	mod_base = um
modified_base	3
	mod_base = OTHER
	note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar
	modification
modified_base	4

-continued

modified_base	5 mod_base = gm mod_base = OTHER note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification
modified_base	6 mod_base = OTHER note = Residue is 2'-O-methylated
modified_base	7 mod_base = OTHER note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification
modified_base	8 mod_base = OTHER note = Residue is 2'-O-methylated
modified_base	9 mod_base = OTHER note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification
modified_base	10 mod_base = gm
modified_base	11 mod_base = OTHER note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification
modified_base	12 mod_base = um
modified_base	13 mod_base = OTHER note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification
modified_base	14 mod_base = gm
modified_base	15 mod_base = OTHER note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification
modified_base	16 mod_base = um
modified_base	17 mod_base = OTHER note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification
modified_base	18 mod_base = OTHER note = Residue is 2'-O-methylated
modified_base	19 mod_base = OTHER note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification
modified_base	20 mod_base = um
modified_base	21 mod_base = OTHER note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification
modified_base	22 mod_base = OTHER note = 2'-a GalNAc clicked cytidine
modified_base	23 mod_base = um
SEQUENCE: 22	
ctgggagagg gttgtttact cct	23

SEQ ID NO: 23	moltype = RNA length = 23
FEATURE	Location/Qualifiers
source	1..23 mol_type = other RNA organism = synthetic construct
modified_base	1 mod_base = OTHER note = 2'-a GalNAc clicked cytidine
modified_base	2 mod_base = um
modified_base	3 mod_base = OTHER

-continued

	note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification
modified_base	4
	mod_base = gm
modified_base	5
	mod_base = OTHER
	note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification
modified_base	6
	mod_base = OTHER
	note = Residue is 2'-O-methylated
modified_base	7
	mod_base = OTHER
	note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification
modified_base	8
	mod_base = OTHER
	note = Residue is 2'-O-methylated
modified_base	9
	mod_base = OTHER
	note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification
modified_base	10
	mod_base = gm
modified_base	11
	mod_base = OTHER
	note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification
modified_base	12
	mod_base = um
modified_base	13
	mod_base = OTHER
	note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification
modified_base	14
	mod_base = gm
modified_base	15
	mod_base = OTHER
	note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification
modified_base	16
	mod_base = um
modified_base	17
	mod_base = OTHER
	note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification
modified_base	18
	mod_base = OTHER
	note = Residue is 2'-O-methylated
modified_base	19
	mod_base = OTHER
	note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification
modified_base	20
	mod_base = um
modified_base	21
	mod_base = OTHER
	note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification
modified_base	22
	mod_base = OTHER
	note = 2'-a GalNAc clicked cytidine
modified_base	23
	mod_base = um

SEQUENCE: 23
ctgggagagg gttgtttact cct

SEQ ID NO: 24
FEATURE
source
mol_type = other RNA
organism = synthetic construct

modified_base	1
	mod_base = OTHER
	note = 2'-a GalNAc clicked cytidine
modified_base	2

23

-continued

	mod_base = OTHER
	note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar
	modification
modified_base	3
	mod_base = gm
modified_base	4
	mod_base = OTHER
	note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar
	modification
modified_base	5
	mod_base = gm
modified_base	6
	mod_base = OTHER
	note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar
	modification
modified_base	7
	mod_base = gm
modified_base	8
	mod_base = OTHER
	note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar
	modification
modified_base	9
	mod_base = OTHER
	note = Residue is 2'-O-methylated
modified_base	10
	mod_base = OTHER
	note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar
	modification
modified_base	11
	mod_base = gm
modified_base	12
	mod_base = OTHER
	note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar
	modification
modified_base	13
	mod_base = um
modified_base	14
	mod_base = OTHER
	note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar
	modification
modified_base	15
	mod_base = um
modified_base	16
	mod_base = OTHER
	note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar
	modification
modified_base	17
	mod_base = um
modified_base	18
	mod_base = OTHER
	note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar
	modification
modified_base	19
	mod_base = cm
modified_base	20
	mod_base = OTHER
	note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar
	modification
modified_base	21
	mod_base = cm
modified_base	22
	mod_base = OTHER
	note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar
	modification
SEQUENCE: 24	
ctgggagaag gctgtttact ct	22
SEQ ID NO: 25	moltype = RNA length = 23
FEATURE	Location/Qualifiers
source	1..23
	mol_type = other RNA
	organism = synthetic construct
modified_base	1
	mod_base = OTHER
	note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar
	modification

-continued

```

modified_base      2
                    mod_base = um
modified_base      3
                    mod_base = OTHER
                    note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar
                        modification
modified_base      4
                    mod_base = gm
modified_base      5
                    mod_base = OTHER
                    note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar
                        modification
modified_base      6
                    mod_base = OTHER
                    note = Residue is 2'-O-methylated
modified_base      7
                    mod_base = OTHER
                    note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar
                        modification
modified_base      8
                    mod_base = OTHER
                    note = Residue is 2'-O-methylated
modified_base      9
                    mod_base = OTHER
                    note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar
                        modification
modified_base     10
                    mod_base = gm
modified_base     11
                    mod_base = OTHER
                    note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar
                        modification
modified_base     12
                    mod_base = um
modified_base     13
                    mod_base = OTHER
                    note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar
                        modification
modified_base     14
                    mod_base = gm
modified_base     15
                    mod_base = OTHER
                    note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar
                        modification
modified_base     16
                    mod_base = um
modified_base     17
                    mod_base = OTHER
                    note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar
                        modification
modified_base     18
                    mod_base = OTHER
                    note = Residue is 2'-O-methylated
modified_base     19
                    mod_base = OTHER
                    note = 2'-a GalNAc clicked cytidine
modified_base     20
                    mod_base = OTHER
                    note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar
                        modification
modified_base     21
                    mod_base = OTHER
                    note = 2'-a GalNAc clicked cytidine
modified_base     22
                    mod_base = OTHER
                    note = 2'-a GalNAc clicked cytidine
modified_base     23
                    mod_base = um
SEQUENCE: 25
ctgggagagg gttgtttact cct

SEQ ID NO: 26      moltype = RNA length = 23
FEATURE           Location/Qualifiers
source            1..23
                  mol_type = other RNA
                  organism = synthetic construct

```

23

-continued

modified_base	1	mod_base = OTHER
		note = 2'-a GalNAc clicked cytidine
modified_base	2	mod_base = OTHER
		note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification
modified_base	3	mod_base = gm
modified_base	4	mod_base = OTHER
		note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification
modified_base	5	mod_base = gm
modified_base	6	mod_base = OTHER
		note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification
modified_base	7	mod_base = gm
modified_base	8	mod_base = OTHER
		note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification
modified_base	9	mod_base = gm
modified_base	10	mod_base = OTHER
		note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification
modified_base	11	mod_base = gm
modified_base	12	mod_base = OTHER
		note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification
modified_base	13	mod_base = um
modified_base	14	mod_base = OTHER
		note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification
modified_base	15	mod_base = um
modified_base	16	mod_base = OTHER
		note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification
modified_base	17	mod_base = um
modified_base	18	mod_base = OTHER
		note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification
modified_base	19	mod_base = OTHER
		note = 2'-a GalNAc clicked cytidine
modified_base	20	mod_base = OTHER
		note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification
modified_base	21	mod_base = OTHER
		note = 2'-a GalNAc clicked cytidine
modified_base	22	mod_base = OTHER
		note = 2'-a GalNAc clicked cytidine
modified_base	23	mod_base = um

SEQUENCE: 26
ctgggagagg gttgtttact cct

SEQ ID NO: 27 moltype = RNA length = 22
FEATURE Location/Qualifiers
source 1..22

-continued

	mol_type = other RNA
	organism = synthetic construct
modified_base	1
	mod_base = OTHER
	note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification
modified_base	2
	mod_base = um
modified_base	3
	mod_base = OTHER
	note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification
modified_base	4
	mod_base = gm
modified_base	5
	mod_base = OTHER
	note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification
modified_base	6
	mod_base = OTHER
	note = Residue is 2'-O-methylated
modified_base	7
	mod_base = OTHER
	note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification
modified_base	8
	mod_base = OTHER
	note = Residue is 2'-O-methylated
modified_base	9
	mod_base = OTHER
	note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification
modified_base	10
	mod_base = gm
modified_base	11
	mod_base = OTHER
	note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification
modified_base	12
	mod_base = OTHER
	note = 2'-a GalNAc clicked cytidine
modified_base	13
	mod_base = um
modified_base	14
	mod_base = OTHER
	note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification
modified_base	15
	mod_base = um
modified_base	16
	mod_base = OTHER
	note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification
modified_base	17
	mod_base = um
modified_base	18
	mod_base = OTHER
	note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification
modified_base	19
	mod_base = OTHER
	note = 2'-a GalNAc clicked cytidine
modified_base	20
	mod_base = um
modified_base	21
	mod_base = OTHER
	note = 2'-a GalNAc clicked cytidine
modified_base	22
	mod_base = OTHER
	note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification
SEQUENCE: 27	
ctgggagaag gctgtttact ct	22
SEQ ID NO: 28	moltype = RNA length = 22
FEATURE	Location/Qualifiers

-continued

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source          1..22
                 mol_type = other RNA
                 organism = synthetic construct
modified_base   1
                 mod_base = OTHER
                 note = 2'-a GalNAc clicked cytidine
modified_base   2
                 mod_base = OTHER
                 note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar
                   modification
modified_base   3
                 mod_base = gm
modified_base   4
                 mod_base = OTHER
                 note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar
                   modification
modified_base   5
                 mod_base = gm
modified_base   6
                 mod_base = OTHER
                 note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar
                   modification
modified_base   7
                 mod_base = gm
modified_base   8
                 mod_base = OTHER
                 note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar
                   modification
modified_base   9
                 mod_base = OTHER
                 note = Residue is 2'-O-methylated
modified_base  10
                 mod_base = OTHER
                 note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar
                   modification
modified_base  11
                 mod_base = gm
modified_base  12
                 mod_base = OTHER
                 note = 2'-a GalNAc clicked cytidine
modified_base  13
                 mod_base = OTHER
                 note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar
                   modification
modified_base  14
                 mod_base = gm
modified_base  15
                 mod_base = OTHER
                 note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar
                   modification
modified_base  16
                 mod_base = um
modified_base  17
                 mod_base = OTHER
                 note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar
                   modification
modified_base  18
                 mod_base = OTHER
                 note = Residue is 2'-O-methylated
modified_base  19
                 mod_base = OTHER
                 note = 2'-a GalNAc clicked cytidine
modified_base  20
                 mod_base = OTHER
                 note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar
                   modification
modified_base  21
                 mod_base = OTHER
                 note = 2'-a GalNAc clicked cytidine
modified_base  22
                 mod_base = um

SEQUENCE: 28
ctgggagaag gctgtttact ct

SEQ ID NO: 29      moltype = RNA  length = 24
FEATURE            Location/Qualifiers

```

22

-continued

source	1..24 mol_type = other RNA organism = synthetic construct
modified_base	1 mod_base = OTHER note = 2'-a GalNAc clicked cytidine
modified_base	2 mod_base = OTHER note = 2'-a GalNAc clicked cytidine
modified_base	3 mod_base = OTHER note = 2'-a GalNAc clicked cytidine
modified_base	4 mod_base = OTHER note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification
modified_base	5 mod_base = gm
modified_base	6 mod_base = OTHER note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification
modified_base	7 mod_base = gm
modified_base	8 mod_base = OTHER note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification
modified_base	9 mod_base = gm
modified_base	10 mod_base = OTHER note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification
modified_base	11 mod_base = gm
modified_base	12 mod_base = OTHER note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification
modified_base	13 mod_base = gm
modified_base	14 mod_base = OTHER note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification
modified_base	15 mod_base = um
modified_base	16 mod_base = OTHER note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification
modified_base	17 mod_base = um
modified_base	18 mod_base = OTHER note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification
modified_base	19 mod_base = um
modified_base	20 mod_base = OTHER note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification
modified_base	21 mod_base = cm
modified_base	22 mod_base = OTHER note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification
modified_base	23 mod_base = cm
modified_base	24 mod_base = OTHER note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification

-continued

SEQUENCE: 29

ccctgggaga gggttgttta ctcc

24

SEQ ID NO: 30 moltype = RNA length = 24
FEATURE Location/Qualifiers
source 1..24
 mol_type = other RNA
 organism = synthetic construct
modified_base 1
 mod_base = OTHER
 note = 2'-a GalNAc clicked cytidine
modified_base 2
 mod_base = OTHER
 note = 2'-a GalNAc clicked cytidine
modified_base 3
 mod_base = OTHER
 note = 2'-a GalNAc clicked cytidine
modified_base 4
 mod_base = OTHER
 note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar
 modification
modified_base 5
 mod_base = gm
modified_base 6
 mod_base = OTHER
 note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar
 modification
modified_base 7
 mod_base = gm
modified_base 8
 mod_base = OTHER
 note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar
 modification
modified_base 9
 mod_base = gm
modified_base 10
 mod_base = OTHER
 note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar
 modification
modified_base 11
 mod_base = OTHER
 note = Residue is 2'-O-methylated
modified_base 12
 mod_base = OTHER
 note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar
 modification
modified_base 13
 mod_base = gm
modified_base 14
 mod_base = OTHER
 note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar
 modification
modified_base 15
 mod_base = um
modified_base 16
 mod_base = OTHER
 note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar
 modification

-continued

modified_base	17	mod_base = um
modified_base	18	mod_base = OTHER
		note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification
modified_base	19	mod_base = um
modified_base	20	mod_base = OTHER
		note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification
modified_base	21	mod_base = cm
modified_base	22	mod_base = OTHER
		note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification
modified_base	23	mod_base = cm
modified_base	24	mod_base = OTHER
		note = Residue has a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification

SEQUENCE: 30
ccctgggaga aggtgttta ctct 24

SEQ ID NO: 31	moltype = RNA length = 24
FEATURE	Location/Qualifiers
source	1..24
	mol_type = other RNA
	organism = synthetic construct
modified_base	1
	mod_base = OTHER
	note = 2'-a GalNAc clicked cytidine
modified_base	2
	mod_base = OTHER
	note = 2'-a GalNAc clicked cytidine
modified_base	3
	mod_base = OTHER
	note = 2'-a GalNAc clicked cytidine
modified_base	4
	mod_base = um
modified_base	5
	mod_base = gm
modified_base	6
	mod_base = gm
modified_base	7
	mod_base = gm
modified_base	8
	mod_base = OTHER
	note = Residue is 2'-O-methylated
modified_base	9
	mod_base = gm
modified_base	10
	mod_base = OTHER
	note = Residue is 2'-O-methylated
modified_base	11
	mod_base = OTHER
	note = Residue is 2'-O-methylated
modified_base	12
	mod_base = gm
modified_base	13
	mod_base = gm
modified_base	14
	mod_base = cm
modified_base	15
	mod_base = um
modified_base	16
	mod_base = gm
modified_base	17
	mod_base = um
modified_base	18
	mod_base = um
modified_base	19
	mod_base = um

-continued

```

modified_base      20
                    mod_base = OTHER
                    note = Residue is 2'-O-methylated
modified_base      21
                    mod_base = cm
modified_base      22
                    mod_base = um
modified_base      23
                    mod_base = cm
modified_base      24
                    mod_base = um
SEQUENCE: 31
ccctgggaga aggctgttta ctct                                24

SEQ ID NO: 32      moltype = DNA length = 21
FEATURE           Location/Qualifiers
source            1..21
                  mol_type = other DNA
                  organism = synthetic construct
SEQUENCE: 32
tgtggcctta ctatggagga a                                    21

```

What is claimed is:

1. A double stranded polynucleotide complex, the double stranded polynucleotide complex comprising a first strand which optionally comprises no nucleotide modifications and a second strand comprising nucleotide modifications forms the double stranded polynucleotide complex with the first strand, wherein the second strand comprising the modifications comprises a sequence selected from the group sequences consisting of:

7. A method for inhibiting apoB secretion from cells, the method comprising introducing into the cells the double stranded polynucleotide complex of claim 1.

8. The method of claim 7, wherein the second strand comprises the C2 strand.

9. The method of claim 8, wherein the first strand comprises no nucleotide modifications.

10. The method of claim 7, wherein the introducing into the cells does not reduce apoA1 secretion, or reduces apoA1

					SEQ ID NO:
miR30c-C1	C1	miR-30c-1-3p	(pC)•U•gGgAgAgGgUuGuUuAcUc•C	1	
miR30c-C2	C2	miR-30c-1-3p	(pC)•UgGgAgAgGgUuGuUuAc•U•c•C	2	
miR30c-C3	C3	miR-30c-1-3p	(pC)•U•gGgAgAgGgUuGuUuAc•U•c•C	3	
miR30c-C4	C4	miR-30c-1-3p	GgGaGaGgGuUgUuUaCuC (pC)•u	4	
miR30c-C5	C5	miR-30c-1-3p	GgGaGaGgGuUgUuUaCu•C• (pC)•u	5	
miR30c-C6	C6	miR-30c-1-3p	C•u•GgGaGaGgGuUgUuUaCuC (pC) u	6	

wherein upper case letters signify a 2'-deoxy-2'-fluoro (2'-F) ribosugar modification; lower case letters signify a 2'-O-methyl (2'-OMe) ribosugar modification; pC signifies 2'-a GalNAc clicked cytidine, and the symbol signifies a phosphorothioate linkage.

2. The double stranded polynucleotide complex of claim 1, wherein the second strand comprises the C2 strand.

3. The double stranded polynucleotide complex of claim 2, wherein the first strand comprises no nucleotide modifications.

4. A composition comprising the double stranded polynucleotide complex of claim 1, wherein the composition is liposome and viral vector free.

5. The composition of claim 4, wherein the second strand comprises the C2 strand.

6. The composition of claim 5, wherein the first strand comprises no nucleotide modifications.

secretion less than a control value obtained from introducing into the cells a double stranded polynucleotide complex that does comprise the C2 strand.

11. The method of claim 8, wherein the introducing into the cells does not reduce apoA1 secretion, or reduces apoA1 secretion less than a control value obtained from introducing into the cells a double stranded polynucleotide complex that does comprise the C2 strand.

12. The method of claim 9, wherein the introducing into the cells does not reduce apoA1 secretion, or reduces apoA1 secretion less than a control value obtained from introducing into the cells a double stranded polynucleotide complex that does comprise the C2 strand.

13. The method of claim 7, wherein the cells are human liver cells.

14. The method of claim 8, wherein the cells are human liver cells.

15. The method of claim 9, wherein the cells are human liver cells.

16. The method of claim **10**, wherein the cells are human liver cells.

17. The method of claim **11**, wherein the cells are human liver cells.

18. The method of claim **12**, wherein the cells are human liver cells.

19. The method of claim **8**, wherein the cells are human liver cells that are present in an individual.

20. The method of claim **9**, wherein the cells are human liver cells that are present in an individual.

* * * * *



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सत्यमेव जयते

क्रम सं/SL No : 011181917



पेटेंट कार्यालय, भारत सरकार

The Patent Office, Government Of India

पेटेंट प्रमाण पत्र

Patent Certificate

(पेटेंट नियमावली का नियम 74)

(Rule 74 of The Patents Rules)

पेटेंट सं. / Patent No.

476616

आवेदन सं. / Application No.

202111048240

फाइल करने की तारीख / Date of Filing

22/10/2021

पेटेंटी / Patentee

1.SURANJIT KUMAR PRASAD 2.ANUSHREE 3.SHIVESH
KUMAR AZAD 4.KAVITA SINGH

प्रमाणित किया जाता है कि पेटेंटी को, उपरोक्त आवेदन में यथाप्रकरित **SORBIPUREAF, AN-ION EXCHANGER ENHANCES POTABILITY OF WATER BY BRINGING ARSENIC AND FLUORIDE LEVEL WITHIN LEVEL OF PERMISSIBLE LIMIT I.E. 10PPB AND 1.5 PPM, RESPECTIVELY** नामक आविष्कार के लिए, पेटेंट अधिनियम, 1970 के उपबंधों के अनुसार आज तारीख अक्टूबर 2021 के बाईसवें दिन से बीस वर्ष की अवधि के लिए पेटेंट अनुदत्त किया गया है।

It is hereby certified that a patent has been granted to the patentee for an invention entitled **SORBIPUREAF, AN-ION EXCHANGER ENHANCES POTABILITY OF WATER BY BRINGING ARSENIC AND FLUORIDE LEVEL WITHIN LEVEL OF PERMISSIBLE LIMIT I.E. 10PPB AND 1.5 PPM, RESPECTIVELY** as disclosed in the above mentioned application for the term of 20 years from the 22nd day of October 2021 in accordance with the provisions of the Patents Act, 1970.



(Signature)

Controller of Patents

अनुदान की तारीख : 04/12/2023
Date of Grant :

टिप्पणी - इस पेटेंट के नवीकरण के लिए फीस, यदि इसे बनाए रखा जाना है, अक्टूबर 2023 के बाईसवें दिन को और उसके पश्चात प्रत्येक वर्ष में उसी दिन देय होगी।

Note. - The fees for renewal of this patent, if it is to be maintained, will fall / has fallen due on 22nd day of October 2023 and on the same day in every year thereafter.



सत्यमेव जयते



पेटेंट कार्यालय, भारत सरकार

The Patent Office, Government Of India

पेटेंट प्रमाण पत्र

Patent Certificate

(पेटेंट नियमावली का नियम 74)

(Rule 74 of The Patents Rules)

पेटेंट सं. / Patent No. 468381

आवेदन सं. / Application No. 201611044997

फाइल करने की तारीख / Date of Filing 30/12/2016

पेटेंटी / Patentee

1.ANIL PANDEY 2.NEELAM YADAV 3.VINITA PURANIK
4.ARUNDHATI VERMA

आविष्कारकों का नाम / Name of Inventor(s)

1.na 2.ANIL PANDEY 3.NEELAM YADAV 4.VINITA PURANIK
5.ARUNDHATI VERMA 6.KOMAL BHADORIA

प्रमाणित किया जाता है कि पेटेंटी को, उपरोक्त आवेदन में यथाप्रकटित **PROCESS UTILITY AND APPLICATION OF STRESS TOLERANT PROBIOTICS** नामक आविष्कार के लिए, पेटेंट अधिनियम, 1970 के उपबंधों के अनुसार आज तारीख दिसम्बर 2016 के तीसरे दिन से बीस वर्ष की अवधि के लिए पेटेंट अनुदत्त किया गया है।

It is hereby certified that a patent has been granted to the patentee for an invention entitled **PROCESS UTILITY AND APPLICATION OF STRESS TOLERANT PROBIOTICS** as disclosed in the above mentioned application for the term of 20 years from the 30th day of December 2016 in accordance with the provisions of the Patents Act, 1970.

अनुदान की तारीख : 10/11/2023
Date of Grant :



[Signature]

पेटेंट नियंत्रक
Controller of Patents

टिप्पणी - इस पेटेंट के नवीकरण के लिए फीस, यदि इसे बनाए रखा जाना है, दिसम्बर 2018 के तीसरे दिन को और उसके पश्चात प्रत्येक वर्ष में उसी दिन देय होगी।

Note. - The fees for renewal of this patent, if it is to be maintained, will fall / has fallen due on 30th day of December 2018 and on the same day in every year thereafter.

*चूंकि पेटेंटी व आविष्कारकों की संख्या अधिक है, पेटेंटी व आविष्कारकों के नाम पृष्ठ संख्या 2 पर जारी हैं।

*Since the Number of Patentees / Inventors is more, the name of Patentees / Inventors are continued on Page No. 2



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पेटेंट प्रमाणपत्र के लिए अनुलग्नक/Annexure to Patent Certificate

पेटेंट सं. / Patent No.

468381

आवेदन सं. / Application No.

201611044997

फाइल करने की तारीख / Date of Filing

30/12/2016

पेटेंटी / Patentee (जारी/Continued)

5.KOMAL BHADORIA



ORIGINAL

क्रम सं/ Serial No.: 160618



पेटेंट कार्यालय, भारत सरकार

The Patent Office, Government Of India

डिजाइन के पंजीकरण का प्रमाण पत्र

Certificate of Registration of Design

डिजाइन सं. / Design No.

404150-001

तारीख / Date

09/01/2024

पारस्परिकता तारीख / Reciprocity Date*

देश / Country

प्रमाणित किया जाता है कि संलग्न प्रति में वर्णित डिजाइन जो **MATHEMATICS LEARNING DEVICE (ETHNOMATHEMATICS BASED)** से संबंधित है, का पंजीकरण, श्रेणी 19-07 में 1.Dr. Harish Pandey 2. Dr. Manish Kumar Gautam 3.Prof. Kaushal Kishore 4.Dr. Kishor Kumar के नाम में उपर्युक्त संख्या और तारीख में कर लिया गया है।

Certified that the design of which a copy is annexed hereto has been registered as of the number and date given above in class 19-07 in respect of the application of such design to **MATHEMATICS LEARNING DEVICE (ETHNOMATHEMATICS BASED)** in the name of 1.Dr. Harish Pandey 2. Dr. Manish Kumar Gautam 3.Prof. Kaushal Kishore 4.Dr. Kishor Kumar.

डिजाइन अधिनियम, 2000 तथा डिजाइन नियम, 2001 के अधधीन प्रावधानों के अनुसरण में।

In pursuance of and subject to the provisions of the Designs Act, 2000 and the Designs Rules, 2001.

जारी करने की तिथि :

Date of Issue

15/03/2024



डिजाइन की पंजीकरण

महानियंत्रक पेटेंट, डिजाइन और व्यापार चिह्न
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*पारस्परिकता तारीख (यदि कोई हो) जिसकी अनुमति दी गई है तथा देश का नाम। डिजाइन का स्वत्वाधिकार पंजीकरण की तारीख से दस वर्षों के लिए होगा जिसका विस्तार, अधिनियम एवं नियम के निबंधनों के अधीन, पाँच वर्षों की अतिरिक्त अवधि के लिए किया जा सकेगा। इस प्रमाण पत्र का उपयोग विधिक कार्यवाहियों अथवा विदेश में पंजीकरण प्राप्त करने के लिए नहीं हो सकता है।

The reciprocity date (if any) which has been allowed and the name of the country. Copyright in the design will subsist for ten years from the date of Registration, and may under the terms of the Act and Rules, be extended for a further period of five years. This Certificate is not for use in legal proceedings or for obtaining registration abroad.



ORIGINAL

क्रम सं/ Serial No.: 148051



पेटेंट कार्यालय, भारत सरकार

The Patent Office, Government Of India

डिजाइन के पंजीकरण का प्रमाण पत्र

Certificate of Registration of Design

डिजाइन सं. / Design No.

370182-001

तारीख / Date

31/08/2022

पारस्परिकता तारीख / Reciprocity Date*

देश / Country

प्रमाणित किया जाता है कि संलग्न प्रति में वर्णित डिजाइन जो COVID VENTILATION MASK से संबंधित है, का पंजीकरण, श्रेणी 29-02 में 1.Dr. Munish Kumar 2. Dr. Sivakumar Vijayaraghavalu 3.Mr. Rishabh Kumar 4.Dr. Shambhusharan Tripathi 5.Dr. Shailendra Kumar Mishra 6.Dr. Syed Ibrahim Rizvi 7.Dr. P. Karthigeyan के नाम में उपर्युक्त संख्या और तारीख में कर लिया गया है।

Certified that the design of which a copy is annexed hereto has been registered as of the number and date given above in class 29-02 in respect of the application of such design to COVID VENTILATION MASK in the name of 1.Dr. Munish Kumar 2. Dr. Sivakumar Vijayaraghavalu 3.Mr. Rishabh Kumar 4.Dr. Shambhusharan Tripathi 5.Dr. Shailendra Kumar Mishra 6.Dr. Syed Ibrahim Rizvi 7.Dr. P. Karthigeyan.

डिजाइन अधिनियम, 2000 तथा डिजाइन नियम, 2001 के अधधीन प्रावधानों के अनुसरण में।

In pursuance of and subject to the provisions of the Designs Act, 2000 and the Designs Rules, 2001.

जारी करने की तिथि : 08/11/2023
Date of Issue



महानियंत्रक पेटेंट, डिजाइन और व्यापार चिह्न
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The reciprocity date (if any) which has been allowed and the name of the country. Copyright in the design will subsist for ten years from the date of Registration, and may under the terms of the Act and Rules, be extended for a further period of five years. This Certificate is not for use in legal proceedings or for obtaining registration abroad.



ORIGINAL

क्रम सं/ Serial No.: 1401445



पेटेंट कार्यालय, भारत सरकार

The Patent Office, Government Of India

डिजाइन के पंजीकरण का प्रमाण पत्र

Certificate of Registration of Design

डिजाइन सं. / Design No.

370183-001

तारीख / Date

31/08/2022

पारस्परिकता तारीख / Reciprocity Date*

देश / Country

प्रमाणित किया जाता है कि संलग्न प्रति में वर्णित डिजाइन जो **RACK SHELF FOR DRUGS** है, का पंजीकरण, श्रेणी 06-04 में 1.Dr. Munish Kumar 2. Dr. Sivakumar Vijayaraghavalu 3.Dr. Selvamarmarjunan 4.Ms. Zainab Feroz 5.Ms. Priyankagautam 6.Mr. Anurag Mishra 7.Dr. S Vijayanand 8.Dr. Challaraj Emmanuel E S 9.R. P. Rajarajan 10.Dr. U B Yadav 11.Dr. P. Karthigeyan के नाम में उपर्युक्त संख्या और तारीख में कर लिया गया है।

Certified that the design of which a copy is annexed hereto has been registered as of the number and date given above in class 06-04 in respect of the application of such design to **RACK SHELF FOR DRUGS** in the name of 1.Dr. Munish Kumar 2. Dr. Sivakumar Vijayaraghavalu 3.Dr. Selvamarmarjunan 4.Ms. Zainab Feroz 5.Ms. Priyankagautam 6.Mr. Anurag Mishra 7.Dr. S Vijayanand 8.Dr. Challaraj Emmanuel E S 9.R. P. Rajarajan 10.Dr. U B Yadav 11.Dr. P. Karthigeyan.

डिजाइन अधिनियम, 2000 तथा डिजाइन नियम, 2001 के अध्याधीन प्रावधानों के अनुसरण में।

In pursuance of and subject to the provisions of the Designs Act, 2000 and the Designs Rules, 2001.

जारी करने की तिथि : 06/07/2023
Date of Issue



महानियंत्रक पेटेंट, डिजाइन और व्यापार चिह्न
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The reciprocity date (if any) which has been allowed and the name of the country. Copyright in the design will subsist for ten years from the date of Registration, and may under the terms of the Act and Rules, be extended for a further period of five years. This Certificate is not for use in legal proceedings or for obtaining registration abroad.



ORIGINAL

मूल/No : 127124



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GOVERNMENT OF INDIA
पेटेंट कार्यालय
THE PATENT OFFICE
डिजाइन के पंजीकरण का प्रमाणपत्र
CERTIFICATE OF REGISTRATION OF DESIGN

डिजाइन सं. / Design No. : 341565-001
तारीख / Date : 26/03/2021
पारस्परिकता तारीख / Reciprocity Date* :
देश / Country :

प्रमाणित किया जाता है कि संलग्न प्रति में वर्णित डिजाइन जो **SEROLOGICAL PIPETTE** से संबंधित है, का पंजीकरण, श्रेणी **24-02** में 1.Dr. Sivakumar Vijayaraghavalu 2. Dr. Munish Kumar 3.Dr. Selvamarmjunan 4.Dr. P. Shanmugapandiyam, 5.Dr. R. Thirumalaikumaran 6.Dr. Prashanthi R 7.Dr P. Rajarajan 8.Zainab Feroz 9.Dr. Ritambhara 10.Dr. Raj Kumar 11.Dr P Karthigeyan के नाम में उपर्युक्त संख्या और तारीख में कर लिया गया है।

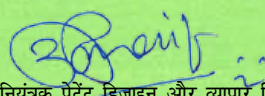
Certified that the design of which a copy is annexed hereto has been registered as of the number and date given above in class **24-02** in respect of the application of such design to **SEROLOGICAL PIPETTE** in the name of 1.Dr. Sivakumar Vijayaraghavalu 2. Dr. Munish Kumar 3.Dr. Selvamarmjunan 4.Dr. P. Shanmugapandiyam, 5.Dr. R. Thirumalaikumaran 6.Dr. Prashanthi R 7.Dr P. Rajarajan 8.Zainab Feroz 9.Dr. Ritambhara 10.Dr. Raj Kumar 11.Dr P Karthigeyan.

डिजाइन अधिनियम, 2000 तथा डिजाइन नियम, 2001 के अध्याधीन प्रावधानों के अनुसरण में।

In pursuance of and subject to the provisions of the Designs Act, 2000 and the Designs Rules, 2001.

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निर्गमन की तारीख/Date of Issue : 25/01/2023


महानियंत्रक पेटेंट डिजाइन और व्यापार चिह्न
Controller General of Patents, Designs and Trade Marks

पारस्परिकता तारीख (यदि कोई हो) जिसकी अनुमति देश के नाम पर की गई है। डिजाइन का सत्वाधिकार पंजीकरण की तारीख से दस वर्षों के लिए होगा जिसका विस्तार, अधिनियम एवं नियम के निबंधनों के अधीन, पाँच वर्षों की अतिरिक्त अवधि के लिए किया जा सकेगा। इस प्रमाण पत्र का उपयोग विधिक कार्यवाहियों अथवा विदेश में पंजीकरण प्राप्त करने के लिए नहीं हो सकता है।

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Department of Industrial Policy & Promotion,
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Government of India

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Application Details

APPLICATION NUMBER	202311059269
APPLICATION TYPE	ORDINARY APPLICATION
DATE OF FILING	04/09/2023
APPLICANT NAME	1 . Dr. Ena Gupta 2 . Shashi Soni 3 . Uroosa Noor
TITLE OF INVENTION	POTENTIAL ANTICANCER ACTIVITY OF ANANAS COMOSUS PEEL AGAINST J774.1 CELL LINE
FIELD OF INVENTION	CHEMICAL
E-MAIL (As Per Record)	soni.mukesh15@gmail.com
ADDITIONAL-EMAIL (As Per Record)	soni.mukesh15@gmail.com
E-MAIL (UPDATED Online)	
PRIORITY DATE	
REQUEST FOR EXAMINATION DATE	--
PUBLICATION DATE (U/S 11A)	06/10/2023





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सत्यमेव जयते

क्रमांक : 011148958
SL No :



भारत सरकार
GOVERNMENT OF INDIA

पेटेंट कार्यालय
THE PATENT OFFICE

पेटेंट प्रमाणपत्र
PATENT CERTIFICATE
(Rule 74 of The Patents Rules)

पेटेंट सं. / Patent No. : 402984
आवेदन सं. / Application No. : 201711014441
फाइल करने की तारीख / Date of Filing : 24/04/2017
पेटेंटी / Patentee : 1.PROF. NEELAM YADAV 2.DR. PINKI SAINI 3.DR.
DEVINDER KAUR 4.DR. VIJAI KISHOR GUPTA et al. et al.
et al.

प्रमाणित किया जाता है कि पेटेंटी को, उपरोक्त आवेदन में यथाप्रकटित "POTATO FLAKES ENERGY BARS" नामक आविष्कार के लिए, पेटेंट अधिनियम, 1970 के उपबंधों के अनुसार आज तारीख अप्रैल 2017 के चौबीसवें दिन से बीस वर्ष की अवधि के लिए पेटेंट अनुदत्त किया गया है।

It is hereby certified that a patent has been granted to the patentee for an invention entitled "POTATO FLAKES ENERGY BARS" as disclosed in the above mentioned application for the term of 20 years from the 24th day of April 2017 in accordance with the provisions of the Patents Act, 1970.



अनुदान की तारीख : 04/08/2022
Date of Grant :

पेटेंट नियंत्रक
Controller of Patent

टिप्पणी - इस पेटेंट के नवीकरण के लिए फीस, यदि इसे बनाए रखा जाना है, अप्रैल 2019 के चौबीसवें दिन को और उसके पश्चात प्रत्येक वर्ष में उसी दिन देय होगी।

Note - The fees for renewal of this patent, if it is to be maintained will fall / has fallen due on 24th day of April 2019 and on the same day in every year thereafter.



Intellectual
Property
Office

Certificate of Registration for a UK Design

Design number: 6308751

Grant date: 20 November 2023

Registration date: 08 September 2023

This is to certify that,

in pursuance of and subject to the provision of Registered Designs Act 1949, the design of which a representation or specimen is attached, had been registered as of the date of registration shown above in the name of

Dr. Shikha Banerjee, Dr. Sunita Minz, Dr. Poonam Pandey, Dr. Devi Prasad

Singh, Dr. Saumya Tiwari

in respect of the application of such design to:

Electronic Teaching Device

International Design Classification:

Version: 14-2023

Class: 19 STATIONERY AND OFFICE EQUIPMENT, ARTISTS' AND TEACHING MATERIALS

Subclass: 07 TEACHING MATERIALS AND APPARATUS

Version: 14-2023

Class: 14 RECORDING, TELECOMMUNICATION OR DATA PROCESSING EQUIPMENT

Subclass: 02 DATA PROCESSING EQUIPMENT AS WELL AS PERIPHERAL APPARATUS AND DEVICES

Adam Williams

Comptroller-General of Patents, Designs and Trade Marks

Intellectual Property Office

The attention of the Proprietor(s) is drawn to the important notes overleaf.



← DOC-20231207-WA00...

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Extracts from the Register of Copyrights



Dated : 22/12/2022

- | | |
|---|--|
| 1. Registration Number | : L-120071/2022 |
| 2. Name, address and nationality of the applicant | : DR. JANAKIDEVI VELMURUGAN, HENNAL TAMILNADU, INDIA-60073, INDIAN
DR. VASUDEVI RAMACHANDRAN, CHENNAI TAMILNADU, INDIA-60073, INDIAN
DR. RAMAN LAKSHMI SUNDARAM, CHENNAI TAMILNADU, INDIA-60053, INDIAN
DR. MUNISH KUMAR, UTTAR PRADESH-211002, INDIAN
M. VASANTH KUMAR, CHENGALPATTU-603001, INDIAN |
| 3. Nature of the applicant's interest in the copyright of the work | : OWNER |
| 4. Class and description of the work | : LITERARY/DRAMATIC WORK |
| 5. Title of the work | : A NOVEL TREATMENT OF COLON CANCER USING VITIS VINIFERA FRUIT EXTRACT AND ANONA MURCATA LEAVES EXTRACT |
| 6. Language of the work | : ENGLISH |
| 7. Name, address and nationality of the author and if the author is deceased, date of his decease | : DR. JANAKIDEVI VELMURUGAN, HENNAL TAMILNADU, INDIA-60073, INDIAN
DR. VASUDEVI RAMACHANDRAN, CHENNAI TAMILNADU, INDIA-60073, INDIAN
DR. RAMAN LAKSHMI SUNDARAM, CHENNAI TAMILNADU, INDIA-60053, INDIAN
DR. MUNISH KUMAR, UTTAR PRADESH-211002, INDIAN
M. VASANTH KUMAR, CHENGALPATTU-603001, INDIAN |
| 8. Whether the work is published or unpublished | : UNPUBLISHED |
| 9. Year and country of first publication and name, address and nationality of the publisher | : N.A. |
| 10. Years and countries of subsequent publications, if any, and names, addresses and nationalities of the publishers | : N.A. |
| 11. Names, addresses and nationalities of the owners of various rights comprising the copyright in the work and the extent of rights held by each, together with particulars of assignments and licences, if any | : DR. JANAKIDEVI VELMURUGAN, HENNAL TAMILNADU, INDIA-60073, INDIAN
DR. VASUDEVI RAMACHANDRAN, CHENNAI TAMILNADU, INDIA-60073, INDIAN
DR. RAMAN LAKSHMI SUNDARAM, CHENNAI TAMILNADU, INDIA-60053, INDIAN
DR. MUNISH KUMAR, UTTAR PRADESH-211002, INDIAN
M. VASANTH KUMAR, CHENGALPATTU-603001, INDIAN |
| 12. Nationalities of other persons, if any, in whose possession of rights comprising the copyright | : N.A. |
| 13. If the work is an 'Artistic work', the location of the original work, and nationality of the person in possession of an architectural work, the year of its construction should also be shown. | : N.A. |
| 14. If the work is an 'Artistic work' which is used in capable of being used in relation to any goods or services, the application should include a certification from the Registrar of Trade Marks as to the provisions in Sub-Section (1) of Section 45 of the Copyright Act, 1957. | : N.A. |
| 15. If the work is an 'Artistic work', whether it is registered under the Designs Act 2000 if yes give details. | : N.A. |



Dr. Janakidevi
Registrar of Copyrights



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मूल/No : 136864



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GOVERNMENT OF INDIA
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THE PATENT OFFICE

डिजाइन के पंजीकरण का प्रमाणपत्र
CERTIFICATE OF REGISTRATION OF DESIGN

डिजाइन सं. / Design No. : 346443-001
तारीख / Date : 19/07/2021
पारस्परिकता तारीख / Reciprocity Date* :
देश / Country :

प्रमाणित किया जाता है कि संलग्न प्रति में वर्णित डिजाइन जो **LUNG CANCER DETECTION MACHINE USING MASS SPECTROMETERY** से संबंधित है, का पंजीकरण, श्रेणी 24-02 में 1.Dr. Ritambhara 2. Dr. Sivakumar Vijayaraghavalu 3.Dr. Munish Kumar 4.Dr. Neha Dobriyal 5.Dr. Kritika Dixit 6.Dr. Raman Lakshmisundaram 7.Dr. Subramani Srinivasan 8.Dr. Thanikkodi Dhanalakshmi 9.Dr P Karthigeyan के नाम में उपर्युक्त संख्या और तारीख में कर लिया गया है।

Certified that the design of which a copy is annexed hereto has been registered as of the number and date given above in class 24-02 in respect of the application of such design to **LUNG CANCER DETECTION MACHINE USING MASS SPECTROMETERY** in the name of 1.Dr. Ritambhara 2. Dr. Sivakumar Vijayaraghavalu 3.Dr. Munish Kumar 4.Dr. Neha Dobriyal 5.Dr. Kritika Dixit 6.Dr. Raman Lakshmisundaram 7.Dr. Subramani Srinivasan 8.Dr. Thanikkodi Dhanalakshmi 9.Dr P Karthigeyan.

डिजाइन अधिनियम, 2000 तथा डिजाइन नियम, 2001 के अध्याधीन प्रावधानों के अनुसरण में।

In pursuance of and subject to the provisions of the Designs Act, 2000 and the Designs Rules, 2001.

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निर्गमन की तारीख/Date of Issue : 23/05/2023


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*The reciprocity date (if any) which has been allowed and the name of the country. Copyright in the design will subsist for ten years from the date of Registration, and may under the terms of the Act and Rules, be extended for a further period of five years. This Certificate is not for use in legal proceedings or for obtaining registration abroad.