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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY. DOCKET NO	TOT CLAIMS	IND CLAIMS
62/893,479	08/29/2019		140	438/103 PROV		

CONFIRMATION NO. 6000

FILING RECEIPT

76934
NK Patent Law - Industrial Heat
4917 Waters Edge Drive
Suite 275
Raleigh, NC 27606



0000000110886270

Date Mailed: 09/05/2019

Receipt is acknowledged of this provisional patent application. It will not be examined for patentability and will become abandoned not later than twelve months after its filing date. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF FIRST INVENTOR, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection.

Please verify the accuracy of the data presented on this receipt. If an error is noted on this Filing Receipt, please submit a written request for a corrected Filing Receipt identifying the requested changes, preferably by including a properly marked-up ADS showing the changes with strike-through for deletions and underlining for additions. If you received a "Notice to File Missing Parts" or other Notice requiring a response for this application, please submit any request for correction to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections provided that the request is grantable.

Inventor(s)

Dennis J. Cravens, Cloudcroft, NM;
Dennis G. Letts, Austin, TX;
Robert J. Higgins, Cloudcroft, NM;

Applicant(s)

Industrial Heat, LLC, Raleigh, NC;

Power of Attorney:

Justin Nifong--59389

Permission to Access Application via Priority Document Exchange: Yes

Permission to Access Search Results: Yes

Applicant may provide or rescind an authorization for access using Form PTO/SB/39 or Form PTO/SB/69 as appropriate.

If Required, Foreign Filing License Granted: 09/04/2019

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 62/893,479**

Projected Publication Date: None, application is not eligible for pre-grant publication

Non-Publication Request: No

Early Publication Request: No

**** SMALL ENTITY ****

Title

SYSTEMS AND METHODS FOR GENERATING HEAT FROM REACTIONS BETWEEN
HYDROGEN ISOTOPES AND METAL CATALYSTS

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at <http://www.uspto.gov/web/offices/pac/doc/general/index.html>.

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, <http://www.stopfakes.gov>. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4258).

LICENSE FOR FOREIGN FILING UNDER

Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

GRANTED

The applicant has been granted a license under 35 U.S.C. 184, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" followed by a date appears on this form. Such licenses are issued in all applications where

the conditions for issuance of a license have been met, regardless of whether or not a license may be required as set forth in 37 CFR 5.15. The scope and limitations of this license are set forth in 37 CFR 5.15(a) unless an earlier license has been issued under 37 CFR 5.15(b). The license is subject to revocation upon written notification. The date indicated is the effective date of the license, unless an earlier license of similar scope has been granted under 37 CFR 5.13 or 5.14.

This license is to be retained by the licensee and may be used at any time on or after the effective date thereof unless it is revoked. This license is automatically transferred to any related applications(s) filed under 37 CFR 1.53(d). This license is not retroactive.

The grant of a license does not in any way lessen the responsibility of a licensee for the security of the subject matter as imposed by any Government contract or the provisions of existing laws relating to espionage and the national security or the export of technical data. Licensees should apprise themselves of current regulations especially with respect to certain countries, of other agencies, particularly the Office of Defense Trade Controls, Department of State (with respect to Arms, Munitions and Implements of War (22 CFR 121-128)); the Bureau of Industry and Security, Department of Commerce (15 CFR parts 730-774); the Office of Foreign Assets Control, Department of Treasury (31 CFR Parts 500+) and the Department of Energy.

NOT GRANTED

No license under 35 U.S.C. 184 has been granted at this time, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" DOES NOT appear on this form. Applicant may still petition for a license under 37 CFR 5.12, if a license is desired before the expiration of 6 months from the filing date of the application. If 6 months has lapsed from the filing date of this application and the licensee has not received any indication of a secrecy order under 35 U.S.C. 181, the licensee may foreign file the application pursuant to 37 CFR 5.15(b).

SelectUSA

The United States represents the largest, most dynamic marketplace in the world and is an unparalleled location for business investment, innovation, and commercialization of new technologies. The U.S. offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to promote and facilitate business investment. SelectUSA provides information assistance to the international investor community; serves as an ombudsman for existing and potential investors; advocates on behalf of U.S. cities, states, and regions competing for global investment; and counsels U.S. economic development organizations on investment attraction best practices. To learn more about why the United States is the best country in the world to develop technology, manufacture products, deliver services, and grow your business, visit <http://www.SelectUSA.gov> or call +1-202-482-6800.

SCORE Placeholder Sheet for IFW Content

Application Number: 62893479

Document Date: 08/29/2019

The presence of this form in the IFW record indicates that the following document type was received in electronic format on the date identified above. This content is stored in the SCORE database.

Since this was an electronic submission, there is no physical artifact folder, no artifact folder is recorded in PALM, and no paper documents or physical media exist. The TIFF images in the IFW record were created from the original documents that are stored in SCORE.

- Drawing

At the time of document entry (noted above):

- USPTO employees may access SCORE content via DAV or via the SCORE web page.
- External customers may access SCORE content via PAIR using the Supplemental Content tab.

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	438/103 PROV
		Application Number	
Title of Invention	SYSTEMS AND METHODS FOR GENERATING HEAT FROM REACTIONS BETWEEN HYDROGEN ISOTOPES AND METAL CATALYSTS		
<p>The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.</p> <p>This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.</p>			

Secrecy Order 37 CFR 5.2:

☐ Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)

Inventor Information:

Inventor	1				Remove	
Legal Name						
Prefix	Given Name	Middle Name	Family Name	Suffix		
	Dennis	J.	Cravens			
Residence Information (Select One) <input checked="" type="radio"/> US Residency <input type="radio"/> Non US Residency <input type="radio"/> Active US Military Service						
City	Cloudcroft	State/Province	NM	Country of Residence	US	

Mailing Address of Inventor:

Address 1	P.O. Box 1317					
Address 2						
City	Cloudcroft	State/Province	NM			
Postal Code	88317	Country i	US			

Inventor	2				Remove	
Legal Name						
Prefix	Given Name	Middle Name	Family Name	Suffix		
	Dennis	G.	Letts			
Residence Information (Select One) <input checked="" type="radio"/> US Residency <input type="radio"/> Non US Residency <input type="radio"/> Active US Military Service						
City	Austin	State/Province	TX	Country of Residence	US	

Mailing Address of Inventor:

Address 1	12015 Ladrado Lane					
Address 2						
City	Austin	State/Province	TX			
Postal Code	78727	Country i	US			

Inventor	3				Remove	
Legal Name						
Prefix	Given Name	Middle Name	Family Name	Suffix		
	Robert	J.	Higgins			
Residence Information (Select One) <input checked="" type="radio"/> US Residency <input type="radio"/> Non US Residency <input type="radio"/> Active US Military Service						

Application Data Sheet 37 CFR 1.76		Attorney Docket Number		438/103 PROV	
		Application Number			
Title of Invention	SYSTEMS AND METHODS FOR GENERATING HEAT FROM REACTIONS BETWEEN HYDROGEN ISOTOPES AND METAL CATALYSTS				
City	Cloudcroft	State/Province	NM	Country of Residence	US
Mailing Address of Inventor:					
Address 1	1098 Woodlands Way				
Address 2					
City	Cloudcroft	State/Province	NM		
Postal Code	88317	Country	US		
All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the Add button.					<input type="button" value="Add"/>

Correspondence Information:

Enter either Customer Number or complete the Correspondence Information section below. For further information see 37 CFR 1.33(a).			
<input type="checkbox"/> An Address is being provided for the correspondence information of this application.			
Customer Number	76934		
Email Address	docket@nkpatentlaw.com	<input type="button" value="Add Email"/>	<input type="button" value="Remove Email"/>

Application Information:

Title of the Invention	SYSTEMS AND METHODS FOR GENERATING HEAT FROM REACTIONS BETWEEN HYDROGEN ISOTOPES AND METAL CATALYSTS		
Attorney Docket Number	438/103 PROV	Small Entity Status Claimed	<input checked="" type="checkbox"/>
Application Type	Provisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	5	Suggested Figure for Publication (if any)	

Filing By Reference:

Only complete this section when filing an application by reference under 35 U.S.C. 111(c) and 37 CFR 1.57(a). Do not complete this section if application papers including a specification and any drawings are being filed. Any domestic benefit or foreign priority information must be provided in the appropriate section(s) below (i.e., "Domestic Benefit/National Stage Information" and "Foreign Priority Information").

For the purposes of a filing date under 37 CFR 1.53(b), the description and any drawings of the present application are replaced by this reference to the previously filed application, subject to conditions and requirements of 37 CFR 1.57(a).

Application number of the previously filed application	Filing date (YYYY-MM-DD)	Intellectual Property Authority or Country

Publication Information:

<input type="checkbox"/> Request Early Publication (Fee required at time of Request 37 CFR 1.219)
<input type="checkbox"/> Request Not to Publish. I hereby request that the attached application not be published under 35 U.S.C. 122(b) and certify that the invention disclosed in the attached application has not and will not be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	438/103 PROV
		Application Number	
Title of Invention	SYSTEMS AND METHODS FOR GENERATING HEAT FROM REACTIONS BETWEEN HYDROGEN ISOTOPES AND METAL CATALYSTS		

Representative Information:

Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32).

Either enter Customer Number or complete the Representative Name section below. If both sections are completed the customer Number will be used for the Representative Information during processing.

Please Select One:	<input checked="" type="radio"/> Customer Number	<input type="radio"/> US Patent Practitioner	<input type="radio"/> Limited Recognition (37 CFR 11.9)
Customer Number	76934		

Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, 365(c), or 386(c) or indicate National Stage entry from a PCT application. Providing benefit claim information in the Application Data Sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78.

When referring to the current application, please leave the "Application Number" field blank.

Prior Application Status	<input type="text"/>	<input type="button" value="Remove"/>	
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the Add button.			<input type="button" value="Add"/>

Foreign Priority Information:

This section allows for the applicant to claim priority to a foreign application. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55. When priority is claimed to a foreign application that is eligible for retrieval under the priority document exchange program (PDX)ⁱ the information will be used by the Office to automatically attempt retrieval pursuant to 37 CFR 1.55(i)(1) and (2). Under the PDX program, applicant bears the ultimate responsibility for ensuring that a copy of the foreign application is received by the Office from the participating foreign intellectual property office, or a certified copy of the foreign priority application is filed, within the time period specified in 37 CFR 1.55(g)(1).

Application Number	Country ⁱ	Filing Date (YYYY-MM-DD)	Access Code ⁱ (if applicable)
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
Additional Foreign Priority Data may be generated within this form by selecting the Add button.			<input type="button" value="Add"/>

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	438/103 PROV
		Application Number	
Title of Invention	SYSTEMS AND METHODS FOR GENERATING HEAT FROM REACTIONS BETWEEN HYDROGEN ISOTOPES AND METAL CATALYSTS		

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications

<p>This application (1) claims priority to or the benefit of an application filed before March 16, 2013 and (2) also contains, or contained at any time, a claim to a claimed invention that has an effective filing date on or after March 16, 2013.</p> <p><input type="checkbox"/> NOTE: By providing this statement under 37 CFR 1.55 or 1.78, this application, with a filing date on or after March 16, 2013, will be examined under the first inventor to file provisions of the AIA.</p>	
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Application Data Sheet 37 CFR 1.76		Attorney Docket Number	438/103 PROV
		Application Number	
Title of Invention	SYSTEMS AND METHODS FOR GENERATING HEAT FROM REACTIONS BETWEEN HYDROGEN ISOTOPES AND METAL CATALYSTS		

Authorization or Opt-Out of Authorization to Permit Access:

When this Application Data Sheet is properly signed and filed with the application, applicant has provided written authority to permit a participating foreign intellectual property (IP) office access to the instant application-as-filed (see paragraph A in subsection 1 below) and the European Patent Office (EPO) access to any search results from the instant application (see paragraph B in subsection 1 below).

Should applicant choose not to provide an authorization identified in subsection 1 below, applicant **must opt-out** of the authorization by checking the corresponding box A or B or both in subsection 2 below.

NOTE: This section of the Application Data Sheet is **ONLY** reviewed and processed with the **INITIAL** filing of an application. After the initial filing of an application, an Application Data Sheet cannot be used to provide or rescind authorization for access by a foreign IP office(s). Instead, Form PTO/SB/39 or PTO/SB/69 must be used as appropriate.

1. Authorization to Permit Access by a Foreign Intellectual Property Office(s)

A. Priority Document Exchange (PDX) - Unless box A in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the European Patent Office (EPO), the Japan Patent Office (JPO), the Korean Intellectual Property Office (KIPO), the State Intellectual Property Office of the People's Republic of China (SIPO), the World Intellectual Property Organization (WIPO), and any other foreign intellectual property office participating with the USPTO in a bilateral or multilateral priority document exchange agreement in which a foreign application claiming priority to the instant patent application is filed, access to: (1) the instant patent application-as-filed and its related bibliographic data, (2) any foreign or domestic application to which priority or benefit is claimed by the instant application and its related bibliographic data, and (3) the date of filing of this Authorization. See 37 CFR 1.14(h)(1).

B. Search Results from U.S. Application to EPO - Unless box B in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the EPO access to the bibliographic data and search results from the instant patent application when a European patent application claiming priority to the instant patent application is filed. See 37 CFR 1.14(h)(2).

The applicant is reminded that the EPO's Rule 141(1) EPC (European Patent Convention) requires applicants to submit a copy of search results from the instant application without delay in a European patent application that claims priority to the instant application.

2. Opt-Out of Authorizations to Permit Access by a Foreign Intellectual Property Office(s)

☐ A. Applicant **DOES NOT** authorize the USPTO to permit a participating foreign IP office access to the instant application-as-filed. If this box is checked, the USPTO will not be providing a participating foreign IP office with any documents and information identified in subsection 1A above.

☐ B. Applicant **DOES NOT** authorize the USPTO to transmit to the EPO any search results from the instant patent application. If this box is checked, the USPTO will not be providing the EPO with search results from the instant application.

NOTE: Once the application has published or is otherwise publicly available, the USPTO may provide access to the application in accordance with 37 CFR 1.14.

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	438/103 PROV
		Application Number	
Title of Invention	SYSTEMS AND METHODS FOR GENERATING HEAT FROM REACTIONS BETWEEN HYDROGEN ISOTOPES AND METAL CATALYSTS		

Applicant Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Applicant	1	Remove
<p>If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section.</p> <p style="text-align: right;">Clear</p>		
<input checked="" type="radio"/> Assignee	Legal Representative under 35 U.S.C. 117	Joint Inventor
Person to whom the inventor is obligated to assign.		Person who shows sufficient proprietary interest
If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:		
<div style="border: 1px solid black; height: 20px; width: 100%;"></div>		
Name of the Deceased or Legally Incapacitated Inventor: <div style="border: 1px solid black; height: 20px; width: 100%;"></div>		
If the Applicant is an Organization check here. <input checked="" type="checkbox"/>		
Organization Name	Industrial Heat, LLC	
Mailing Address Information For Applicant:		
Address 1	310 S. West Street, Suite 100	
Address 2		
City	Raleigh	State/Province NC
Country	US	Postal Code 27603
Phone Number		Fax Number
Email Address		
Additional Applicant Data may be generated within this form by selecting the Add button. Add		

Assignee Information including Non-Applicant Assignee Information:

Providing assignment information in this section does not substitute for compliance with any requirement of part 3 of Title 37 of CFR to have an assignment recorded by the Office.

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	438/103 PROV
		Application Number	
Title of Invention	SYSTEMS AND METHODS FOR GENERATING HEAT FROM REACTIONS BETWEEN HYDROGEN ISOTOPES AND METAL CATALYSTS		

Assignee 1				
Complete this section if assignee information, including non-applicant assignee information, is desired to be included on the patent application publication. An assignee-applicant identified in the "Applicant Information" section will appear on the patent application publication as an applicant. For an assignee-applicant, complete this section only if identification as an assignee is also desired on the patent application publication.				
Remove				
If the Assignee or Non-Applicant Assignee is an Organization check here. <input type="checkbox"/>				
Prefix	Given Name	Middle Name	Family Name	Suffix
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
Mailing Address Information For Assignee including Non-Applicant Assignee:				
Address 1		<input type="text"/>		
Address 2		<input type="text"/>		
City	<input type="text"/>	State/Province	<input type="text"/>	
Country ⁱ	<input type="text"/>	Postal Code	<input type="text"/>	
Phone Number	<input type="text"/>	Fax Number	<input type="text"/>	
Email Address	<input type="text"/>			
Additional Assignee or Non-Applicant Assignee Data may be generated within this form by selecting the Add button. Add				

Signature:[Remove](#)

NOTE: This Application Data Sheet must be signed in accordance with 37 CFR 1.33(b). However, if this Application Data Sheet is submitted with the **INITIAL** filing of the application and either box A or B is not checked in subsection 2 of the "Authorization or Opt-Out of Authorization to Permit Access" section, then this form must also be signed in accordance with 37 CFR 1.14(c).

This Application Data Sheet **must** be signed by a patent practitioner if one or more of the applicants is a **juristic entity** (e.g., corporation or association). If the applicant is two or more joint inventors, this form must be signed by a patent practitioner, **all** joint inventors who are the applicant, or one or more joint inventor-applicants who have been given power of attorney (e.g., see USPTO Form PTO/AIA/81) on behalf of **all** joint inventor-applicants.

See 37 CFR 1.4(d) for the manner of making signatures and certifications.

Signature	/Justin R. Nifong/		Date (YYYY-MM-DD)	2019-08-29
First Name	Justin	Last Name	Nifong	Registration Number
				59389
Additional Signature may be generated within this form by selecting the Add button. Add				

Application Data Sheet 37 CFR 1.76		Attorney Docket Number	438/103 PROV
		Application Number	
Title of Invention	SYSTEMS AND METHODS FOR GENERATING HEAT FROM REACTIONS BETWEEN HYDROGEN ISOTOPES AND METAL CATALYSTS		

This collection of information is required by 37 CFR 1.76. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 23 minutes to complete, including gathering, preparing, and submitting the completed application data sheet form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

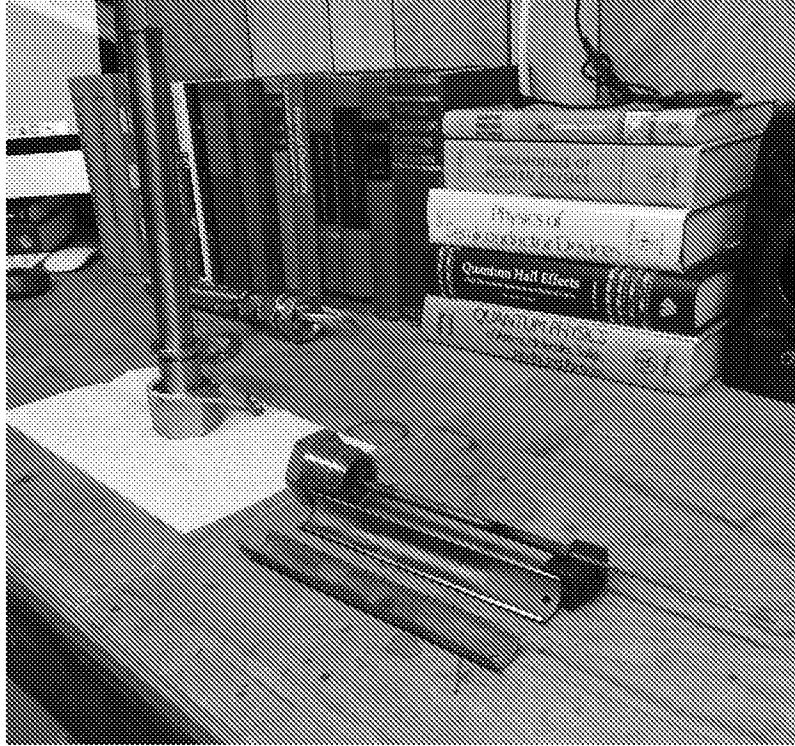


Figure 1

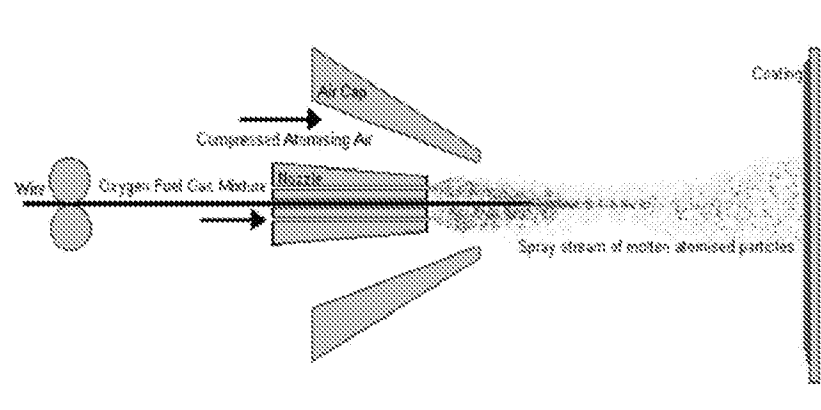


Figure 2

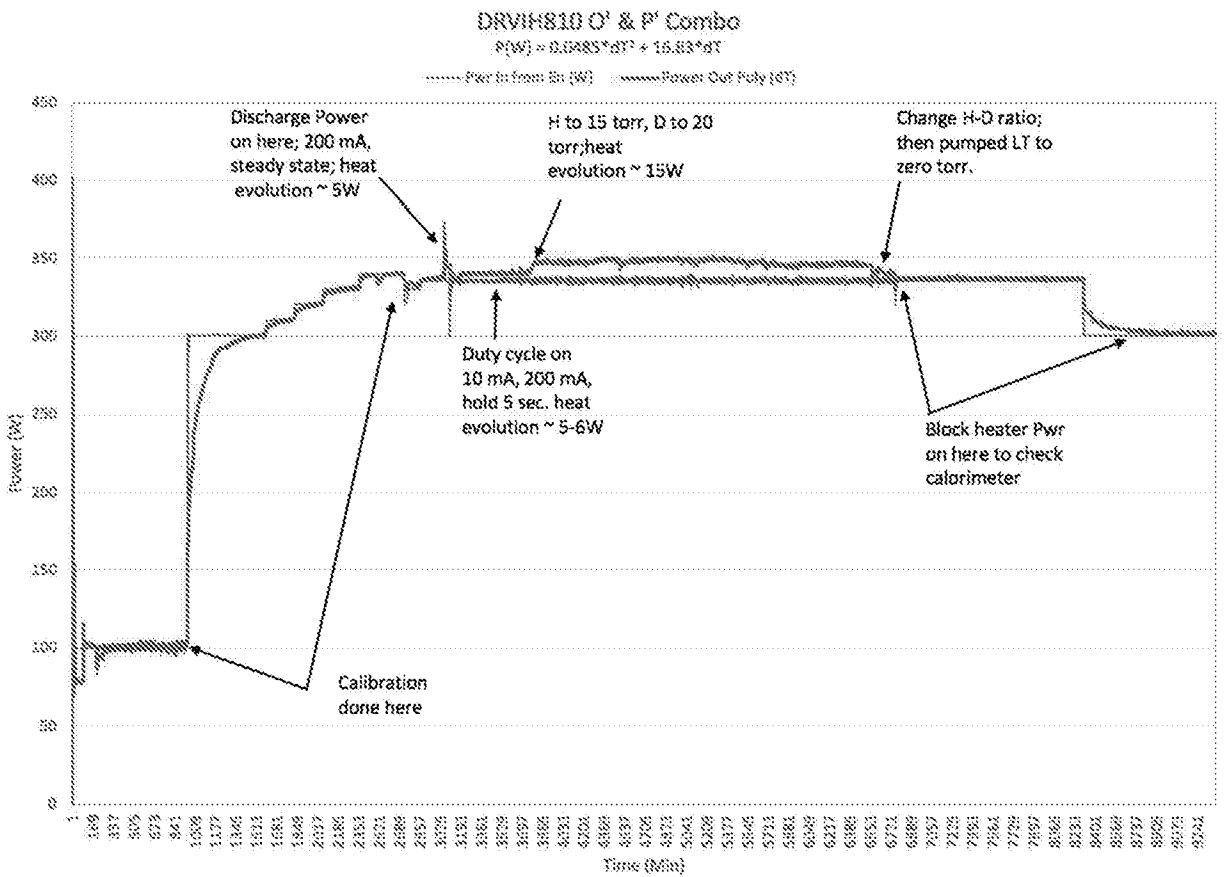


Figure 3

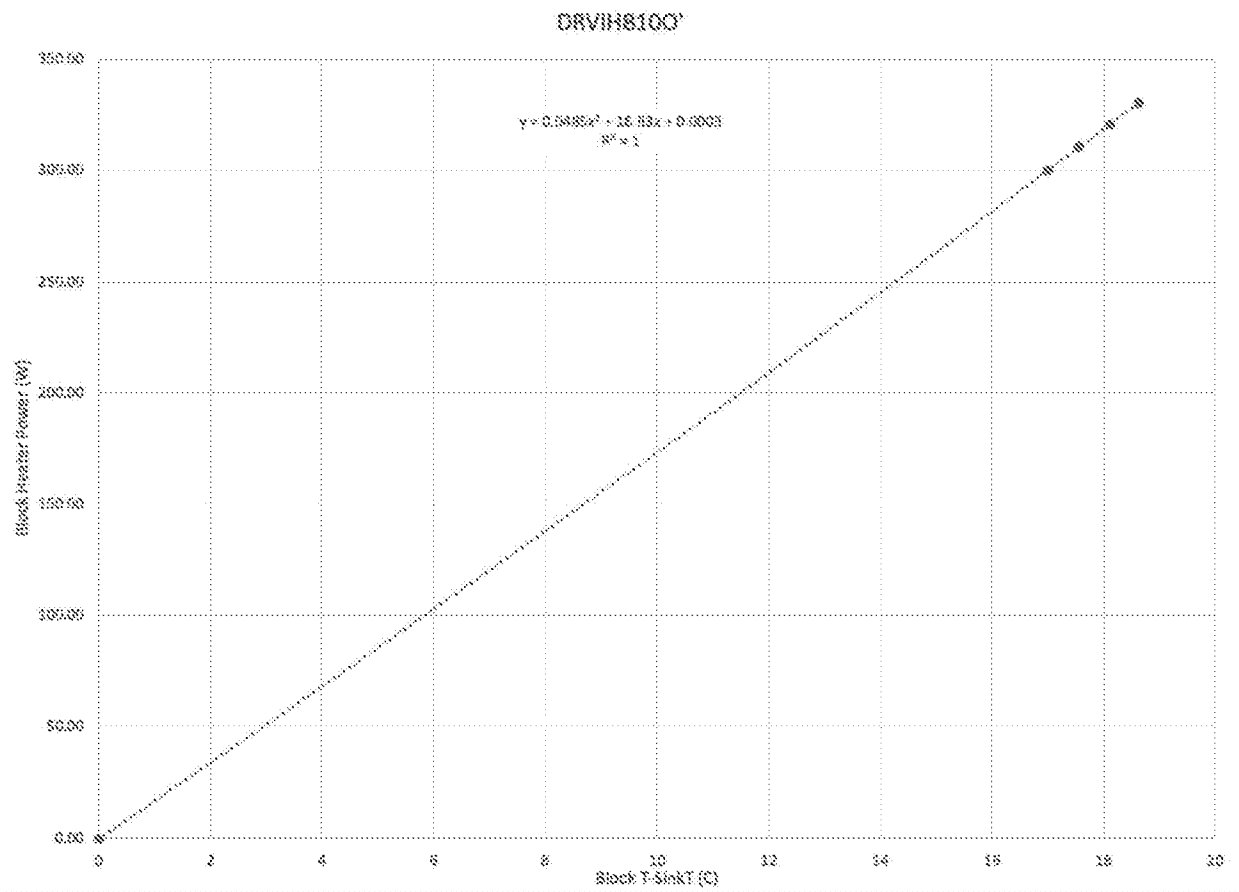


Figure 4

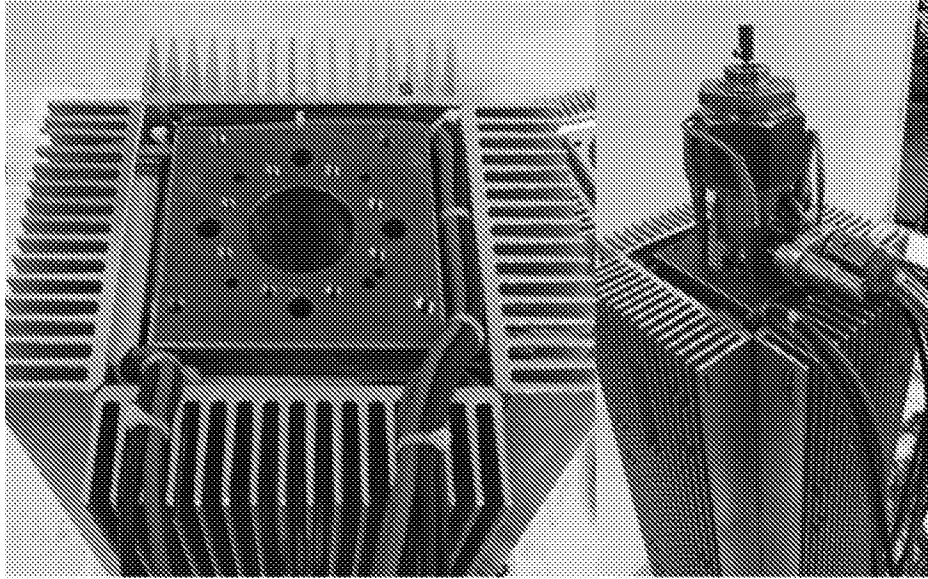


Figure 5

Electronic Patent Application Fee Transmittal

Application Number:				
Filing Date:				
Title of Invention:	SYSTEMS AND METHODS FOR GENERATING HEAT FROM REACTIONS BETWEEN HYDROGEN ISOTOPES AND METAL CATALYSTS			
First Named Inventor/Applicant Name:	Dennis J. Cravens			
Filer:	Justin Robert Nifong/Donna Donovan			
Attorney Docket Number:	438/103 PROV			
Filed as Small Entity				
Filing Fees for Provisional				
Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Basic Filing:				
PROVISIONAL APPLICATION FILING FEE	2005	1	140	140
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Extension-of-Time:				
Miscellaneous:				
Total in USD (\$)				140

Electronic Acknowledgement Receipt

EFS ID:	37021305
Application Number:	62893479
International Application Number:	
Confirmation Number:	6000
Title of Invention:	SYSTEMS AND METHODS FOR GENERATING HEAT FROM REACTIONS BETWEEN HYDROGEN ISOTOPES AND METAL CATALYSTS
First Named Inventor/Applicant Name:	Dennis J. Cravens
Customer Number:	76934
Filer:	Justin Robert Nifong/Donna Donovan
Filer Authorized By:	Justin Robert Nifong
Attorney Docket Number:	438/103 PROV
Receipt Date:	29-AUG-2019
Filing Date:	
Time Stamp:	15:56:05
Application Type:	Provisional

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	\$ 140
RAM confirmation Number	E20198SF57115465
Deposit Account	506191
Authorized User	Donna Donovan

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37 CFR 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Application Data Sheet	438-103PROV-2019829-ADS.pdf	1823042	no	9
			68329f2557e77605e4bda8b4d6e6f299c2bd9589		
Warnings:					
Information:					
2	Specification	438-103PROV-20190829-Spec-Claims-Abs.pdf	89584	no	17
			1e862de50f6616358847531b1f268ddb56584967		
Warnings:					
Information:					
3	Drawings-other than black and white line drawings	438-103PROV-20190829-Dwgs.pdf	1840292	no	5
			0d45369e20d07f2a3340365dffa5812238d0e4b4		
Warnings:					
Information:					
4	Fee Worksheet (SB06)	fee-info.pdf	30072	no	2
			ca5b966592643e81cfbe89b568ea45552f22a164		
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National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PROVISIONAL PATENT APPLICATION

TITLE: SYSTEMS AND METHODS FOR GENERATING HEAT FROM REACTIONS BETWEEN HYDROGEN ISOTOPES AND METAL CATALYSTS

BACKGROUND

[001] Many metals and their alloys are known to take up hydrogen in its various isotopic forms and mixtures; some metal-hydrogen systems are classified as exothermic absorbers and produce a small amount of chemical heat when loaded with hydrogen. Often, hydrogen in its various isotopic forms as pure isotopes, mixtures, or naturally abundant hydrogen are loaded into hydrogen absorbing metals with the intent of evolving usable heat or other physical events. Methods of triggering the metal-hydrogen reaction have been developed using radio frequency stimulation, laser stimulation, or magnetic field stimulation to generate and investigate physical responses. All of these methods require external agents to act on the hydrogen isotopes contained within the absorbing catalyst or attached to its surface.

[002] Externally applied triggering methods are known to work in evolving modest amounts of heat from catalysts by absorbing hydrogen or by catalysts formed from metal hydrides and their alloys. Two of the currently known external triggering methods are limited in the extent to which they are able to couple with the contained hydrogen and its isotopes. Radio frequency energy cannot penetrate into the metal or hydride beyond a few microns; lasers operate at a much higher frequency, making their penetration depth much less than radio frequency stimulation. Heat evolution is thought to be directly related to the amount of hydrogen that can be stimulated by an external triggering method.

SUMMARY OF THE INVENTION

[003] The term “hydrogen” as used herein refers to hydrogen in all its isotopic forms

including hydrogen, deuterium, tritium, or mixtures thereof unless specified otherwise.

[004] This disclosure provides a system and method for evolving larger amounts of usable heat from a metal-hydrogen system that has been loaded with hydrogen and deuterium in a predetermined specified range of isotopic ratios and over a range of predetermined specified pressures.

[005] Specifically, the present invention discloses a system and method for providing for internal triggering of hydrogen that evolves usable heat from a catalyst capable of absorbing hydrogen. This system and method obviates the need for external stimulation and has the potential to couple the stimulation to a much larger amount of hydrogen fuel contained in the catalyst than externally applied triggering methods.

[006] In one embodiment of the present invention, a system for generating heat reactions between hydrogen isotopes and a metal catalyst may include a reactor. The reactor may include an anode and a cathode, wherein the cathode is a metallic vessel. The system may further include at least one fuel source disposed within the reactor, wherein the at least one fuel source may include a metal substrate thermally sprayed with a metal catalyst, and wherein the at least one fuel source is in thermal and electrical contact with the reactor. The system may further include a hydrogen source configured to add hydrogen to the reactor after the reactor is sealed, and a deuterium source configured to add deuterium to the reactor after the reactor is sealed. The system may further include a DC power supply configured to supply a current to the reactor.

[007] In another embodiment of the present invention, a method for generating heat reactions between hydrogen isotopes and a metal catalyst may include placing at least one fuel source within a reactor. The reactor may include an anode and a cathode, wherein the cathode is a metallic vessel, wherein the at least one fuel source comprises a metal substrate thermally

sprayed with a metal catalyst, and wherein the at least one fuel source is in thermal and electrical contact with the reactor. The method may further include sealing the reactor to produce a vacuum within the reactor. The method may further include adding hydrogen to the reactor and adding deuterium to the reactor. The method may further include supplying a current to the reactor from a DC power supply.

[008] In yet another embodiment of the present invention, the anode may be a metallic rod.

[009] In yet another embodiment of the present invention, the metallic rod may be comprised of one of molybdenum and tungsten.

[0010] In yet another embodiment of the present invention, the metallic vessel may be comprised of stainless steel.

[0011] In yet another embodiment of the present invention, the at least one fuel source may be configured to slidably fit into the reactor.

[0012] In yet another embodiment of the present invention, the at least one fuel source may be hemicylindrical.

[0013] In yet another embodiment of the present invention, the metal catalyst may be a hydrogen-absorbing metal.

[0014] In yet another embodiment of the present invention, the metal catalyst may be comprised of a nickel and aluminum alloy.

[0015] In yet another embodiment of the present invention, the metal substrate may be titanium.

[0016] In yet another embodiment of the present invention, sealing the reactor may produce a vacuum of at least 1×10^{-4} torr in the reactor.

[0017] In yet another embodiment of the present invention, the hydrogen source and deuterium source may be configured to add enough hydrogen and deuterium to produce at least 20 torr pressure in the reactor.

[0018] In yet another embodiment of the present invention, the DC power supply may be configured to supply at least 200 mA of current to the reactor.

[0019] In yet another embodiment of the present invention, the DC power supply may be configured to supply current in pulsed cycles.

DETAILED DESCRIPTION

[0020] In the following description, for the purposes of explanation, numerous specific details are set forth in order to provide a thorough understanding of the embodiments of the invention. One skilled in the art will recognize that the embodiments of the invention may be practiced without these specific details or with an equivalent arrangement. In other instances, well-known structures and devices are shown in block diagram form in order to avoid unnecessarily obscuring the embodiments of the invention.

[0021] The presently disclosed subject matter is presented with sufficient details to provide an understanding of one or more particular embodiments of broader inventive subject matters. The descriptions expound upon and exemplify particular features of those particular embodiments without limiting the inventive subject matters to the explicitly described embodiments and features. Considerations in view of these descriptions will likely give rise to additional and similar embodiments and features without departing from the scope of the presently disclosed subject matter.

[0022] In one embodiment of the present invention, a system for generating heat reactions between hydrogen isotopes and a metal catalyst may comprise a reactor. The reactor

may comprise an anode and a cathode, wherein the cathode is a metallic vessel. The system may further comprise at least one fuel source disposed within the reactor, wherein the at least one fuel source may include a metal substrate thermally sprayed with a metal catalyst, and wherein the at least one fuel source is in thermal and electrical contact with the reactor. The system may further comprise a hydrogen source configured to add hydrogen to the reactor after the reactor is sealed, and a deuterium source configured to add deuterium to the reactor after the reactor is sealed. The system may further comprise a DC power supply configured to supply a current to the reactor.

[0023] In another embodiment of the present invention, a method for generating heat reactions between hydrogen isotopes and a metal catalyst may comprise placing at least one fuel source within a reactor. The reactor may include an anode and a cathode, wherein the cathode is a metallic vessel, wherein the at least one fuel source comprises a metal substrate thermally sprayed with a metal catalyst, and wherein the at least one fuel source is in thermal and electrical contact with the reactor. The method may further comprise sealing the reactor to produce a vacuum within the reactor. The method may further comprise adding hydrogen to the reactor and adding deuterium to the reactor. The method may further comprise supplying a current to the reactor from a DC power supply.

[0024] The systems and methods of this disclosure begin with thermal spraying a hydrogen-absorbing catalyst onto a metal substrate. In one embodiment chosen to illustrate the present invention, the catalyst was 95% nickel and 5% aluminum. The geometry of the substrate may be arbitrary and will depend upon the shape and size of the thermal reactor used. In the configuration discussed here, the reactor is a tubular stainless-steel vessel serving as the cathode (negative DC) and a slender metallic rod serving as the anode (positive DC). The anode can be any rugged metal, such as molybdenum or tungsten.

[0025] At least one fuel source within the reactor may be comprised of a metal substrate thermally sprayed with a metal catalyst. For example, in one embodiment, the metal substrate may be a tube open on both ends is selected so it will enter the tubular reactor with a sliding fit to maintain thermal and electrical contact with the surrounding reactor. The tube may be cut longitudinally into two equal sections as shown in figure 1 such that they are hemicylindrical. Before inserting into the tubular reactor, the two hemispherical sections (fuel sleeves) are thermally sprayed with a known hydrogen absorbing metal as depicted in figure 2. Thermal spraying is commonly known and available commercially – for example, at Midwest Thermal Spray of Farmington Hills, Michigan.

[0026] Thermal spraying has several attractive features such as producing a robust and adherent catalyst over a metal substrate, such as titanium. Thermally-sprayed surfaces are also coarse and the coarseness of the surface can be controlled by various parameters inherent to the thermal spray process. The material used to spray onto the substrates discussed here is in powder form and can be an alloyed powder of many known metals. The powder can also be a mixture or a combination of powders with various sizes. Metal wires can also be used as feed stock, as in figure 2.

[0027] After the fuel sleeves are placed in the reactor, it may be sealed to produce a vacuum of at least 1×10^{-4} torr. The hydrogen source and deuterium source are configured to add enough hydrogen and deuterium to produce at least 20 torr pressure in the reactor. For example, naturally abundant hydrogen may be added to the reactor to a pressure of 15 torr; then the flow of naturally abundant hydrogen may be stopped and deuterium may be added to the reactor up to a pressure of 20 torr. Then a DC power supply may be turned on to at least 200 mA of current to ignite a glow discharge, forming a plasma. While the discharge is running at 200 mA, the reactor

pressure is reduced to 0.5 to 1 torr, sufficient pressure to maintain the glow discharge. Hold at this low pressure for at least 5 minutes, then add hydrogen with a predominance of mass 1 to 15 torr, then switch to a gas predominant in deuterium up to 20 torr. This process is repeated several times until heat evolution changes.

[0028] Although flame spraying is the preferred embodiment, it should be readily apparent that other methods of adhering the active material to the sleeve to be put in the tube or to affix to the tube itself can be utilized. Such methods include electroplating, burnishing, materials selected for the inserts and other methods.

[0029] In yet another embodiment, the DC power supply may be configured to provide current at a predetermined pulse rate. In one embodiment chosen to illustrate the present invention, a KEPCO power supply was set at 10 mA for 5 seconds, then at 200 mA for 5 seconds and repeated through similar cycles. This method is thought to improve loading and to provide a flux of hydrogen across the metal-gas interface, which enhances heat evolution from the catalyst. This method typically triggers a larger thermal signal than steady-state operation (figure 3). The cycling between high and low plasma currents appears in this embodiment to increase the ability of the metal to take up hydrogen. Although an Ni alloy was used in the embodiment discussed here, metals such as Ti and Pd and its alloys are envisioned and are under investigation; it is envisioned that any hydrogen absorbing metals with significant hydrogen diffusion rates can be used, such as those with a permeability rate above $0.05 \text{ cm}^3/\text{cm}^2/\text{sec}$ at the expected working temperature. Preferably, cycles have a duration between about 0.01 seconds and 10 minutes to produce significant heat about that of equivalent steady state high voltage applications.

[0030] Heat evolution can be detected and quantified using several methods: the isoperibolic method, the Seebeck method, and the mass flow method. For this disclosure, heat

evolution was measured by a carefully calibrated isoperibolic method (figure 4).

[0031] The heat evolution measured for this disclosure is shown in figure 3. The test began by powering the reactor at 100 watts with power applied to resistance heaters only, embedded in a copper block surrounding the reactor (figure 5). Then the discharge was turned on at a steady 200 mA and the resistance heater power was reduced under computer control to keep total power at 100W (refer to figure 3). Over the range of 400 minutes to 900 minutes the reactor was in thermal equilibrium when powered by resistance heaters or by the discharge. The dT was approximately 5.98C in all cases. Then power to the block heaters was advanced to 300 watts and then to 340 watts in steps of 10W. A thermal balance was achieved in all cases. Then the system was set to 335 watts of resistance heater power at the 2900-minute marker. At the 3100-minute marker, discharge power was turned on to 200 mA in steady state with heat evolution in the 5-watt range. This low thermal evolution persisted even in duty cycle or pulse mode until minute-marker 3760 when the hydrogen to deuterium ratio was set to 15:5 torr. At that instant, heat evolution increased from 5 watts to 15 watts and held until the hydrogen-deuterium gas ratio was intentionally changed and the pressure reduced to around 1 torr. At that point, heat evolution declined to baseline and the calorimeter showed zero heat evolution above that provided by the electrical input (figure 3).

[0032] The above description and drawings are illustrative and are not to be construed as limiting the invention to the precise forms disclosed. Persons skilled in the relevant art can appreciate that many modifications and variations are possible in light of the above disclosure. Numerous specific details are described to provide a thorough understanding of the disclosure. However, in certain instances, well-known or conventional details are not described in order to avoid obscuring the description.

[0033] Reference in this specification to "one embodiment" or "an embodiment" means that a particular feature, structure, or characteristic described in connection with the embodiment is included in at least one embodiment of the disclosure. The appearances of the phrase "in one embodiment" in various places in the specification are not necessarily all referring to the same embodiment, nor are separate or alternative embodiments mutually exclusive of other embodiments. Moreover, various features are described which may be exhibited by some embodiments and not by others. Similarly, various requirements are described which may be requirements for some embodiments but not other embodiments.

[0034] Unless the context clearly requires otherwise, throughout the description and the claims, the words "comprise," "comprising," and the like are to be construed in an inclusive sense, as opposed to an exclusive or exhaustive sense; that is to say, in the sense of "including, but not limited to." As used herein, the terms "connected," "coupled," or any variant thereof, means any connection or coupling, either direct or indirect, between two or more elements; the coupling of connection between the elements can be physical, logical, or any combination thereof. Additionally, the words "herein," "above," "below," and words of similar import, when used in this application, shall refer to this application as a whole and not to any particular portions of this application. Where the context permits, words in the above Detailed Description using the singular or plural number may also include the plural or singular number respectively. The word "or," in reference to a list of two or more items, covers all of the following interpretations of the word: any of the items in the list, all of the items in the list, and any combination of the items in the list.

[0035] The teachings of the disclosure provided herein can be applied to other systems, not necessarily the system described above. The elements and acts of the various embodiments

described above can be combined to provide further embodiments.

[0036] These and other changes can be made to the disclosure in light of the above Detailed Description. While the above description describes certain embodiments of the disclosure, and describes the best mode contemplated, no matter how detailed the above appears in text, the teachings can be practiced in many ways. Details of the system may vary considerably in its implementation details, while still being encompassed by the subject matter disclosed herein. As noted above, particular terminology used when describing certain features or aspects of the disclosure should not be taken to imply that the terminology is being redefined herein to be restricted to any specific characteristics, features, or aspects of the disclosure with which that terminology is associated. In general, the terms used in the following claims should not be construed to limit the disclosure to the specific embodiments disclosed in the specification, unless the above Detailed Description section explicitly defines such terms. Accordingly, the actual scope of the disclosure encompasses not only the disclosed embodiments, but also all equivalent ways of practicing or implementing the disclosure under the claims.

[0037] The terms used in this specification generally have their ordinary meanings in the art, within the context of the disclosure, and in the specific context where each term is used. Certain terms that are used to describe the disclosure are discussed above, or elsewhere in the specification, to provide additional guidance to the practitioner regarding the description of the disclosure. For convenience, certain terms may be highlighted, for example using capitalization, italics and/or quotation marks. The use of highlighting has no influence on the scope and meaning of a term; the scope and meaning of a term is the same, in the same context, whether or not it is highlighted. It will be appreciated that same element can be described in more than one

way.

[0038] Consequently, alternative language and synonyms may be used for any one or more of the terms discussed herein, nor is any special significance to be placed upon whether or not a term is elaborated or discussed herein. Synonyms for certain terms are provided. A recital of one or more synonyms does not exclude the use of other synonyms. The use of examples anywhere in this specification including examples of any terms discussed herein is illustrative only, and is not intended to further limit the scope and meaning of the disclosure or of any exemplified term. Likewise, the disclosure is not limited to various embodiments given in this specification.

[0039] Without intent to further limit the scope of the disclosure, examples of instruments, apparatus, methods and their related results according to the embodiments of the present disclosure are given below. Note that titles or subtitles may be used in the examples for convenience of a reader, which in no way should limit the scope of the disclosure. Unless otherwise defined, 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. In the case of conflict, the present document, including definitions will control.

[0040] Some portions of this description describe the embodiments of the invention in terms of algorithms and symbolic representations of operations on information. These algorithmic descriptions and representations are commonly used by those skilled in the data processing arts to convey the substance of their work effectively to others skilled in the art. These operations, while described functionally, computationally, or logically, are understood to be implemented by computer programs or equivalent electrical circuits, microcode, or the like. Furthermore, it has also proven convenient at times, to refer to these arrangements of operations

as modules, without loss of generality. The described operations and their associated modules may be embodied in software, firmware, hardware, or any combinations thereof.

[0041] Finally, the language used in the specification has been principally selected for readability and instructional purposes, and it may not have been selected to delineate or circumscribe the inventive subject matter. It is therefore intended that the scope of the invention be limited not by this detailed description, but rather by any claims that issue on an application based hereon. Accordingly, the disclosure of the embodiments of the invention is intended to be illustrative, but not limiting, of the scope of the invention, which is set forth in the following claims.

[0042] Unless defined otherwise, all technical and scientific terms used herein have the same meaning as commonly understood to one of ordinary skill in the art to which the presently disclosed subject matter pertains. Although any methods, devices, and materials similar or equivalent to those described herein can be used in the practice or testing of the presently disclosed subject matter, representative methods, devices, and materials are now described.

[0043] Following long-standing patent law convention, the terms “a”, “an”, and “the” refer to “one or more” when used in the subject specification, including the claims. Thus, for example reference to “an additive” can include a plurality of such additives, and so forth.

[0044] Unless otherwise indicated, all numbers expressing quantities of components, conditions, and so forth used in the specification and claims are to be understood as being modified in all instances by the term “about”. Accordingly, unless indicated to the contrary, the numerical parameters set forth in the instant specification and attached claims are approximations that can vary depending upon the desired properties sought to be obtained by the presently disclosed subject matter.

[0045] As used herein, the term “about”, when referring to a value or to an amount of mass, weight, time, volume, concentration, and/or percentage can encompass variations of, in some embodiments +/-20%, in some embodiments, +/-10%, in some embodiments +/- 5%, in some embodiments +/-1%, in some embodiments +/-0.5%, and in some embodiments, +/-0.1%, from the specified amount, as such variations are appropriate in the disclosed products and methods.

CLAIMS

1. A system for generating heat from reactions between hydrogen isotopes and a metal catalyst comprising:
 - a reactor comprising:
 - an anode; and
 - a cathode, wherein the cathode is a metallic vessel;
 - at least one fuel source disposed within the reactor,
 - wherein the at least one fuel source comprises a metal substrate thermally sprayed with a metal catalyst, and
 - wherein the at least one fuel source is in thermal and electrical contact with the reactor; and
 - a hydrogen source configured to add hydrogen to the reactor after the reactor is sealed;
 - a deuterium source configured to add deuterium to the reactor after the reactor is sealed; and
 - a DC power supply configured to supply a current to the reactor.
2. The system of claim 1, wherein the anode is metallic rod.
3. The system of claim 2, wherein the metallic rod is comprised of one of molybdenum and tungsten.
4. The system of claim 1, wherein the metallic vessel is comprised of stainless steel.
5. The system of claim 1, wherein the at least one fuel source is configured to slidably fit into the reactor.
6. The system of claim 5, wherein the at least one fuel source is hemicylindrical.
7. The system of claim 1, wherein the metal catalyst is a hydrogen-absorbing metal.
8. The system of claim 7, wherein the metal catalyst is comprised of a nickel and aluminum alloy.

9. The system of claim 1, wherein the metal substrate is titanium.
10. The system of claim 1, wherein sealing the reactor produces a vacuum of at least 1×10^{-4} torr in the reactor.
11. The system of claim 1, wherein the hydrogen source and deuterium source are configured to add enough hydrogen and deuterium to produce at least 20 torr pressure in the reactor.
12. The system of claim 1, wherein the DC power supply is configured to supply at least 200 mA of current to the reactor.
13. The system of claim 1, wherein the DC power supply is configured to supply current in pulsed cycles.
14. A method of generating heat from reactions between hydrogen isotopes and a metal catalyst comprising:
- placing at least one fuel source within a reactor,
 - wherein the reactor comprises:
 - an anode; and
 - a cathode, wherein the cathode is a metallic vessel;
 - wherein the at least one fuel source comprises a metal substrate thermally sprayed with a metal catalyst, and
 - wherein the at least one fuel source is in thermal and electrical contact with the reactor;
 - sealing the reactor to produce a vacuum within the reactor;
 - adding hydrogen to the reactor;
 - adding deuterium to the reactor; and
 - supplying a current to the reactor from a DC power supply.
15. The method of claim 14, wherein the anode is metallic rod.
16. The method of claim 15, wherein the metallic rod is comprised of one of molybdenum and tungsten.

17. The method of claim 14, wherein the metallic vessel is comprised of stainless steel.
18. The method of claim 14, wherein the at least one fuel source is configured to slidably fit into the reactor.
19. The method of claim 18, wherein the at least one fuel source is hemicylindrical.
20. The method of claim 14, wherein the metal catalyst is a hydrogen-absorbing metal.
21. The method of claim 20, wherein the metal catalyst is comprised of a nickel and aluminum alloy.
22. The method of claim 14, wherein the metal substrate is titanium.
23. The method of claim 14, wherein sealing the reactor produces a vacuum of at least 1×10^{-4} torr in the reactor.
24. The method of claim 14, wherein adding hydrogen and deuterium includes adding hydrogen and deuterium sufficient to produce at least 20 torr pressure in the reactor.
25. The method of claim 14, wherein supplying current includes supplying at least 200 mA of current to the reactor.
26. The method of claim 14, wherein supplying current includes supplying current in pulsed cycles.

ABSTRACT

A method for generating heat reactions between hydrogen isotopes and a metal catalyst includes placing at least one fuel source within a reactor. The reactor includes an anode and a cathode, wherein the cathode is a metallic vessel, wherein the at least one fuel source comprises a metal substrate thermally sprayed with a metal catalyst, and wherein the at least one fuel source is in thermal and electrical contact with the reactor. The method includes sealing the reactor to produce a vacuum within the reactor. The method includes adding hydrogen to the reactor and adding deuterium to the reactor. The method includes supplying a current to the reactor from a DC power supply.