對外合作組織與機構動態報導

2017/6/9

REPORT SHEDS NEW INSIGHTS ON THE SPIN DYNAMICS OF A MATERIAL CANDIDATE FOR LOW-POWER DEVICES

研究展現新觀點：材料的電子自旋動態有望應用於低電力材料之設備

By Joan Koka • May 22, 2017

Computers process and transfer data through electrical currents passing through tiny circuits and wires. As these currents meet with resistance, they create heat that can undermine the

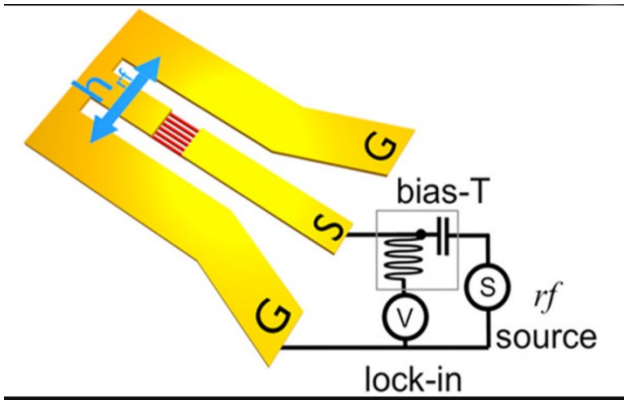
報告摘要(KEY INFORMATION)

1. 為減少熱能逸散並使低動力科技的表現最佳化，科學家嘗試找出更具效率的傳輸資訊方式。其中阿岡實驗室目前正著手一項研究，探討如何操控材料的電子自旋——即所謂「自旋電子學」；如能將激發磁極應用於資料處理，將可能減少過程中的能量損耗。
2. 距離國際原子能總署 4700 英里以外的阿岡國家實驗室，有一團隊致力於訓練各國科學家與工程師有關原子能科技的種種和平用途，提供各領域決策者當今原子能應用與應變的統計資料，為促進國際原子能相關合作貢獻心力。
3. 基本上，全球的寒帶地區皆具可觀的風力發電潛能，惟需仰賴穩定可靠的技術以應付低溫與結冰的情況。瑞典研究機構與荷蘭能源研究中心即將一同設立的風能測試中心應運而生，全球風能產業將可至該中心進行測試。
4. 海綿狀氧化鈰材料常用於處理空氣汙染物之觸媒轉換器以及多種綠能應用科技，一聚焦該材料的研究最近發現，延展或壓縮可大幅影響其氧氣涵容量。該研究將有利於往後效能更佳材料之開發。
5. 自 2013 年亞洲的天然氣價格達到最高價以來，建立亞洲樞紐以使天然氣供價合理、公平的概念逐漸成形。儘管許多專家學者認為，設立的過程恐怕進展緩慢、曠日持久；但如今前置作業皆已上軌道，該市場成形似已指日可待。

efficiency and even the safety of these devices.

To minimize heat loss and optimize performance for low-power technology, researchers are exploring other ways to process information that could be more energy-efficient. One approach that researchers at the U.S. Department of Energy's (DOE) Argonne National Laboratory are exploring involves manipulating the magnetic spin of electrons, a scientific field known as spintronics.

"In spintronics, you can think of information as a magnet pointing one way and another magnet pointing in the opposite direction," said Argonne materials scientist Axel Hoffman. "We're interested in how we can use magnetic excitation in applications because processing information this way expends less energy than carrying information through an electrical charge."



> **"**Understanding the behavior at a small size is crucial because these materials need to be small to ever have the potential to be successfully integrated in low-power devices**."**

In a report published in Nano Letters, Hoffman and fellow researchers reveal new insights into the properties of a magnetic insulator that is a candidate for low-power device applications; their insights form early stepping-stones towards developing high-speed, low-power electronics that use electron spin rather than charge to carry information.

The material they studied, yttrium iron garnet (YIG), is a magnetic insulator that generates and transmits spin current efficiently and dissipates little energy. Because of its low dissipation, YIG has been used in microwave and radar technologies, but recent discoveries of spintronic effects associated with YIG have prompted researchers to explore potential spintronic applications.

In their report, Argonne researchers characterize the spin dynamics associated with a small-scale sample of YIG when that material is exposed to an electrical current.

"This is the first time for anyone to have measured spin dynamics on a sample size this small," said Benjamin Jungfleisch, an Argonne postdoctoral appointee and lead author of the report. "Understanding the behavior at a small size is crucial because these materials need to be small to ever have the potential to be successfully integrated in low-power devices."

Researchers attached the YIG sample to platinum nanowires using electric beam lithography, creating a micrometer-size YIG/platinum structure. They then sent an electrical current through the platinum to excite the YIG and drive spin dynamics. They then took electrical measurements to

characterize the magnetization dynamics and measure how these dynamics changed by shrinking the YIG.

"When shrinking materials, they can behave in different ways, ways that could present a roadblock to identifying and actualizing potential new applications," Hoffman said. "What we've observed is that, although there are small details that change when YIG is made smaller, there doesn't appear to be a fundamental roadblock that prevents us from using the physical approaches we use for small electrical devices."

The report, titled "Insulating Nanomagnets Driven by Spin Torque," is published in Nano Letters. Other authors of the study include Junjia Ding, John E. Pearson and Valentine Novosad from Argonne's Materials Science Division, Wei Zhang from Oakland University, and Wanjun Jiang, joint with Argonne, Tsinghua University and the Collaborative Innovation Center of Quantum Matter.

This work was supported by the DOE's Office of Science. Lithography was carried out at the Center for Nanoscale Materials, a DOE Office of Science User Facility.

THE GLOBAL REACH OF ARGONNE'S NUCLEAR SECURITY TRAINING TEAM

阿岡核安訓練團隊的全球影響力

By Dave Bukey • May 25, 2017

In a modern sleek building at Department of Energy's (DOE) Argonne National Laboratory, a team of experts is training foreign scientists and engineers in the peaceful uses of nuclear energy and technology. Although the building is more than 4700 miles from the headquarters of the International Atomic Energy Agency (IAEA) in Vienna, the team is helping it uphold decades of international nuclear cooperation.

Under the umbrella of the United Nations, the IAEA provides a framework for its 168 member states to ensure the safety and security of the hundreds of nuclear power plants, reactors and fuel sites worldwide.

The Argonne's IAEA team organizes international training courses covering different areas of nuclear safety and security, nuclear energy and nuclear science and technology, including ways to improve healthcare as well as measure and enhance water quality and soil nutrition with radioisotopes. Not every country has nuclear power plants, but all have agricultural needs, as well as

hospitals or cancer treatment centers with radiological materials to supervise.

This May, Diana Naples, lead senior analyst for counterintelligence at Argonne and seminar co-chair, is again leading its pioneering, annual two-week course in nuclear security. More than 30 students from 19 countries will delve into all aspects of nuclear security – assessing threats and risks, detecting accidents, mastering legalities and combating illicit trafficking.

"We provide our participants – who are managers and decision-makers in their respective countries – with an intense contemporary survey of nuclear security relating to prevention, detection of and response to threats from terrorism, theft, sabotage, unauthorized access and illegal transfer or other malicious acts," said Naples. "We also present them with tabletop scenarios, exercises and other activities involving nuclear security situations, based on real events. We even engage them in a mock press conference."

With credentials in hand, students can help fulfill the agency's mission in their home countries.

Although Argonne first became an official IAEA partner in 1976, the laboratory's nuclear teaching role precedes the agency's launch in 1957.

Today's nuclear security course, led by Naples, stems from the 1955 opening of Argonne's International School of Nuclear Science and Engineering, whose inaugural class included 40 students from 20 countries. For nearly 20 years, the school even had its own small training nuclear reactor – dubbed Argonaut – that students could operate in a safe environment.

With its unique facilities and expertise, Argonne is "an ideal setting," said Argonne's IAEA Program Manager Sunaree Hamilton. "We have many leading experts here who want to share their knowledge with the students."

Over the years, Argonne has taught more than 220 courses to more than 5,000 students, many of whom became leaders of nuclear safety and security abroad.

RISE AND ECN SET UP TEST CENTRE FOR WIND ENERGY IN COLD CLIMATE

瑞典研究所(RISE)與荷蘭能源研究中心(ECN)將在瑞典設置風能測試中心

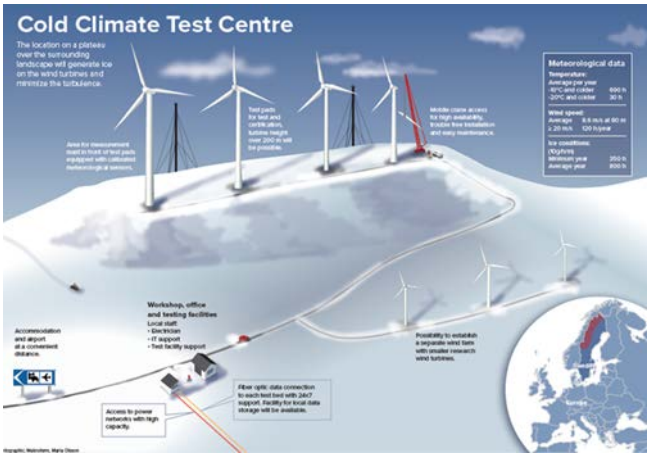
Swedish research institute RISE and ECN will jointly set up a test centre in Sweden, where the global wind industry can test their equipment in cold climate conditions.

Cold climate areas offer a great potential for wind power worldwide. However, cold temperatures and ice demand reliable, proven technology. To achieve this a cold climate test centre for the wind industry is needed.

The two institutes will provide:

- a test centre in the northern part of Sweden for full-scale testing, research, verification and certification of new generations of wind turbines and subsystems in cold climate;
- qualified services such as test and validation services, data collection, measurements, monitoring and field services of test and prototype turbines, but also test and validation of sub systems and components to the global wind industry.

Together, the two organisations have extensive experience in wind energy and testing activities. Their strengths complement each other and together they form an ideal team for developing such a unique cold climate facility.



RISE already operates field facilities in cold conditions in Sweden and has a long experience in measurement, testing and validation. ECN has its own full-scale wind turbine test centre, an accredited measurement team, and over 40 years of dedicated R&D in wind energy.

Operated by RISE, the test centre will be located in a place with excellent conditions for testing wind turbines, turbine components and sub systems in cold climate. Now work is continuing to determine which location best meets the meteorological and geographic requirements of the test centre.

USING NANOTECHNOLOGY TO MAKE A KEY INDUSTRIAL CATALYST MORE EFFECTIVE

奈米科技使重要工業觸媒氧化鈰的淨化效果大幅提升

By Mark Shwartz

ENGINEERING

Catalytic converters and clean-energy technologies sop up air pollution like a sponge. Researchers find that stretching or compressing a key material boosts its cleansing power.

A tiny amount of squeezing or stretching can produce a big boost in catalytic performance,

according to a new study led by scientists at Stanford University and SLAC National Accelerator Laboratory.

The discovery, published May 18 in *Nature Communications*, focuses on an industrial catalyst known as cerium oxide, or ceria, a spongy material commonly used in catalytic converters, self-cleaning ovens and various green-energy applications, such as fuel cells and solar water splitters.

"Ceria stores and releases oxygen as needed, like a sponge," said study co-author Will Chueh, an assistant professor of materials science and engineering at Stanford and a faculty scientist at SLAC. "We discovered that stretching and compressing ceria by a few percent dramatically increases its oxygen storage capacity. This finding overturns conventional wisdom about oxide materials and could lead to better catalysts."

Catalytic converters

Ceria has long been used in catalytic converters to help remove air pollutants from vehicle exhaust systems. "In your car, ceria grabs oxygen from poisonous nitrogen oxide, creating harmless nitrogen gas," said study lead author Chirranjeevi Balaji Gopal, a former postdoctoral researcher at Stanford. "Ceria then releases the stored oxygen and uses it to convert lethal carbon monoxide into benign carbon dioxide."

Studies have shown that squeezing and stretching ceria causes nanoscale changes that affect its ability to store oxygen.

"The oxygen storage capacity of ceria is critical to its effectiveness as a catalyst," said study co-author Aleksandra Vojvodic, a former staff scientist at SLAC now at the University of Pennsylvania, who led the computational aspect of this work. "The theoretical expectation based on previous studies is that stretching ceria would increase its capacity to store oxygen, while compressing would lower its storage capacity."

To test this prediction, the research team grew ultrathin films of ceria, each just a few nanometers thick, on top of substrates made of different materials. This process subjected the ceria to stress equal to 10,000 times the Earth's atmosphere. This enormous stress caused the molecules of ceria to separate and squeeze together a distance of less than one nanometer.

Surprise results

Typically, materials like ceria relieve stress by forming defects in the film. But atomic-scale analysis revealed a surprise. "Using high-resolution transmission electron microscopy to resolve the position of individual atoms, we showed that the films remain stretched or compressed without forming such defects, allowing the stress to remain in full force," said Robert Sinclair, a professor of materials science and engineering at Stanford.

To measure the impact of stress under real-world operating conditions, the researchers analyzed the ceria samples using the brilliant beams of X-ray light produced at Lawrence Berkeley National Laboratory's Advanced Light Source.

The results were even more surprising.

"We discovered that the strained films exhibited a fourfold increase in the oxygen storage capacity of ceria," Gopal said. " It doesn't matter if you stretch it or compress it. You get a remarkably similar increase."

The high-stress technique used by the research team is readily achievable through nanoengineering, Chueh added. "This discovery has significant implications on how to nanoengineer oxide materials to improve catalytic efficiency for energy conversion and storage," he said. "It's important for developing solid oxide fuel cells and other green-energy technologies, including new ways to make clean fuels from carbon dioxide or water."

JAPAN'S PURSUIT OF ITS OWN LNG HUB

日本正籌備成立一液化天然氣樞紐

By Hiroshi Hashimoto

Introduction

At the height of the Asian premium of LNG prices in 2013, concepts of Asia's LNG hub emerged as a way to introduce fair and reasonable LNG pricing in the region. While the progress may look slow in terms of institutional and framework aspects of the development and experts expect it will take many years to actually establish an LNG trading hub, preconditions and necessary elements for such a market are steadily coming true.

Potentially tradable and flexible LNG is certainly growing, as more new LNG projects are coming online with buyers equity participation and hence equity lifting arrangements. More LNG sales and optimization deals are concluded between portfolio players and Asian LNG buyers without destination restrictions and with different pricing conditions, potentially enabling more flexible movements of LNG cargoes.

In addition to the flexible contractual arrangements, the timely and transparent customs statistics systems in Japan and other East Asian importers are expected to make future LNG markets in the region more visible. Although significant portion of LNG may still be traded under long-term contracts in the future, the inherent flexibility and potential tradability should be deemed as part of liquidity of the region's LNG markets.

A more comprehensive coverage of bidding and offering information (with cooperation between PRAs and government agencies) with easier access by companies with less appetite for trading may lead to more reliable price formation for the spot market. The industry

does not have to solely rely on the spot market prices to establish a fair and equitable LNG price index in the region. Another potential index is the JLC as Japan's weighted average delivered LNG price for a month.

An LNG hub there does not mean a pure spot trading hub, but can be a combination of more flexible term contracts and enhanced spot trading.

Efforts toward a more flexible LNG market

One of the most successful efforts by the Japanese government and LNG buyers toward a flexible LNG market has been relaxation of destination clauses in the LNG term contracts. This is of course thanks to LNG sellers' great help and understanding.

The trend is expected to continue and the world will see a more flexible and globally connected LNG market in the future.

The greatest expansion of the LNG industry in its history

The global LNG market is finally gearing up for the anticipated major expansion and a structural shift. In 2016, around 260 million tonnes of LNG was produced, of which 45 million tonnes was exported from Australia.

Signs of consuming markets growth have been observed, responding to the production expansion, including emerging markets in Southeast Asia and the Middle East, as well as more matured markets in Northeast Asia. The four importers in the region - Japan, Korea, China and Chinese Taipei - imported 47 million tonnes of LNG in total in the first quarter of 2017, 13% or 5.4 million tonnes more than the same period of 2016. These are indications that if supply is ample and reliable, additional demand will be developed. LNG can be a major driving force to expand new natural gas demand.

Along with volumetric growth, ways of moving LNG from production to consumption are changing. The value-chain structure is no longer vertically integrated. Because of diversification of sales practices, market participants, and project development models, new ideas will be needed for future LNG project development.

One of the more recent significant changes in the LNG market has been the lower prices and consequently smaller monetary size of the market.

Among the above-mentioned four importers in the Northeast Asia region, only China increased imported LNG volumes by 33% in 2016 but paid only slightly more than the previous year. The other three importers paid significantly less in 2016 than in 2015. LNG importers around the world as a whole are estimated to have paid less than USD 100 billion in 2016, compared to USD 200 billion in 2014.

By the way custom statistics in this part of the world are always published in a timely and transparent manner. The quality of the information is greatly helping market players and analysts.

Why an LNG hub

The need for an LNG hub, or market flexibility in a broader sense, has been evolving along with the market evolution. Only three years ago, some people were still talking about market tightness. Other people thought that the main causes of the Asian premium of LNG prices were the lack of Asia's own pricing system reflecting

supply and demand balance, and the lack of an actively traded LNG market.

It is true that pure spot trading of LNG may not be active enough to have liquidity to create a reliable price index. But isn't the Asia Pacific region the most active LNG market as a whole? The region should take advantage of the position as the largest LNG market.

Since then the market balance has changed and the Asian premium has shrunk for some time. While LNG market players and commodity exchange places have made efforts to make LNG market more flexible, today the need for LNG market flexibility itself include various elements. Existing LNG players want to obtain favourable LNG prices. New players may be able to buy and sell LNG only if there is a flexible LNG market. Some traditional LNG buyers want to sell their LNG for different reasons.

In May 2016, the Japanese government released the LNG Market Strategy. Recognising the evolving nature of the LNG market, the strategy is expected to be revised when it is deemed necessary. There are three cores in the strategy: (1) Enhancement of tradability is focusing on removal or relaxation of restrictive practices in LNG contracts; (2) Creation of a proper price discovery mechanism means facilitation of a fair and transparent spot market leading to a price index that can be used in long-term and short-term contracts; and (3) Open and sufficient infrastructure means facilitation of third-party use of LNG terminals and pipeline networks. The last item may be tricky because of the specific nature of the Japanese and Asian LNG markets. Since Japan is entirely dependent on LNG for its natural gas supply and other Asian countries are also heavily dependent on LNG fir their natural gas supply without significant access to pipeline supply, security of supply remains the top priority and the primary user's right should remain respected.

Progress may look slow but it is being made

Since the significant expansion of the market is just beginning, it is still difficult to see how flexibility of the market evolves in the future. Some people say that it will take 10 to 15 years to establish an LNG trading hub, while others say it will never come.

However, preconditions and necessary elements for such a market are steadily coming true.

While the share of spot and short-term transactions did not grow much in 2015 and 2016, according to the latest GIIGNL annual report, "pure" spot trades grew from 15% of the total or 37 million tonnes in 2015 to 18% or 47 million tonnes in 2016. Moreover, potentially tradable and flexible LNG is growing, thanks to more flexible LNG contracts in recent years, as more new LNG projects are coming online in the Asia Pacific region with buyers equity participation and hence equity lifting arrangements.

More LNG sales and optimization deals are concluded between portfolio players and Japanese and other Asian LNG buyers without destination restrictions and with different pricing conditions, potentially enabling more flexible movements of LNG cargoes.

With expected increase of the flexible portion under long-term arrangements more parties are expected to have ability and desire to

potentially bid or offer LNG cargoes in the spot market. In fact more players are today conducting tenders to buy or sell LNG cargoes.

Lastly but most significantly LNG export projects in the United States are expected to enhance flexibility in the global LNG trades especially from 2017 with destination flexibility and the gas-indexed LNG pricing, along with notable project participation by Japanese and other Asian companies either as offtakers, investors, or financers.

In addition to the flexible contractual arrangements, the transparent transaction (in particular, price) reporting requirements under the Department of Energy (DOE) regulation in the United States, combined with the timely and transparent customs declaration and statistics systems in Japan and other East Asian importers, are expected to make future LNG markets in the Asia Pacific region more visible. Price information is transparent at both ends. DOE releases cargo-by-cargo information, including seller and FOB buyer identities, countries of destination, exported volumes, and prices.

In the first quarter of 2017, Japan imported much anticipated LNG cargoes from the United States for the first time, for an average price of USD 12 / million Btu compared with the across-the-board average of USD 7.64 for the total LNG imports into Japan from all sources in the period.

The price level is one thing to note. Another thing to note is that, in addition to import prices, we can also obtain FOB price information for each cargo from DOE. This transparency of information will certainly help market players to make actions and decisions.

A more comprehensive coverage of bidding and offering information (with some kind of cooperation between Price Reporting Agencies (PRAs) and even government agencies) with easier access by companies with less appetite for trading may lead to more reliable price formation for the spot market.

The author also argues that the industry do not have to solely rely on the spot market prices to establish a fair and equitable LNG price index in the region. Another potential index is the JLC as Japan's weighted average delivered LNG price for a month. It has been possible to know the JLC for the month by the end of the following month, thanks to timely publication of the customs statistics.

There may be a risk at this moment that the JLC may still fluctuate with volatile movement of crude oil prices as many of Japanese long-term LNG import contracts are indexed with the JCC as Japan's weighted average delivered crude oil price. However, in the future, by gradually shifting long-term purchasing contracts from oil-index to JLC-index, the risk may be gradually mitigated and the JLC-indexed price may move month by month with adjustment made by certain volumes of spot LNG transactions.

Further consequences from the LNG market expansion

In the next five years a generation shift is expected in Japan's and Asia Pacific's LNG supply sources, with additions of projects from the United States and more portfolio deals, leading to even greater flexibility.

At the same time the total procured volumes by Japanese buyers for 2020 have already

surpassed 85 million tonnes, leaving little room to additionally procure spot and short-term volumes. Supply sources are expected to shift to Australia and the United States, decreasing the share of Southeast Asia.

Those flexible portions of LNG procurement may be imported to originally intended destinations under contracts, resold to different buyers under secondary contracts, or resold in the spot market. A possible LNG hub should include not only a pure spot LNG market but also incorporate the broader sense of flexibility in the whole LNG market.

Recent LNG production projects have also seen increasing minority equity participation by Japanese and other Asian companies, which is also part of efforts to obtain more flexibility in the LNG market, as those equity arrangements are often accompanied with LNG offtake arrangements.

Japan opened up its city gas residential market for competition in April 2017. This is an ambitious attempt by the government of a country which is totally dependent on imported supply sources. Although the initial number of new market participants is small and switching rates are not expected to be very high, the initiative is considered to be very important to continue affordable energy supply to customers and businesses, while streamlining energy supply systems.

Efforts by the Japanese government and institutions

During the last several years, the Japanese government has been active in communicating with LNG producing and consuming nations on LNG market issues. Although Japan does not have national champion LNG buying companies, the government hosts the annual LNG Producer-Consumer Conference, which has become one of the most important events in the LNG industry.

Starting from the Strategic Energy Plan in April 2014, the government has been successful in engaging other governments to promote flexibility in LNG trades. Official documents from those governmental meetings have included statements to promote more flexible LNG markets, including phasing out of destination restrictions. The Tokyo Commodity Exchange (Tocom) has incorporated contracts to help grow the LNG market.

Conclusion

Along with the ongoing significant expansion of LNG capacity in the global market, Japanese players and the government continue evolving business models and market structures. Players are expected to streamline their activities and change their mindsets to cope with new market reality. Japan and Asia should be able to take advantage of their own market positions and information assets to establish their own equitable and fair LNG market. An LNG hub there does not mean a pure spot trading hub, but can be a combination of more flexible term contracts and enhanced spot trading.