2017 CYBER DEFENSE COMPETITION ENTHRALLS CROWD AT ARGONNE

2017 資安防護競賽，阿岡高手雲集

By Dave Bukey • April 14, 2017

Argonne NATIONAL LABORATORY

More than 100 college and high school students from nine states honed their cyber defense skills against experts at the U.S.

報告摘要(KEY INFORMATION)

1. 來自九個不同的州、超過 100 名大專院校與高中學生，在阿岡國家實驗室與資安領域專家學者同臺競技資安攻防。阿岡每年都舉辦該項競賽，幫助學生在實戰中掌握自身實力，並瞭解資安工作的優勢。

2. 鏽，一般發生在我們疏於照料日常用具的時候，它會蠶食我們的汽車、橋梁，和建築等。但在精密的控制之下，生鏽——氧化的過程或許有助科學家研發出更先進的電池與藥物傳遞技術。

3. 為了減低碳排放量並增加可再生能源的發電量，能源相關部門與化學產業正尋找創新方法，以產生 CO_2 零排放的氨氣；該產物具有取代天然氣作為燃料及用於肥料、美耐皿之生產等潛在用途。

4. 碳排放交易系統訂其「量」，卻無法訂其「價」，導致排放額度價格有顯著的波動與「碳洩漏」等情況。該系統原先設立時，是希望企業考量其成本效益而減少內部碳排，否則須由外購買碳排額度。然而實際上，由於政府經常性的介入造成價格浮動，反而令企業更難預測碳排成本。

5. 今年 3 月 14 日，東芝(Toshiba)發布了有關其營運策略的消息：東芝決定出脫美國核電事業西屋電器的大部分控股，以處理其破產後所須面對的高額債務，此舉亦是在與其海外核能新建業務切割。同月三菱重工(MHI)卻收購 Areva 旗下核燃料循環公司 NewCo 的 5%股份。兩家企業對當前核電市場所採取的策略截然不同，值得探討。

Department of Energy's (DOE) Argonne National Laboratory during Argonne's second annual Collegiate Cyber Defense Competition.

In the competition, 15 college teams defended mock electrical and water utilities from the repeated cyber attacks of a team of experts from Argonne, the Illinois and Wisconsin National Guard and the technology industry.

"The gloves were off," said Matt Kwiatkowski, a cyber security manager at Argonne and leader of the "Red Team" of aggressors. "We sought to access and manipulate the college teams' networks. But some teams learned from it."

Argonne hosts the competition each year to highlight the advantages of a career in cyber security for students and to let them test their skills in real-world scenarios, said Meridith Bruozas, who leads educational programs and outreach at Argonne.

The seven-hour contest followed remarks from U.S. Representative Bill Foster (D-IL-11); Devon Streit, Deputy Assistant Secretary for Infrastructure Security and Energy Restoration in the DOE's Office of Electricity Delivery and Energy Reliability; and John P. Quintana, Argonne's Interim Deputy Laboratory Director for Operations.

The Red Team notched several first-hour wins, briefly cutting the lights and water utilities of the Lewis University and John A. Logan College teams.

As part of the "Pink Team" learning about cyber security, Jocelyn Murray, a student at Wakefield Memorial High School in Massachusetts, beamed as she helped the Red Team plot its attacks.

"Once we analyzed the IP addresses, we chose the type of attacks based on the cyber defenders' operating systems," Murray said.

Kwiatkowski's Red Team also soon spotted unprotected passwords and documents hosted by the University of Northern Iowa's team – an opening to further cyber attacks.

Yet the defending teams remained optimistic. Ben Holland, a graduate student and leader of the Iowa State team, stressed that his network was working perfectly after more than an hour of defense.

Despite a hectic week of preparation, "I had a chance to bond with my team as we had an 'a-ha' moment about how to build our network," Holland said.

Like Holland, Ian Springer, a senior and leader of the Indiana Tech team, is a veteran of several cyber competitions and found the Argonne experience invaluable. "It's a great opportunity to demonstrate my skills outside the classroom," Springer said.

Springer's experience grounded his team as the terrain became tricky. In the first hour, "we saw a few attacks, but managed to defend against them," he said.

Throughout the day, several teams – including University of Illinois Chicago (UIC) and Dakota State University – held the Red Team at bay.

Ultimately, UIC won first place as Dakota State and Kansas State shared second-place ribbons.

The enthusiasm was infectious. “Cyber security is our biggest challenge,” said Streit, who briefly joined the fun as an ad-hoc Red Team member.

“It is so rewarding to be a part of such a unique competition.”The competition was so successful that it may need a bigger venue next year, according to Nate Evans, group lead for Argonne's Cyber Operations Analysis and Research team, which led the event.

In 2018, “we hope to host more teams and even coordinate teams at multiple national laboratories at the same time,” said Evans.

Students and schools interested in upcoming competitions can register for updates on Argonne’s Cyber Defense Competition website

NEW STUDY REVEALS THE MYSTERY BEHIND THE FORMATION OF HOLLOWED NANOPARTICLES DURING METAL OXIDATION MATERIALS

新的研究揭示金屬氧化過程中形成空洞奈米顆粒之奧秘

By Joan Koka • April 21, 2017

Rust usually indicates neglect; it undermines the structures and tools we rely on every day, from cars to bridges and buildings.

But if carefully controlled, the same process that creates rust – metal oxidation – could offer scientists ways to advance state-of-the-art battery or drug delivery technologies.

To achieve such control, scientists must first understand exactly how the oxidation process works. With the help of supercomputers and synchrotrons, researchers at the U.S. Department of Energy’s (DOE) Argonne National Laboratory and Temple University are illustrating the process on a finer scale than ever before.

In a paper published today in Science, Argonne and Temple University researchers describe the behavior of metal nanoparticles by watching them in real time as they oxidized. By using a combination of X-ray scattering and computational simulation, the researchers were able to observe and model the changes in nanoparticle geometry as they occurred.

This knowledge adds to our understanding of fundamental everyday reactions like corrosion, and builds a foundation for developing new techniques to image, manipulate and control such reactions at the atomic scale.

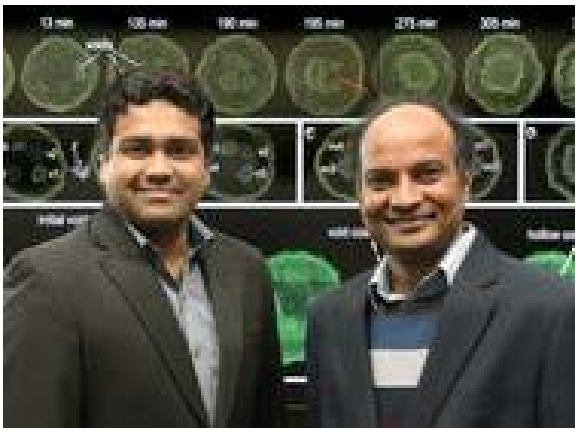
“During oxidation of metals, there is a directional flow of material across a solid/gas or solid/liquid interface which can sometimes lead to the formation of holes in the atomic lattice. This process is known as the Kirkendall effect. If well understood, it can be used to design exotic materials at the nanoscale,” said computational scientist Subramanian Sankaranarayanan, one of the principal investigators of the study and a researcher at Argonne’s Center for Nanoscale Materials.

In their study, researchers sought to understand the Kirkendall effect in small particles of iron during oxidation at the nanoscale level, specifically in the 10-nanometer range.

At this scale, roughly 10,000 times thinner than a sheet of paper, iron nanoparticles exposed to an oxygen environment exhibit a unique property – they form exotic structures, such as hollowed-out nanoparticles or nanoshells, which already have been used as electrodes in battery applications and as vehicles for drug delivery in medicine. The shape, structure and distribution of the holes in these nanoshells depend on how oxidation progresses in time.

“A full 3-D evolution of morphologies of nanoparticles under real reaction conditions with sub-nanometer to atomistic resolution had not been realized until this study.”

“What we’ve done, through experimental and theoretical approaches, is build an understanding of the process itself — how these holes form and coalesce,” said co-author Badri Narayanan, an Argonne staff scientist who was a postdoctoral appointee at the time of study. “Without understanding these processes as they naturally occur, you can never hope to control them to produce new materials with exceptional functionality.”



The Argonne study was the first time-resolved analysis to use two X-ray scattering techniques to monitor structural evolution during nanoparticle oxidation in 3-D.

Small-angle X-ray scattering at the Advanced Photon Source helped characterize the void structures, while wide-angle X-ray scattering provided information on the crystalline structure of the nanoparticles; the combination of the two enabled researchers to experimentally investigate both the metal lattice and pore structure.

With these experimental techniques, researchers could see how voids formed at a relatively high spatial resolution, but not one that reached the level of individual atoms. For this insight, researchers turned to the

supercomputing resources at the Argonne Leadership Computing Facility.

Computer simulations complemented the experimental observations and enabled the researchers to simulate the oxidation of iron nanoparticles atom-by-atom – meaning researchers could visualize the formation and breakage of bonds and track the movement of individual atoms.

X-ray experiments and multimillion-atom reactive simulations were performed on exactly the same particle size to facilitate direct comparison of the evolving structure.

"We needed the immense computing power of the Argonne Leadership Computing Facility's 10-petaflop supercomputer, Mira, to perform these large-scale reactive simulations," said Narayanan. "The simulations provided more detailed insight into the transformation of nanoparticles into nanoshells and the atomic-scale processes that govern their evolution."

The ability to integrate synthesis and experimental methods (X-ray imaging and nanoparticle synthesis and transmission electron microscopy performed at the Center for Nanoscale Materials) with computer modeling and simulation to build new knowledge is among the most valuable aspects of the study, the authors said.

"A full 3-D evolution of morphologies of nanoparticles under real reaction conditions with sub-nanometer to atomistic resolution had not been realized until this study," said Sankaranarayanan. "This truly exemplifies how the sum can be greater than the parts – how theory and imaging together give us information that is better than what can be obtained when these methods are used independently."

The study, titled "Quantitative 3D Evolution of Colloidal Nanoparticle Oxidation in Solution," is published in Science.

Other authors of this study include Yugang Sun, Xiaobing Zuo, Sheng Peng and Ganesh Kamath. The research was supported by Temple University.

The work was completed using resources at the Advanced Photon Source, the Center for Nanoscale Materials and the Argonne Leadership Computing Facility, as well as the National Energy Research Scientific Computing Center at Lawrence Berkeley National Laboratory – all DOE Office of Science User Facilities. Computing time at the Argonne Leadership Computing Facility was awarded through the Innovative and Novel Computational Impact on Theory and Experiment (INCITE) program and the ASCR Leadership Computing Challenge

POWER TO AMMONIA: FROM RENEWABLE ENERGY TO CO2-FREE AMMONIA AS CHEMICAL FEEDSTOCK AND FUEL

前進阿摩尼亞：從可再生能源產生的 CO2 零排放氨產物可作為化學原料及燃料

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The Power to Ammonia (P2A) project has recently successfully concluded a feasibility study into the storage of renewable energy in ammonia (NH3) for three business cases. ECN, on behalf of Shared Innovation Program VoltaChem is one of the participants of this ISPT initiative with ten parties of the energy and chemistry sector.

Driven by ambitious CO2 reduction targets and increasing production of renewable energy (e.g., wind and solar), parties in the energy sector, together with chemical industries, are looking for innovative ways to produce CO2-free ammonia and use this ammonia to balance supply and demand without having to revert to fossil-fuel-based generation of electricity. The study shows that the electrochemical production of ammonia from renewable energy is a likely option and also offers a very promising solution for large-scale seasonal storage and import of renewable energy.

The benefits of ammonia

The idea is simple: at times when or at locations where there is a surplus of renewable energy, it can be converted via electrolysis into hydrogen and finally into ammonia. Ammonia can be stored and transported as a liquid. Thanks to its high energy density, transportation and storage of ammonia in large volumes is more feasible than, say, hydrogen. What's more, the chemical industry can use this ammonia as a renewable feedstock for the production of fertilizers and other products. Applications could even include wind turbines that provide electricity solely for the sustainable local production of ammonia. Such facilities do not need to be linked to the electrical grid, which would eliminate the need for expensive power cables.

Sustainable super battery

The feasibility study included a business case in an industrial setting at the new high-efficient gas-fired Magnum power plant operated by energy provider Nuon in Eemshaven, in the north of the Netherlands. The aim of this case study was to find out whether ammonia from renewable energy could be used as an alternative fuel to natural gas to generate electricity in the plant. "As an energy company, Nuon is very interested in carbon-free fuels for our plants, as well as new ways of storing electricity," says Geert Laagland, Head of Engineering at Nuon. "By storing local surpluses of renewable energy in ammonia, we can turn our power plant into a sustainable super battery. In addition, we're interested in the option of importing sustainably produced ammonia from renewable electricity sources in remote locations. Another option is to produce CO2-neutral ammonia from natural gas near remote gas fields and inject the CO2 back into these same gas fields.

Ammonia as a chemical feedstock

Ammonia produced from renewable energy can also help the energy-intensive chemical industry to move towards more sustainable ways of working. “If we can use ‘renewable’ ammonia as the primary feedstock for our fertilizer and melamine production, we can significantly reduce our CO2 footprint,” says Ruud Swarts, Technology Manager at OCI Nitrogen. “Electrolysis can currently not compete with conventional ammonia production. However, the P2A study has shown that the technology could be competitive in 10 to 15 years’ time, particularly if current trends such as increasing renewable electricity production and rising CO2 prices can be combined with innovative business models. Of course, there are still many hurdles to be overcome. By setting up pilots for this new technology, we can identify these and find ways to solve them.”

Alleviating the grid

For grid owners a major advantage of producing ammonia from wind and solar power will be that investments in the grid can be reduced. If the share of wind and solar power increases without energy storage, the investment required to increase grid capacity will be substantial. “P2A enables energy to be stored for periods of days, weeks or even months,” says Guy Konings, Market Manager at Joulz. “Substantial amounts of electricity can be converted into ammonia when needed, providing enormous flexibility in the grid.”

Getting ready for the future

Just increasing the generation of wind and solar energy will not be enough to achieve our national CO2 reduction targets in the coming decades. The P2A feasibility study shows that ammonia can play an essential role in achieving these targets, by offering opportunities for the production of CO2-neutral ammonia and using this ammonia for storage of renewable energy. Gas-fired power plants could soon be made more sustainable by importing CO2-neutral ammonia from abroad for immediate use. Local storage of surplus renewable energy in ammonia will probably be technologically feasible by 2030, when the supply (and surplus) of renewable energy is likely to be much higher than today. “However evaluation of different technologies to convert electricity into ammonia; either existing technology, such as the technology of Proton Ventures, as well as future technologies, like the ones Professor Fokko Mulder develops with his team at TU Delft, shows that a dramatic decrease of the investment costs for electrolysers is needed” says Yvonne van Delft, Innovation Manager at VoltaChem co-initiator ECN. “The development and piloting of low-cost electrolyzers is key to a broad implementation of CO2-neutral ammonia.” By giving power to ammonia, we’re getting ready for a sustainable future.

UPDATE ON POLICIES RELATED TO CLIMATE CHANGE

氣候變遷相關政策之近況

Takahiko Tagami, Senior Coordinator
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The US Trump administration released "America First" budget blueprint on March 16. The budget will eliminate, for the State Department, the Global Climate Change Initiative that makes contributions to the UN Framework Convention on Climate Change (UNFCCC) and Intergovernmental Panel on Climate Change, as well as the US's funding for the UN's Green Climate Fund. For the Environmental Protection Agency, funding for the Clean Power Plan and climate change research will stop. The new administration's environmental policies have been unveiled in the form of a budget blueprint, which will be deliberated in Congress.

A nationwide emissions trading system, which was introduced in 2005 in the EU and in 2015 in Korea, is scheduled for introduction this year in China.

In the EU, economic recessions have caused great gaps between predetermined allowances and actual emissions, resulting in a year's worth of surplus emission allowances in the market. The price of allowances plummeted, currently at around 5 euros/tonne, due to Lehman Brothers' bankruptcy and economic downturn. The auctioning of allowances has partially been postponed since 2014 to reduce surplus, but with little progress. Regulator's intervention in the market is increasing as the establishment of a market stabilization reserve is being proposed to absorb surplus allowances from 2021.

Korea designed a rigorous system to avoid surplus allowances based on the lessons learnt from the EU, but on the contrary, a shortage of emissions allowances became a problem due to production increase. Market transaction volumes are low due to a lack of sellers, and as a result, the emissions allowance price has soared to 26,500 won (2,600 yen) per tonne. For 2015, the first compliance year, it was initially expected that many companies would be unable to purchase emissions allowances and meet the targets. However, immediately before the compliance deadline, the government raised the limit for borrowing from next year's allowances, from 10% to 20%, averting the problem for the time being. Frequent changes in system management policy and government intervention are causing unpredictability for companies.

In China, the pilot emissions trading systems that run in seven provinces and cities have seen limited trading volume, and the trading price is highest in Beijing City at 50 yuan (approx. 800 yen) per tonne. The nationwide uniform trading system planned for 2017 is expected to cover companies that exceed a certain energy consumption in 18 subsectors in eight sectors.

Allowances will be allocated in principle based on a benchmark system, in which energy intensity prescribed for each sector is multiplied by the output of each company, and not based on historical emissions. Allowance allocations were initially planned until the first quarter of 2017 but it is taking time and they are now expected to end in the second half of 2017.

Since the emissions trading system essentially determines the "quantity" but cannot control the "price", it has the problem that prices may fluctuate significantly, as well as challenges such as carbon leakage. The system intends to achieve cost-efficient reductions by allowing companies to choose between reducing internally and buying allowances from other companies. However, in reality, the market system could be subject to frequent government interventions that cause unpredictability for companies.

DEVELOPMENTS IN NUCLEAR POWER

核能發電的發展

Tomoko Murakami
Manager Nuclear Energy Group
Strategy Research Unit

On March 14, Toshiba released a document summarizing its management strategies, and announced plans to sell its majority stake in Westinghouse (WEC) and remove the company from the Toshiba Group's earnings in the wake of losses incurred in the US nuclear new build business, effectively withdrawing from the US and other overseas nuclear new build business. As the buyer of the majority stake in WEC is undecided, it is unknown whether the buyer will continue with the ongoing new build projects in the US. After years of strong momentum behind nuclear new build projects in the US dubbed the "nuclear renaissance" following the implementation of the Energy Policy Act of 2005, nuclear energy is facing historic headwinds in which even projects with a Combined License for Construction and Operation (COL) face uncertainty due to low electricity prices, and ongoing construction projects may not be completed. It is very unclear what decisions a prospective purchaser of the stake in WEC will make, or indeed whether there will be a purchaser. On March 29, WEC has filed for Chapter 11 bankruptcy. The future situation is in doubt and needs to be monitored.

Coincidentally, also on March 14, in a damage claim by Southern California Edison (SCE) against Japan's Mitsubishi Heavy Industries (MHI) on failed replacement steam generators for San Onofre Units 2 and 3, the International Chamber of Commerce decided that MHI must pay approximately 125 million dollars to SCE. This is a major victory for MHI considering that SCE had claimed over 7 billion dollars, including compensation for lost opportunity for electricity

sales. The ruling indicated that a manufacturer can minimize business risks within its scope of responsibility by fulfilling the manufacturer's guarantee obligations. While Toshiba aims to remove the risk of the overseas nuclear business, MHI decided on March 21 to acquire a 5% stake in nuclear fuel cycle company NewCo in the Areva Group (approx. 250 million euros). It will be interesting to see the impact of these two companies' contrasting strategies on the nuclear power markets in the US, Europe, Asia and the Middle East.

In Japan, on March 17, the Maebashi District Court ruled that Tokyo Electric must pay damages to evacuees, including voluntary ones, from Fukushima prefecture to Gunma prefecture. Some consider this ruling as a fresh challenge to restarting the nuclear plants and the related policies, and that its impact must be monitored. On March 28, the Osaka High Court lifted the provisional injunction ordering Takahama Units 3 and 4 to cease operation, roughly one year after the injunction.

For the utility, which had received a provisional injunction with penalty for its plant despite having passed the Nuclear Regulation Authority's safety assessment, and had been forced to close the plant for a long time, it is significant that a higher level of judiciary clearly approved the legitimacy of restarting a plant that has passed the safety assessment. This important decision could affect the direction of future court cases to stop the operation of nuclear power plants and discourage new lawsuits.