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Business Standard

Thu, 12 May 2022

Advancements in futuristic technologies need of the hour: MoS Ajay Bhatt

Union Minister of State for Defence Ajay Bhatt on Wednesday called upon the scientific community to make advancements in technologies, such as Artificial Intelligence (AI), so that the nation is prepared to deal with future threats. He was addressing the National Technology Day function organised by Defence Research and Development Organisation (DRDO) in New Delhi. The Government is making all efforts to meet the defence requirements through domestic procurement, he said, exhorting all sectors of the defence ecosystem to work together to achieve excellence in cutting edge technologies.

Bhatt lauded the efforts of DRDO in establishing a self-reliant research and development (R & D) ecosystem which provides the Armed Forces with state-of-the-art equipment, in line with the Prime Minister Narendra Modi's vision of 'Aatmanirbhar Bharat'. "DRDO has proved itself through design, development and production of highly-sophisticated weapon platforms/systems. It has enhanced the involvement of the private sector. Due to these efforts, India is now among the top 25 nations exporting defence equipment," he said. National Technology Day is observed on May 11 every year to commemorate the nuclear tests conducted in Pokhran in 1998. The theme this year is 'Integrated Approach in Science and Technology for Sustainable Future'.

Bhatt said, the theme underlines the importance of all-round development of science and technology for the progress of a nation. During the event, Bhatt gave away DRDO awards for the year of 2019 to the scientific fraternity for displaying outstanding acumen in realising the technological dreams of the nation. The category of awards included awards for Life-Time Achievement, Technology leadership, Senior Scientists Awards, Academy Excellence, Techno-Managerial, Self-Reliance and Performance Awards.

Bhatt also released two monographs - 'Endeavours in Self-reliance Defence Research (1983-2018)' authored by former Director DRDO Dr KG Narayanan and 'Concepts and Practices for Cyber Security' by former Director General at DRDO Dr G Athithan. A Defence Technology Spectrum was also released on the occasion. The event also witnessed three orations from DRDO scientists on advanced technologies.

https://www.business-standard.com/article/current-affairs/advancements-in-futuristic-technologies-need-of-the-hour-mos-ajay-bhatt-122051200070_1.html

Wed, 11 May 2022

Advancements in futuristic technologies will lead in realising Atmanirbhar Bharat

“I call upon the scientific community to make advancements in technologies, such as Artificial Intelligence (AI) so that the Nation is prepared to deal with future threats,” said Union Minister of State Ajay Bhatt while addressing the National Technology Day event organised by Defence Research and Development Organisation (DRDO) in New Delhi. In order to make the defence ecosystem work, the government is making concerted efforts to meet the defence requirements through domestic procurement. This way the aim is to achieve excellence in cutting edge technologies.

DRDO’s realising the vision of ‘Atmanirbhar Bharat’

Union Minister Ajay Bhatt, during the event, lauded the efforts of DRDO in establishing a self-reliant R&D ecosystem which provides the Armed Forces with state-of-the-art equipment. The minister said, “DRDO has proved itself through design, development and production of highly-sophisticated weapon platforms/systems. It has enhanced the involvement of the private sector. Due to these efforts, India is now among the top 25 nations exporting defence equipment.”

An innovative perspective for Innovation

It is well-established fact that the Defence sector holds a critical position in India. We have the second-largest armed forces in the world. Military modernisation and technological intervention are on the radar for achieving self-reliance in defence production. As soon as the government opened up the Defence industry for private sector participation, much impetus has been given to indigenous manufacturing.

Constant work is been done on including futuristic technologies in the ecosystem and the sector like drones and anti-drone technology, robotics, cyber security, artificial intelligence, quantum computing and asymmetric technologies. With the focus being on indigenization, this presents an excellent opportunity for Indian researchers and the industry, especially MSMEs and Startups, who are working on significant upgradations/ improvements to existing products/ processes as well as novel futuristic/ innovative technologies with a use case for defence applications, to come forward and help make India self-reliant in defence technology.

<https://newsonair.com/2022/05/11/advancements-in-futuristic-technologies-will-lead-in-realising-atmanirbhar-bharat/>

DRDO On Twitter



Advancements in futuristic technologies need of the hour: Raksha Rajya Mantri during National Technology Day function at DRDO

pib.gov.in/PressReleasePa...



2:39 pm · 11 May 2022 · Twitter for Android



#DRDOforIndia | Best wishes on #NationalTechnologyDay - A historic moment signifying the #technological excellence & #scientific prowess of our nation. #AtmaNirbharDefence #AmritMahotsav @PMOIndia @DefenceMinIndia @SpokespersonMoD



10:54 am · 11 May 2022 · Twitter for Android

Defence News

Defence Strategic: National/International

THE ECONOMIC TIMES

Wed, 11 May 2022

Army Chief Gen Manoj Pande speaks to Bangladeshi counterpart

Army Chief Gen Manoj Pande on Wednesday spoke to his Bangladeshi counterpart Gen SM Shafiuddin Ahmed with a focus on enhancing bilateral defence cooperation. It is learnt that the two Army chiefs also exchanged views on evolving geopolitical situation as well as its possible impact on regional security. "General Manoj Pande #COAS had a video interaction with General SM Shafiuddin Ahmed, Chief of Army Staff, #BangladeshArmy and discussed ways to enhance the defence cooperation between both the Nations," the Army tweeted. The defence and security ties between India and Bangladesh are on an upswing in the last few years.

The year 2021 marked the 50th anniversary of the liberation of Bangladesh. In reflection of close ties, India is also hosting a number of events to mark the 50th anniversary of the 1971 war that led to the liberation of Bangladesh. Around 93,000 Pakistani troops had surrendered before the joint forces of the Indian Army and the "Mukti Bahini" on December 16, 1971, which paved way for the birth of Bangladesh. Gen Pande held a telephonic conversation with his Nepalese counterpart Gen Prabhu Ram Sharma last week.

https://m.economictimes.com/news/defence/army-chief-gen-manoj-pande-speaks-to-bangladeshi-counterpart/amp_articleshow/91497434.cms

The Daily Star

Thu, 12 May 2022

JS body on Defence ministry wants tour to see UN peacekeeping mission

After the parliamentary body on the Ministry of Railways wanting foreign tour to gain experience, now the parliamentary standing committee on the Ministry of Defence wants to go abroad to see the activities of Bangladesh Armed Forces members in the United Nations peacekeeping missions. The parliamentary watchdog in its meeting today (May 11, 2022) at the Jatiya Sangsad Bhaban said they want to see the activities of the Bangladesh Armed Forces members working in the UN peacekeeping mission. In light of the committee's recommendation, the defence ministry said considering the Covid-19 situation, they are planning to arrange a trip to a mission area at any convenient time in July-August. However, it has not been decided yet where and when the tour will take place. Earlier, the committee had twice visited peacekeeping missions in the current 11th parliament.

The outcome of such a trip at the cost of public money in the past had triggered criticism from different quarters. Usually, the expenditure of the members of the delegation of parliamentary standing committees which include MPs and officials of the parliament secretariat and the ministries concerned is borne by the government exchequer. There have been criticisms over such tours as many such trips at public expense reportedly yield nothing. Prime Minister Sheikh Hasina also spoke against such frequent trips abroad.

Finance Minister AHM Mustafa Kamal today while talking to reporters said in a bid to ease pressure on foreign exchange reserves, the government has decided to stop foreign trips of its officials and postponed the implementation of less important projects that require imports. According to sources, the parliamentary committee had recommended the ministry make arrangements for visiting peacekeeping mission areas late last year. The ministry in a meeting of the Standing Committee held in December, last year said the Armed Forces Division was in the process to arrange a tour for inspecting the activities of the members of the Bangladesh Armed Forces in the UN peacekeeping mission. But so far this tour has not taken place. According to the working paper of the meeting, this issue was discussed again in the committee's meeting held in February.

Ruling Awami League MP Motahar Hossain, a member of the committee raised the issue. Later, the committee again asked to fix a schedule of visits at the earliest convenient time considering the overall situation. The Ministry of Defence today informed the standing committee about the progress of the visit. They said the Armed Forces had informed them a process to arrange the visit at any convenient time in July-August, is going on. Detailed tour plans will be sent soon in coordination with the field mission. When asked about this, Motahar Hossain said it has been decided that the visit will take place in July-August. Their committee has not visited in the last three years. He said the boys of the country are working abroad, and they are planning to go on the tour to encourage them.

There is no such thing here as a conflict of interest, he added. The Parliamentary Committee on the Ministry of Railways recently recommended to the concerned ministry to make arrangements for a visit to Korea, China or Japan to see the activities of the railways.

<https://www.thedailystar.net/news/bangladesh/diplomacy/news/bangladesh-not-any-chinese-debt-trap-ambassador-reiterates-3021466>



Thu, 12 May 2022

Row over offset commitments: Global Defence biggies to face government's wrath

The Union Ministry of Defence (MoD) has decided to crack the whip to get top foreign defence companies to honour their offset commitments linked to multi-billion-dollar contracts received from India.

The Defence Acquisition Council (DAC), which is the apex body of the MoD for finalising procurement for the three services, is scheduled to meet at the end of this month. The review committee that prepares the agenda for the DAC is scheduled to meet on May 11. Sources said offset default is one of the subjects that would come up at the DAC. The MoD, according to sources, is preparing to issue a final warning to the defaulters with a message that if they do not deliver on their offset promise, the government would be forced to bar them from any future bidding.

The biggest names in the global defence industry have won contracts to supply a range of products — from airplanes to missiles, helicopters and guns — to India. As per the government of India's defence offset policy 2005, 30% of the value of the contract has to be spent in India by companies winning Indian defence contracts. Over the last 15 years, offset commitments to the tune of \$13 billion have been made by foreign original equipment manufacturers (OEMs). But these companies have so far executed contracts worth only \$2.4 billion.

Sources said the defaulting OEMs that have been issued offset show-cause notices are: Russian Aircraft Corporation (MiG) for a \$964 million contract signed in 2008 for the upgrade of 69 MiG-29 fighters; Boeing of US for a \$1.09 billion contract signed in 2010 for the supply of 10 heavy-lift aircraft; Rafael Advanced Defence Systems for a \$200 million contract signed in 2014

for the supply of Barak missiles; Elbit Systems of Israel for \$270 million contract signed in 2014 for the supply of thermal imaging fire control systems for T-72 tanks; BAE Systems' GCS International Limited for \$542 million contract for the supply of 140 ultra-light howitzer guns; Dassault Aviation, Safran, Thales of France for \$8.7 billion contract signed in 2016 for the supply of 36 Rafale fighters; Elta Systems of Israel for the supply of air route surveillance radars; etc.

<http://www.indiandefensenews.in/2022/05/row-over-offset-commitments-global.html?m=1>



Wed, 11 May 2022

Defence Diary: Why India needs to urgently bridge data integration gap for better Maritime security

Three top initiatives in the last decade have underpinned India's growing maritime consciousness. The latest, and a pivotal one, is the appointment of former naval vice chief, Vice Admiral G Ashok Kumar, as India's first Maritime Security Coordinator. The appointment comes over two decades after a maritime structure on similar lines was first recommended by a Group of Ministers in 2001 post the 1999 Kargil conflict. The other pioneering efforts towards this direction was setting up the Indian Navy's Information Management and Analysis Centre (IMAC) at Gurugram in 2014 at a cost of Rs450 crore as the nodal agency for the fusion of maritime data from various agencies and other sources in response to the 26/11 Mumbai terror attacks.

The subsequent establishment of the Information Fusion Centre – Indian Ocean Region (IFC-IOR) in 2018 under the aegis of IMAC to promote international cooperation and data sharing with partner nations was another crucial milestone towards bettering maritime security and safety in the Indian Ocean Region (IOR). It is linked with 21 partner countries and 22 multi-national agencies. Both IMAC and IFC-IOR were put in place to generate a comprehensive maritime domain awareness of Indian waters with the former slated to soon transform into a maritime information hub for the IOR. These surely were concrete steps towards piecing together India's overall maritime domain awareness picture — critical to India's maritime security. However, it is paramount to close the loop with another step for the picture to be complete.

This would be to bridge the data integration gap for creating a common operational picture that would provide India with a comprehensive maritime domain awareness. A 2020 report in *The Hindu* stated that there are plans to transform IMAC into a multi-agency National Maritime Domain Awareness (NMDA) centre. There were also some discussions in the defence and security circles to expand the NC3I network for integration of data from all maritime agencies towards this project, which is aimed at a comprehensive maritime domain awareness and is intrinsically linked to India's maritime security. However, the pace of integrating the networks for strengthening national maritime domain awareness has been slow in the last two years.

There are more than 25 agencies or departments that are either responsible for coastal security and maintaining law and order at sea or have a role to play in piecing together the complete

picture for maritime domain awareness with their databases. Maintaining law and order at sea includes prevention of illegal trafficking of drugs, weapons, humans, piracy and illegal fishing or exploitation of resources in India's exclusive economic zones, among others. Coastal security involves unwanted elements piercing the maritime security layers and landing on the Indian coasts. The IMAC currently puts together a consolidated picture from the fusion of maritime data which primarily comes from the Indian Navy and the Indian Coast Guard through the National Command Control Communication and Intelligence System (NC3I) network, which has been operational since 2014 as an independent network.

The network has interlinked 51 coastal stations, Joint Operations Centres of the Indian Navy and the Indian Coast Guard, other maritime security agencies and their headquarters. This information is collated at IMAC with data from other sources. The other sources also include data from ships, maritime surveillance aircraft, satellite data gathered from Automatic Identification Systems (AIS) transponders fitted on merchant ships and larger fishing boats, long range identification and tracking data from the Ministry of Shipping and white shipping data from partner countries. Efforts are also underway to install AIS on fishing vessels under 20m to track them efficiently.

Despite this heavy infrastructure, there remains a significant data integration vacuum since most of the other 25-plus agencies do not share data with IMAC — either due to absence of a dedicated network or other reasons. Thus, there is lack of a larger and more comprehensive common operational picture. The vacuum looks bigger with around 12,000 vessels present in the IOR at any given time and tracking them continuing to be a major challenge. What adds to the challenge is the multiplicity of agencies involved in maritime affairs and different laws empowering each one of them. Plugging this gap to generate a comprehensive common operational picture which is available with all the relevant agencies will ensure that crucial time and resources are not wasted in turf wars, and in flagging a threat in the sea by one agency and taking action against it by the other. The post of the Maritime Security Coordinator can make this happen.

Focus of Maritime Security

In the last three years, maritime affairs have dominated the discourse in the military and government circles. The Niti Aayog last year set up a high-level Blue Economy Coordination Committee (BECC) with representation from National Security Council Secretariat, as well as ministries of external affairs, defence, home affairs, commerce, fisheries, earth sciences and department of expenditure, among others for coordination and integration of initiatives in India's blue economy domain. Maritime security was also one of the three key priority areas when India started its month-long presidency of the United Nations Security Council (UNSC) last year.

With the heightened focus on maritime security at this time, making changes to the data integration apparatus should take precedence over other issues. Filling up this data integration gap on priority will go a long way in ensuring India growing stature in the IOR in providing maritime safety and security, thus preventing crimes and yet another 26/11 kind of terror attack.

<https://www.news18.com/news/india/defence-diary-why-india-needs-to-urgently-bridge-data-integration-gap-for-better-maritime-security-5151121.html>

Border Security Force: History, objectives and other details of India's first line of Defence

A soldier is standing on the border, with rifle in hand. The soldier is keenly surveying the surrounding area, the senses are alert to spot any kind of discrepancy. The soldier may very well know that there is no danger, but the sense of duty is pushing that individual to be at the top of game while defending the borders of his or her country. The Border Security Force (BSF) personnel who guard the borders of India are essentially defending each and everyone of us from any kind of foreign intrusion. In this article, we will take a look in details about what is BSF.

BSF, the organisation that protects our borders

Since Indian achieved independence in 1947, it was the responsibility of the local police to each border state to protect our international boundaries, with little inter-state coordination. However, during the 1965 India-Pakistan War, the Pakistan Army attacked Sardar Post, Chhar Bet, and Beria Bet on April 9 in Kutch. It brought forth the inadequacy of the state police to cope with armed aggression. And, the need for Border Security Force (BSF). Established on December 1, 1965, it is one of the seven Central Armed Police Forces (CAPF) of India, and was established "for ensuring the security of the borders of India and for matters connected there with". Khusro Faramurz Rustamji, popularly known as KF Rustamji, is regarded as the founding father of the BSF. It is the only CAPF to have a Water Wing, Air Wing and an Artillery Regiment.

The head of BSF is designated as a Director General (DG). Currently, Pankaj Kumar Singh, a 1988-batch IPS officer from the Rajasthan cadre, is serving as the new Director General (DG) of the Border Security Force. His tenure will last till his superannuation on December 31, 2022. During its establishment in 1965, the BSF had 25 battalions. But since, it has grown exponentially and currently has 192 battalions and seven Artillery Regiments guarding international border with Pakistan and Bangladesh. It currently stands as the world's largest border guarding force, and is called the First Line of Defence of Indian territories. Apart from guarding the borders, the BSF is also performing anti-infiltration role in the Kashmir Valley, fighting against insurgency in North East India, conducting anti-Naxal operations in Odisha and Chhattisgarh.

Interesting facts about BSF

BSF contributes its personnel every year for various missions of the United Nations. During the 1999 Kargil War, the BSF remained on the heights of the mountains and defended the country along with the Army. BSF personnel have been performing Internal Security Duty in Manipur for the last ten years and have been successfully fighting insurgency in those areas. During the earthquake in Gujarat on January 26, 2001, the BSF was the first to reach out to help the distressed people. T

The BSF is handling the security issues on the famous Kartarpur Corridor.

BSF has sensitized people living in border areas during the COVID-19 pandemic and provided them necessary support under the Civic Action Program. At the time of natural disaster or

calamities, BSF provides assistance in areas of deployment such as the Kashmir flood in 2014, Kerala flood in 2018 and Kedarnath Tragedy in 2013

What are the objectives of the BSF?

During the time of peace, the BSF is responsible with the tasks of guarding the border, prevent trans-border crimes or unauthorised entry or exit via border, prevent smuggling and other illegal activities on the border, fight against infiltration, collect trans-border intelligence and promote a sense of security among the people living in the border areas. During the time of war, the BSF is entrusted with holding ground in assigned sectors, conducting limited aggressive action against irregular forces of the enemy, maintaining law and order in enemy territory administered under the Army's control, guiding the Army in border areas, providing assistance in controlling the refugees, performing special tasks connected with intelligence including cross-border raids and replenishing manpower.

<https://www.news9live.com/knowledge/border-security-force-history-objectives-and-other-details-of-indias-first-line-of-defence-169702?infinitescroll=1>



Thu, 12 May 2022

Indian-American lawmaker advocates for US providing more strategic arms to India

Indian-American Congressman Ro Khanna on Tuesday advocated the need for the Biden Administration to provide more strategic arms to India so that New Delhi can protect itself against China on its border. "In my time in Congress, I have been leading the initiative to have the US provide more strategic arms to India to protect itself against China on its border," Khanna said.

"I will continue to find ways to make sure India can choose US weapons over Russian ones," he said in a statement after a meeting with community Leader Ajay Bhutoria, wherein they had conversations on advancing stronger US-India ties at all levels -- people to people, business to business and industry to industry. "Both the democracies -- India and the US -- need each other for global stability and specifically in the Indo-Pacific region. The formation of Quad with Australia, Japan, India and the US is playing a strong role in balancing the influence of China and to counter the influence of China, the US needs to build a stronger partnership with India in the defence sector and supply the required arms to India," Bhutoria said.

<https://www.hindustantimes.com/world-news/indianamerican-lawmaker-advocates-for-us-providing-more-strategic-arms-to-india-101652313651735-amp.html>



Wed, 11 May 2022

Non-invasive imaging of atomic arrangement at the sub-angstrom scale in 2-D hybrid perovskites

Materials scientists aim to identify the atomic arrangement of 2D Ruddlesden-Popper hybrid perovskites (RPP) using non-invasive imaging; however, the process is challenging due to the insulating nature and softness of the organic layers. In a new report now published in *Science Advances*, Mykola Telychko, Shayan Edaltnanesh, and Kai Leng, and a team of scientists in physics, chemistry, and materials at the National University of Singapore, and Palacky University Czech Republic, demonstrated sub-angstrom resolution imaging of soft organic layers and inorganic frameworks in a two-dimensional lead-halide perovskite crystal.

The team accomplished this using scanning tunneling microscopy and noncontact atomic force microscopy supported with theoretical simulations. The scanning tunneling microscopy results unveiled the atomic reconstruction of the inorganic lead-halide lattice and composition of the crystal, while atomic force microscopy provided undisputed visualization of the materials surface and bonding interactions with the inorganic lattice. The joint method allowed the scientists to obtain atomic scale imaging and electrostatic potential of the material to reveal alternative quasi 1-D electron and hole channels at the neighboring twin boundaries.

Ruddlesden-Popper hybrid perovskites (RPPs)

The research team described two-dimensional hybrid perovskites as a remarkable platform for optoelectronic device applications. They credited the productivity of the platform to a close link between excitonic properties and quantum well structures of soft insulating organic layers sandwiched between conducting inorganic lead-halide frameworks. The presence of two-dimensionality led to the emergence of many quantum phenomena, while significantly enhancing photo and chemical stability and tunability of optoelectronic properties. Based on the unique dielectric and quantum effects, Telychko et al established the perovskites as a promising class of materials for next-generation optoelectronic applications.

The team showed how the structural relaxation of inorganic lattices of 2D perovskites lead to the emergence of a variety of materials properties at the atomic scale in hybrid perovskites that had hitherto remained to be studied. To understand the influence of the lattice architecture on the inherent properties of interest, they used scanning tunneling microscopy and scanning transmission electron microscopy at first, but since some of these methods could cause structural damage via collisions of perovskites with the energetic beam. Telychko et al used recent advances in tuning fork (qPlus)-based non-contact atomic force microscopy (nCAFM) imaging with a carbon monoxide functionalized tip for atomically resolved studies. The methods provided an ideal tool for non-invasive sub-angstrom scale imaging of the perovskite crystals and their insulating organic layers.

Conducting scanning tunneling microscopy (STM) measurements

Telychko et al selected lead-iodine perovskite family for the combined imaging process, and described the perovskite family via a general chemical formula. The team mechanically exfoliated the bulk perovskite crystals to produce monolayer and few-layer flakes to facilitate the imaging process. Using representative STM (scanning tunneling microscopy), the researchers obtained a periodic dimer-like pattern. In contrast, they noted that images obtained at negative bias voltages to contain abundantly fuzzy features, due to the instability of imaging the organic cations.

Non-contact atomic force microscopy (ncAFM) measurements

To overcome the challenge of non-invasive imaging, the team next used non-contact atomic force microscopy (ncAFM) imaging of the perovskite surface to reveal "arrow-like" features and unveil the geometry of the constituent butyl ammonium organic cations (denoted BA^+). The researchers revealed these features alongside the underlying inorganic octahedral lattice architecture via non-invasive imaging of perovskite structures in quasi-3D. The team gained deeper insight to the origin of the unique arrangement of cations by performing large-scale density functional theory and van der Waals calculations of the perovskite in low-temperature to validate the atomic perovskite structure. In this way, Telychko et al observed the quasi-1D twin boundaries of the twin domain composition of perovskite crystals for the first time.

They verified the twin domain composition, by conducting Kelvin probe force microscopy measurements to obtain new quantitative insights into the nanoscale domain composition. The outcomes revealed the polarized electrostatic potential across twin boundaries for the first time to allow long-distance exciton propagation to enhance the performance of perovskite-based photovoltaic and optoelectronic devices.

Outlook

In this way, Mykola Telychko, Shayan Edaltnanesh, and Kai Leng, and colleagues combined scanning tunneling microscopy (STM), and non-contact atomic force microscopy measurements (ncAFM) to precisely identify the ground state configuration and microstructure of Ruddlesden-Popper hybrid perovskites (RPP). The STM imaging method resolved the dimer-like atomic reconstruction of the underlying inorganic lead-halide lattice, while ncAFM facilitated visualization of surface cations. The team validated the combined imaging outcomes with density functional theory calculations, the work provided details of atomic structures and the electrostatic potential distribution across the twin domain. The outcomes have several implications for the optoelectronic performance of the 2D perovskite films. Using the combined imaging method, and more specifically, relying on ncAFM, the team underpinned tremendous potential for non-invasive imaging of a wide-range of soft organic-inorganic hybrid functional materials. The synergistic combination of methods can facilitate deeper insight into technically relevant optoelectronic phenomena.

<https://phys.org/news/2022-05-non-invasive-imaging-atomic-sub-angstrom-scale.html>



Wed, 11 May 2022

Unexpected semiconductor properties revealed by innovative new tool

Discovery reveals the role of oxygen impurities in semiconductor properties

A team of researchers investigating the properties of a semiconductor combined with a new thin oxide sheet discovered an unexpected new source of conductivity from oxygen atoms trapped within. Scott Chambers, a materials scientist at the Department of Energy's Pacific Northwest National Laboratory, revealed the team's findings at the American Physical Society's Spring 2022 meeting. The study's findings are detailed in the journal *Physical Review Materials*.

The finding has far-reaching implications for understanding the function of thin oxide films in future semiconductor design and manufacturing. Specifically, semiconductors utilized in modern electronics are classified into two basic types: n-type and p-type, depending on the electronic impurity introduced during crystal formation. Both n- and p-type silicon-based materials are used in modern electronic devices. However, there is ongoing interest in the development of new types of semiconductors. Chambers and his colleagues were experimenting with germanium in conjunction with a thin crystalline layer of lanthanum-strontium-zirconium-titanium-oxide (LSZTO).

"We are reporting on a powerful tool for probing semiconductor structure and function," said Chambers. "Hard X-ray photoelectron spectroscopy revealed in this case that atoms of oxygen, an impurity in the germanium, dominate the properties of the material system when germanium is joined to a particular oxide material. This was a big surprise." Using the Diamond Light Source on the Harwell Science and Innovation Campus in Oxfordshire, England, the research team discovered they could learn a great deal more about the electronic properties of the germanium/LSZTO system than was possible using the typical methods.

"When we tried to probe the material with conventional techniques, the much higher conductivity of germanium essentially caused a short circuit," Chambers said. "As a result, we could learn something about the electronic properties of the Ge, which we already know a lot about, but nothing about the properties of the LSZTO film or the interface between the LSZTO film and the germanium—which we suspected might be very interesting and possibly useful for technology."

A new role for hard X-rays

The so-called "hard" X-rays produced by the Diamond Light Source could penetrate the material and generate information about what was going on at the atomic level. "Our results were best interpreted in terms of oxygen impurities in the germanium being responsible for a very interesting effect," Chambers said. "The oxygen atoms near the interface donate electrons to the LSZTO film, creating holes, or the absence of electrons, in the germanium within a few atomic layers of the interface. These specialized holes resulted in behavior that totally eclipsed the

semiconducting properties of both n- and p-type germanium in the different samples we prepared. This, too, was a big surprise.”

The interface, where the thin-film oxide and the base semiconductor come together, is where interesting semiconducting properties often emerge. The challenge, according to Chambers, is to learn how to control the fascinating and potentially useful electric fields that forms at these interfaces by modifying the electric field at the surface. Ongoing experiments at PNNL are probing this possibility. While the samples used in this research do not likely have the immediate potential for commercial use, the techniques and scientific discoveries made are expected to pay dividends in the longer term, Chambers said. The new scientific knowledge will help materials scientists and physicists better understand how to design new semiconductor material systems with useful properties.

PNNL researchers Bethany Matthews, Steven Spurgeon, Mark Bowden, Zihua Zhu and Peter Sushko contributed to the research. The study was supported by the Department of Energy Office of Science. Some experiments and sample preparation were performed at the Environmental Molecular Sciences Laboratory, a Department of Energy Office of Science user facility located at PNNL. Electron microscopy was performed in the PNNL Radiochemical Processing Laboratory. Collaborators Tien-Lin Lee and Judith Gabel performed experiments at the Diamond Light Source. Additional collaborators included the University of Texas at Arlington’s Matt Chrysler and Joe Ngai, who prepared the samples.

<https://scitechdaily.com/unexpected-semiconductor-properties-revealed-by-innovative-new-tool/>

