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# समाचार पत्रों से चयित अंश Newspapers Clippings

A Daily service to keep DRDO Fraternity abreast with DRDO Technologies, Defence Technologies, Defence Policies, International Relations and Science & Technology

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Thu, 18 March 2021

## DRDO developing DURGA II laser weapon for land, naval, air use?

*A directed-energy weapon damages or destroys its target using focussed energy*

The work of the Defence Research and Development Organisation (DRDO) has often been commended, or criticised, with reference to a handful of notable projects.

These are usually the Light Combat Aircraft Tejas, the Arjun tank and missiles like the Agni series. Less well-known has been the DRDO's work on cutting-edge technologies and weapons, which are yet to enter widespread operational service worldwide.

One such area is the field of 'directed-energy weapons' (DEW). In layman's parlance, a directed-energy weapon damages or destroys its target using focussed energy by means of lasers, microwaves or particle beams.

According to the US think tank, Lexington Institute, "Directed-energy weapons have several advantages over conventional munitions. First, they transmit lethal force at the speed of light (about 300,000 kilometers per second). Second, their beams are not affected by the constraining effects of gravity or atmospheric drag. Third, they are extremely precise. Fourth, their effects can be tailored by varying the type and intensity of energy delivered against targets."

Directed-energy weapons are already in service in the role of 'drone defence' systems. In such systems, laser beams are used to knock out parts of drones, which are becoming an integral part of the military arsenal of most nations. However, their potential extends far beyond to being able to both destroy enemy targets and defend vital infrastructure from air and missile attack.

Earlier this week, US defence website *Defense News* reviewed the status of hypersonic weapons and DEW programmes worldwide. *Defense News* reported the DRDO has sought \$100 million from the ministry of defence to develop a high-power laser weapon.

"The classified project, dubbed DURGA II (Directionally Unrestricted Ray-Gun Array), will see the Indian Army receive the 100-kilowatt, lightweight directed-energy system, a service official told *Defense News*. A senior DRDO scientist said on condition of anonymity that the DURGA II program is currently in the concept stage. He added that the organization is developing and improving various laser-generation techniques using solid state, fiber and chemical lasers for defensive and offensive use.

The scientist also said DURGA II is to be integrated with land-, sea- and air-based platforms," *Defense News* reported.

The *Defense News* report noted the Laser Science and Technology Centre at Delhi was the lead laboratory in developing laser weapons. "The center has so far made a 25-kilowatt laser that can



Artist's rendering of Lockheed Martin's HELIOS system | Lockheed Martin

target a ballistic missile during its terminal phase at a maximum distance of 5 kilometers," *Defense News* reported.

Interestingly, the existence of a DURGA project has been reported for around two decades now, dating back to the early 2000s. A study by Indian Air Force officer K.K. Nair published by the United Service Institution of India (USI) in 2008 referred to the Directionally Unrestricted Ray-Gun Array (DURGA), and noted there was little progress in the project.

In 2017, DRDO tested a 1KW laser weapon mounted on a truck at a test facility in Chitradurga. *The Economic Times* reported the laser hit a target 250m away. The laser test was conducted in the presence of then defence minister Arun Jaitley.

### **Tough to develop**

High-power laser weapons are difficult to develop, a notable problem being provision of adequate power to the system. The *Economic Times* highlighted challenges including "developing a cooling mechanism for the system that heats up when the laser beam is fired, ensuring a focused beam towards a distant target and optoelectronics, or optronics, involving lenses to create that focus..."

### **HELIOS**

In January, US aerospace giant Lockheed Martin delivered the first unit of its High Energy Laser with Integrated Optical-dazzler and Surveillance (HELIOS) laser system to the US Navy. The HELIOS has power in excess of 60KW and is used primarily to damage smaller surface ships and drones. However, according to reports, upgrades to HELIOS with increased power would enable the system to target anti-ship missiles fired at ships.

<https://www.theweek.in/news/sci-tech/2021/03/17/drdo-developing-durga-ii-laser-weapon-for-land-naval-air-use.html>



*Thu, 18 March 2021*

## **India's new Aircraft Carrier, Vikrant, may get 5th-Generation Fighter**

The Indian Navy's first indigenous aircraft carrier, INS Vikrant, may start sea trials soon. This could pave the way for her to be commissioned this year. She is currently moored near the shipyard in Kochi on the south-western coast of India. When she joins the fleet, she will be a key component to India's ability to face China's growing naval reach. In particular China is building up its aircraft carrier capabilities.

Initially Vikrant will likely be equipped with the existing MiG-29K Fulcrum aircraft. But there is an expectation that a new type will be fielded. India's main aircraft manufacturer, HAL, is developing a dedicated carrier-borne 5th generation fighter.

The existence of the the new plane, dubbed the TEDBF (Twin Engine Deck-Based Fighter), was reported by DRDO (Defence Research and Development Organisation) in April 2020. More recently it was showcased at Aero India 2021 in February. It is being developed by Aeronautical Development Agency (ADA), part of India's DRDO. It is a naturally successor to the (ultimately unsuccessful) Naval variant of the indigenous Tejas jet. The Tejas is a small single engine fighter. However the Indian Navy has determined that it requires a twin engine aircraft to replace the MiG-29K. The TEDBF will learn a lot from the Naval Tejas project however.



The TEDBF is expected to be a true multirole fighter. Missions should include combat air patrol (CAP), interception, ground attack, strike, maritime strike, reconnaissance, electronic warfare and buddy-buddy refueling.

One feature of 5th generation fighters which the TEDBF will forego, in order to save weight, is the internal weapons bay. Instead a wide range of stores will be carried on its 11 hardpoints. Based on the model at Aero India this might include the ASRAAM short range and Astra beyond-visual-range (BVR) air-air missiles. Also shown attached to the hard points were the Rudram-1 and Rudram-2 anti-radiation missiles. It is to be expected that the TEDBF will be capable of carrying a wide range of ordnance.

Unlike the Tejas, the TEDBF is designed from the outset as a carrier-based fighter. This means folding wings and other practical features. It also shifts to a true canard configuration, and incorporates 5th Generation hallmarks such as reduced radar cross-section shaping in the forward fuselage.

Due to its twin-engine configuration the aircraft is larger than the Naval Tejas, yet slightly smaller than the Fulcrum. Its physical dimensions, with a wingspan of 11.2 meters and length of 16.2 meters, are compact. And the width is reduced further to 7.6m with the wings folded. The maximum take-off weight is likely to be similar to the Fulcrum however.

This contrasts with the Chinese Navy's much larger Shenyang J-15 fighter which has a wingspan of 14.7 meters and a length of 21.9m. The J-15 is a reverse-engineered copy of the Russian Sukhoi Su-33 Flanker-D. Like other Chinese Flanker derivatives the J-15 is equipped with a range of Chinese air-air missiles including the PL-12 beyond visual range missile. They can also carry anti-ship missiles and land-attack missiles.

The smaller fighter size should allow Vikrant to carry a similar sized air wing to the much larger Chinese carriers.

### **Interim solution? Super Hornet and Rafale**

The TEDBF is expected to fly in 2026 and will take years after that before it enters service. In the meantime, the Indian Navy is looking to acquire a twin-engine fighter for the carriers. On January 17, the Directorate of Naval Air Staff issues a request for information (RFI) for a multirole carrier borne fighter. The number quoted is 57 aircraft.

The two types being discussed are the Boeing Super Hornet and Dassault Rafale. Both are relatively mature designs which are still in production, making them low-risk options. The F/A-18E/F Super Hornet (-E is single seat, -F is two seat) first entered service with the U.S. Navy in 2001. The Rafale-M carrier fighter also entered service with the French Navy (Marine Nationale) in 2001.

The Rafale may have an advantage as it is already in service with the Indian Air Force. 36 Rafales have been ordered with the first deliveries in July 2020. More orders may follow. These are the land-based variant but share some commonality with the carrier fighter.

So we will see how the TEDBF project fares in the coming years if off-the-shelf aircraft prove effective. In the meantime it is also probable that China will deploy its own 5th generation carrier fighter.

<https://www.defencenews.in/article/India%e2%80%99s-New-Aircraft-Carrier,-Vikrant,-May-Get-5th-Generation-Fighter-1034121>

## **Centre working on second indigenisation list in defence sector**

New Delhi: The Centre is working on a second 'positive indigenisation list' in the defence sector to boost the Aatmanirbhar Bharat (Self-reliant India) mission.

The Centre said it is pursuing initiatives to achieve higher levels of indigenisation and self-reliance in the defence sector by harnessing the capabilities of public and private sector industries in the country.

The government also said that the case for procurement of Light Utility Helicopters (LUH) and Light Combat Helicopters (LCH) is being progressed in accordance with existing procedures.

To boost Make in India initiatives, the Innovations for Defence Excellence (iDEX) framework was launched in April, 2018 with an aim to achieve self-reliance and to foster innovation and technology development in defence and aerospace by engaging industries including MSMEs, start-ups, individual innovators, research and development institutes and academia.

The iDEX framework provides grants for prototype development and promotes innovation and entrepreneurship among the Defence start-ups.

The initiatives being undertaken under iDEX include Defence India Startup Challenge (DISC), iDEX Open Challenges and iDEX 4 FAUJI.

As part of the iDEX initiative, the Ordnance Factory Board has taken up in-house research and development projects for development of armament, ammunition and equipment items of land systems pertaining to artillery and air defence gun systems, small arms weapons systems, armoured fighting vehicles and futuristic smart ammunition systems.

The DRDO, through the technology development scheme (TDF) aims to fund private sector industry, especially MSMEs, including Start-ups.

In all 25 Projects have been awarded to various private industries including MSMEs and start-ups under the TDF scheme so far. The DRDO has also launched a pan-India contest to bring innovators, entrepreneurs, individual and start-ups for innovative ideas in the field of Defence and Aerospace.

"There are 11 projects of the Indian Army as part of DISC and Open Challenges of iDEX which involves hand holding of 23 start-ups," said Minister of State (Defence) Shripad Naik, replying to a question raised by a few parliamentarians in the Lok Sabha on Wednesday.

The Indian Navy has leveraged the iDEX scheme and is presently engaging 21 start-ups in design and development for nine projects.

The IAF, as part of these initiatives, is progressing with 11 cases and is engaged with 17 start-ups and individual innovators and MSMEs for design and development of innovative equipment through iDEX, the minister said.

<https://www.daijiworld.com/news/newsDisplay?newsID=813182>

Thu, 18 March 2021

## Road Transport and Highways Ministry to mitigate landslide, avalanche hazards on highways; inks pact with DRDO

*The pact is intended at utilising the expertise of the organization in providing sustainable landslide, avalanches along other geo-hazard mitigation measures on the NHs*

*By Devanjana Nag*

Union Minister Nitin Gadkari chaired Road Transport and Highways Ministry has inked a pact with Defence Research and Development Organisation (DRDO) in order to utilize its expertise in providing sustainable steps to mitigate landslide as well as avalanche hazards on the national highways. The minister, in a written reply to Rajya Sabha on Monday, said an MoU was signed between the Road Transport and Highways Ministry and DRDO on January 20. The minister was quoted in a PTI report saying that the pact is intended at utilising the expertise of the organization in providing sustainable landslide, avalanches along other geo-hazard mitigation measures on the NHs.



An MoU was signed between the Road Transport and Highways Ministry and DRDO on January 20.

According to Gadkari, Defence Geo-informatics Research Establishment (DGRE)- a premier laboratory of DRDO, is known for its expertise in the area of landslide and snow avalanche mitigation techniques, terrain modelling as well as trafficability utilizing geo spatial intelligence. The DGRE's role and charter is mapping, monitoring, forecasting, control and mitigation of avalanches in the Indian Himalayas as well as landslides mapping and monitoring in all kinds of terrain, the minister said.

Further, the pact intends to outline the general framework of collaboration between Road Transport and Highways Ministry and DGRE, including detailed investigation of the existing critical avalanches or geo hazards like slope instability, landslides, sinking problems, etc., the minister said. The pact also involves outline planning, designing as well as formulation of sustainable mitigation steps for geo-hazards for the National Highways across the country, including tunnels. Gadkari further mentioned that the cooperation will be monitored through joint periodic half-yearly review. Also, he said that each party will provide funding to their own personnel. It is expected that the initiative will evolve a long-term strategy for sustainable geo-hazard mitigation measures on the highways, which will result in safer transportation, the Road Transport and Highways Minister added.

<https://www.financialexpress.com/infrastructure/roadways/road-transport-and-highways-ministry-to-mitigate-landslide-avalanche-hazards-on-highways-inks-pact-with-drdo/2214308/>

# Kalyani JV among top bidders for DRDO missiles

By CR Sukumar

## Synopsis

**Rafael is willing to offer the interceptor made of new technology as a part of the Derby missile as a part of India's low-level quick reaction missile system (LLQRM) project.**

Kalyani Rafael Advanced Systems (KRAS), a joint venture between India's Kalyani group and Israel's Rafael Advanced Defense Systems, has emerged among a handful of bidders to integrate the missile sub-parts program invited by the Defence Research and Development Organisation (DRDO).

Disclosing this on Tuesday, Rajinder Bhatia, president and chief executive of BFL Defence of Kalyani group, told media that it was part of the Development cum Production Partner (DCCP) initiative of DRDO inviting the domestic partners for various missile programs.

"We are actively bidding for it and we have already won some sub-sections," said Bhatia, adding that they were waiting for the contract to be placed with them. "We are among the handful 2-3 Indian companies who are going all-out for this," he said, adding that the initiative enables the Indian private sector defence player to develop and become a production partner to DRDO for missiles.

Bhatia was interacting with media on the sidelines of a program to roll-out its first batch of the medium-range surface to air missile (MRSAM) for the Indian Army and Air Force. KRAS has committed to deliver more than 1,000 MRSAM 'missile kits' for the Indian Army and Air Force over the coming years. These missile sections will then be forwarded to India's state-run defence giant Bharat Dynamics for further and future integration. Brigadier General (Res.) Pinhas (Pini) Yungman, Head of Air and Missile Defense Systems division of Rafael, said the Israeli defence giant is currently in the final stages of developing air-to-air and ground-to-air extended range missiles with interceptors using the latest electronics and technology to offer to the Indian defence forces.

Rafael is willing to offer the interceptor made of new technology as a part of the Derby missile as a part of India's low-level quick reaction missile system (LLQRM) project.

Pinhas said once the purchase order was received from the Indian Air Force for the long-range interceptor-cum-missile, it will be decided among Rafael, Kalyani and the joint venture KRAS on the workshare and what parts will be produced in India. "The capabilities and technologies exist with Rafael and we can transfer the technology and capabilities to produce it here (in India)."

Further, Pinhas said Rafael was willing to share more technologies, capabilities and contracts with KRAS to produce various ranges of missiles and also use KRAS' production facility at Hyderabad to meet the defence needs of customers around the world.

Rajinder Bhatia said the Kalyani group has set up a separate incubation Centre at Hyderabad for research and development and design and engineering capabilities in defence equipment for Rafael, which could be merged into KRAS going forward.

<https://economictimes.indiatimes.com/news/defence/kalyani-jv-among-top-bidders-for-drdo-missiles/articleshow/81545223.cms>



**L-R: Lt Gen T S A Narayanan Comdt MCEME & Col Comdt EME Army , Mr Rajinder Singh Bhatia President and CEO of BFL Defence, Dr Dasharath Ram DIR DRDL, Air Marshal Mr I P Vipin COMDT AFA, Mr M S R Prasad DS & DG MSS DRDO, Cmde Siddharth Mishra (Retd) Chairman & MD BDL, Shri B H V S Narayana Murthy Dir RCI DRDO and Brig Gen Pinhas Yungman Exec VM-AMDS DIV DIR RAFAEL, in Hyderabad during the first delivery of 1000 MRSAM missile kits for the Indian Army and Airforce**



# How India changed preference for arms suppliers in 50 years

*India's arms suppliers are changing fast. From traditional arms partners like Russia, India is now fast moving towards new markets such as South Korea, Brazil and South Africa. A report by India Today's DIU team*

*By Samrat Sharma*

New Delhi: India's choice of arms trade partners has changed significantly over time as the country strives to reduce dependence on old partners such as Russia. India spends around 2.3 per cent of its Gross Domestic Product (GDP) on defence and accounts for 15 per cent of the global arms import. The Indian government had planned to spend USD 64.4 billion to equip and modernise the second largest armed forces in the world in the current financial year.

France, Russia, United States, South Korea and Israel were the largest suppliers of arms to India in 2020, according to the Stockholm International Peace Research Institute. However, new players such as South Korea, Brazil and South Africa have also emerged as important arms exporters for India in recent years. The below chart shows the change in India's arms trade partners over the last 50 years.

SIPRI compares data on the volume of international transfers of major conventional weapons using a common unit known as trend-indicator value (TIV). The TIV is based on the known unit production costs of a core set of weapons and is intended to represent the transfer of military resources rather than the financial value of the transfer.



## Changing face of India's arms imports

India is continuously trying to reduce its arms dependence on Russia. Overall, arms exports by Russia fell by 22 per cent, which is majorly due to India's cut in arms imports. Arms imports by India fell by 33 per cent between 201115 and 201620.

Though Russia was the most affected supplier, India's imports of US arms also fell by 46 per cent during the same period. Imports from France, on the other hand, have increased. India, Egypt and

### INDIGENOUS WEAPON ARSENAL

Major weapons, military equipment developed by DRDO for Indian armed forces

 <p><b>Astra Beyond Visual Range Missile System</b></p>	<p>10m Short Span Bridging System</p> <p>Indian Maritime Situational Awareness System (IMSAS)</p>	<p>Heavy Weight Torpedo (HWT) Varunastra</p> <p>Border Surveillance System (BOSS)</p>  <p><b>Arjun Mk-1A</b></p>
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### WEAPONS, MILITARY EQUIPMENT DEVELOPED LAST YEAR

<p>Advanced Towed Artillery Gun System (ATAGS)</p>	 <p><b>Heavy Weight Torpedo (HWT) Varunastra</b></p>	<p>Indian Maritime Situational Awareness System (IMSAS)</p> <p>Border Surveillance System (BOSS)</p>
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Source: Lok Sabha 

Qatar together received 59 per cent of French arms exports. Russia, US, Israel, France and UK were the highest arms exporters in the last 20 years.

Smaller countries such as Uzbekistan and South Korea have also been part of India's arms procurement journey. Uzbekistan was one of the largest arms exporters to India for three years in a row since 2009, while South Korea has significantly increased its share of arms exports in India in the last three years.

### **Self-reliance in defence**

India aims at cutting its import dependence and increase self-sustenance for weapons as the country is the second-largest importer of arms in the world. India has planned to spend USD 130 billion on military modernisation in the next five years. The government has also allowed private companies to participate in the defence industry to provide impetus to indigenous manufacturing.

Last week, junior defence minister Shripad Naik said in reply to a question in Lok Sabha, "28 successful tests have been carried out by the Defence Research and Development Organisation (DRDO) in the last one year."

The major weapons and other systems that have been handed over to the armed forces by DRDO are Beyond Visual Range Missile System, 10-metre Short Span Bridging System, Indian Maritime Situational Awareness System (IMSAS), Heavy Weight Torpedo (HWT) Varunastra, Border Surveillance System (BOSS) and Arjun Mk-1A, Naik added.

Projects worth USD 7.3 billion are ongoing in India, according to Invest India. All systems designed and developed by DRDO are manufactured by Indian industries, which include both public and private sectors entities.

Some of the systems developed by such collaboration during the last one year are Advanced Towed Artillery Gun System (ATAGS), Extended Range Pinaka System & Guided Pinaka Rocket System, 10-metre Short Span Bridging System, Indian Maritime Situational Awareness System (IMSAS), Heavy Weight Torpedo (HWT) Varunastra, Border Surveillance System (BOSS), Arjun Mk-1A, etc.

DRDO has several foreign collaborations, such as the India-USA Joint Technology Group, Indo-Israel Management Council, India-Russia R&D Subgroup, India-Singapore defence technology steering committee, India-UK steering committee and India-Korea steering committee.

India exported defence equipment worth USD 780 million between March and December 2020. DRDO's latest list of export equipment released on February 3, 2021, includes 19 aeronautical systems, 41 armament and combat systems, 4 missile systems, 27 electronic and communication system, 10 life protection items, 4 microelectronic devices, 28 naval systems, 16 Nuclear Biological Chemical equipment NBC and 7 other materials.

The government has formulated policies to boost defence exports and achieve a defence export target of USD 5 billion in the next five years. It has allowed 100 per cent FDI in the defence industry to expedite defence manufacturing infrastructure.

<https://www.indiatoday.in/diu/story/how-india-changed-preference-for-arms-suppliers-in-50-years-1780458-2021-03-17>

# Aligning a missile deal with destination Manila

*India's emergence as a regional security provider will depend on the way it handles the BrahMos sale to the Philippines*

*By Harsh V Pant, Javin Aryan*

Earlier this month, India and the Philippines signed the “Implementing Arrangement” for “procurement of defense material and equipment procurement”. This agreement lays the groundwork for sales of defence systems such as the highly anticipated export of the BrahMos cruise missile, through the government-to-government route. As the Secretary, Philippine Department of National Defense publicly acknowledges, the archipelagic country’s intention of purchasing the missile, and a potential export deal for India, moves one step closer to reality. This deal will be of great significance for multiple reasons, and even though the procurement process is progressing steadfastly, there are many challenges that lie ahead.

## **Features of the system**

Research and development of the BrahMos cruise missile systems began in the late 1990s. Manufactured by BrahMos Aerospace Limited, a joint venture between the Defence Research and Development Organisation and the joint stock company Military Industrial Consortium NPO Mashinostroyeniya (earlier known as the Federal State Unitary Enterprise NPOM of Russia), this is the first supersonic cruise missile to enter service. Capable of attaining a speed of Mach 2.8 (almost three times the speed of sound), it has a range of at least 290 km (a new version can reach up to 400km).

Travelling with such velocity means that it would be difficult for air defence systems utilising surface-to-air missiles to intercept the BrahMos while making it easier for it to target and neutralise advanced fighter jets such as the Chinese J-20 fighter aircraft moving at less than Mach 2. Even so, efforts to increase the speed and range of the missile in its next iterations are under way, with a goal of achieving hypersonic speeds (at or above Mach 5) and a maximum range of 1,500 km.

Early naval and land variants of the BrahMos were inducted into service by the Indian Navy in 2005 and the Indian Army in 2007. Subsequently, an air-launched variant was successfully tested in November 2017 by the Indian Air Force from its Sukhoi-30MKI fighter jet, giving the missile a dominating presence in all three domains.

## **Export as a goal**

These advanced and powerful capabilities of the BrahMos not only augment the strength of the Indian military but make it a highly desirable product for other countries to procure as well. Exporting the system, hence, has been on the agenda for more than a decade. Doing so would boost the credibility of India as a defence exporter, help it meet the target of \$5 billion in defence exports by 2025, and elevate its stature as a regional superpower. Countries such as Vietnam, the Philippines, Indonesia, the United Arab Emirates, Argentina, Brazil, and South Africa have so far shown an interest in acquiring the systems.

## **Geo-political impact**

The implications of the Philippines becoming the first country to import the BrahMos would be wide-ranging and consequential in the Indo-Pacific. To begin with, it would caution China, with whom the Philippines has been engaged in a territorial conflict in the South China Sea, and act as a deterrent to Beijing’s aggressive posturing. Indeed, this is why China has been wary of the Association of Southeast Asian Nations (ASEAN) countries acquiring defence systems such as the BrahMos. Further, taking lessons, other nations threatened by Chinese belligerence may come forward to induct the BrahMos into their arsenal, thereby boosting India’s economic, soft, and hard power profile in the region and providing the Indo-Pacific with a strong and dependable anchor with which they can protect their sovereignty and territory.

## **Possible hurdles**

The Government of India has prioritised making the country ‘Atmanirbhar’ in the defence manufacturing sector and establishing itself as a major defence exporter. The Philippines, on the other hand, has decided to buy the BrahMos out of geopolitical and strategic necessities. Nonetheless, two major roadblocks still remain in the Manila deal.

The first is the Countering America’s Adversaries Through Sanctions Act (CAATSA), which aims to sanction individuals and entities who engage in a “significant transaction” with a listed entity. So far, Turkey and China have been penalised under CAATSA for purchasing the S-400 Triumf air defense systems from Russia. NPO Mashinostroyenia is one of the listed Russian entities. And since 65% of the components, including the ramjet engine and radar seeker used in the BrahMos, are reportedly provided by NPO Mashinostroyenia, the export of the missile systems may attract sanctions. Remarkably, the United States, of which India is a major defence partner, has maintained ambiguity over whether it will introduce sanctions over India’s acquisition of the S-400, licensed production of the AK-203 assault rifle, and export of the BrahMos. Hesitant of being sanctioned themselves, countries may shy away from purchasing the BrahMos. However, there is an excellent case for India to receive a waiver from CAATSA, especially *vis-à-vis* the BrahMos that can help contain a confrontational China.

The second issue pertains to financing. A regiment of the BrahMos, including a mobile command post, four missile-launcher vehicles, several missile carriers, and 90 missiles, reportedly costs around \$275.77 million (₹2,000 crore). Ravaged by the COVID-19 pandemic, many countries which are interested in the BrahMos would find it difficult to purchase it. The cost of the systems has been a major hurdle in moving forward to reach a deal with the Philippines. To remedy this, India has offered a \$100 million line of credit, and the Philippines is thinking of purchasing just one battery of the BrahMos, consisting of three missile launchers with two to three missile tubes each.

With India determined to develop itself as a hub of defence manufacturing, how it handles the sale of the BrahMos would be an important factor in its potential emergence as a net provider of regional security in the Indo-Pacific.

*(Harsh V. Pant is Director, Studies at the Observer Research Foundation (ORF), New Delhi and Professor, International Relations at King’s College London. Javin Aryan is a research intern at the ORF)*

<https://www.thehindu.com/opinion/op-ed/aligning-a-missile-deal-with-destination-manila/article34094305.ece>



Press Information Bureau  
Government of India

Ministry of Defence

Wed, 17 March 2021 2:55PM

## Domestic Procurements

The Government is working on Second 'Positive Indigenisation List' as part of Aatmanirbhar Bharat Abhiyan on domestic procurements.

Government is pursuing initiatives to achieve higher levels of Indigenisation and self-reliance in the defence sector by harnessing the capabilities of the public and private sector industries in the country.

Case for procurement of Light Utility Helicopters (LUH) and Light Combat Helicopters (LCH) is being progressed in accordance with extant procedures.

Innovations for Defence Excellence (iDEX) framework was launched in April, 2018 with an aim to achieve self-reliance and to foster innovation and technology development in defence and aerospace by engaging industries including MSMEs, Start-ups, individual innovators, R&D institutes and academia.

iDEX provides grants for prototype development and promotes innovation and entrepreneurship among the Defence Start-ups.

Various initiatives being undertaken under iDEX are as follows:-

1. **Defence India Startup Challenge (DISC):** iDEX is emerging as a front runner & has gained substantial traction in the Defence Startup Community. Various MSMEs/Startups have been funded so far, to evolve services related research towards challenges/Problem Statement of Indian Forces. DISC IV was launched on 29 September, 2020 by the Hon'ble RM.

2. **iDEX Open Challenges:** As part of the iDEX Open Challenges, the received proposals are reviewed for approval by the High Powered Selection Committee (HPSC).

3. **iDEX 4 FAUJI:** iDEX 4 FAUJI was launched, along with Defence India Startup Challenge IV to support innovations identified by grass root service personnel serving in the field conditions. This would incorporate the first-hand experience for improving and bringing operational and maintenance improvements in existing platforms, as also generate futuristic ideas for innovations in defence manufacturing. These would then be issued as challenges under iDEX with the shortlisted start-ups being assisted by the applicant servicemen.

4. As part of iDEX initiative, OFB has taken up in-house R&D projects for development of Armament, Ammunition & Equipment items of Land Systems pertaining to i.e. Artillery & Air Defence Gun Systems, Small Arms Weapons Systems, Armored Fighting Vehicles and futuristic smart ammunition systems.

5. DRDO through Technology development scheme (TDF) scheme aims to fund private sector industry especially MSMEs including Start-ups. Total 25 Projects have been awarded to various private industries including MSMEs and start-ups under TDF scheme so far. The DRDO has also launched a pan India contest' to bring innovators, entrepreneurs, individual and start-ups for innovative ideas in the field of Defence and Aerospace.

6. There are 11 projects of Indian Army as part of DISC and Open Challenges of iDEX which involves hand holding of 23 start-ups. Indian Navy has leveraged iDEX scheme and is presently engaging 21 start-ups in design and development for 09 projects. IAF, as part of these initiatives, is progressing 11 cases and is engaged with 17 start-ups/individual innovators/MSMEs for design and development of innovative equipment through iDEX.

Following are the steps to bring down the delays in timelines of capital acquisition:-

1. The aim of the Defence Acquisition Procedure- 2020 (DAP) is to ensure timely procurement of military equipment, systems and platforms are required by the Armed Forces in terms of performance, capabilities and quality standards, through optimum utilisation of allocated budgetary resources. The following measures have been envisaged in DAP for achieving timely, efficient and effective procurement:-

- Exemption of CNC (Contract Negotiation Committee) from furnishing Reasonability of Cost Certificate for DPSU Equipment already Priced by Committee constituted under orders of Hon'ble Raksha Mantri.
- (b) Delegation of Financial powers to Services Headquarters from Rs.150 Crores to Rs. 300 Crores.
- Broad timeframe for completing procurement activities (from AoN to award of contract) had been reduced from 80-117 weeks to 70-94 weeks in multi vendor cases and from 92-137 weeks to 82-114 weeks in resultant Single Vendor cases.
- Acceptance of Necessity (AoN) validity has been reduced to six months (from one year) for 'Buy' cases and to one year (from two years) for 'Buy & Make (Indian)' cases.
- Draft Request for Proposal (RFP) has to accompany Statement of case (SOC) for AoN.
- Single vendor cases at the bid submission and TEC stages will not be automatically retraced but processed with due justification with the approval of Defence Acquisition Council(DAC).
- Guidelines for change of Name of Vendor have been incorporated in DPP-2016 and Guidelines for Handling of Complaints have been notified to address avoid delays on this account.
- To rationalize time taken for Field Evaluation Trials (FET), it has been provided that FET be held in conditions where equipment is most likely to be deployed. In addition, provisions have been incorporated for increased use of certification and simulations in the technical evaluation of equipment.

2. **Monitoring Mechanism:** As part of DAP-2020, various monitoring mechanism have been introduced. Some of the existing monitoring mechanism for the Acquisition schemes is as follows:-

- Periodic review of Pre-contract schemes by PSO/APSO at SHQ and by DG(Acq) at MoD.
- Periodic review of delayed cases by DPB/DAC.
- Six monthly Review of shipbuilding cases by the Apex Steering Committee, headed by Secretary (DP) and Quarterly review by CWP&A.
- Empowered Project Committee (EPC) for SP Model 10(1) schemes, FTP cases.
- Monitoring of Make cases by Secretary (DP) and Head PMU-Make.
- Post Contract Monitoring for Projects.

This information was tabled in a written reply by Raksha Rajya Mantri Shri Shripad Naik to a question asked by Shri Komati Reddy Venkat Reddy and Shrimati Vanga Geetha Viswanath in Lok Sabha today.

<https://pib.gov.in/PressReleasePage.aspx?PRID=1705441>



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*Wed, 17 March 2021 2:45PM*

## **Indigenous Aircraft and Submarines**

Indian Navy has placed orders for following indigenous aircraft and submarines:-

(1) **Aircraft by Hindustan Aeronautics Ltd (HAL)**

(i) 12 Dorniers

(ii) 16 Advanced Light Helicopters (ALH MK III)

(iii) 8 Chetak helicopters

(2) **Submarines:** Six Scorpene class submarines are being built by Mazagon Dock and Shipbuilders Limited (MDL) under Project-75.

There are some delays in the projects. Reasons for delays are as follows:-

(1) **Aircraft:** The deliveries have been delayed due to the supply chain disruptions caused by COVID-19 pandemic.

(2) **Submarines:** The delays have been caused due to the various defects observed during the trials of the submarines, requirement of certain modifications and delays in the supply of items required for construction by the collaborator / ToT provider - Naval Group, France.

The outbreak of Covid-19 pandemic has further impacted the delivery schedule of the submarines.

In the interest of national security, the details cannot be divulged. However, the existing submarine fleet is being maintained combat worthy through life extension & modernization/upgradation.

This information was tabled in a written reply by Raksha Rajya Mantri Shri Shripad Naik to a question asked by Shri Ravindra Kushwaha and others in Lok Sabha today.

<https://pib.gov.in/PressReleasePage.aspx?PRID=1705440>



**Press Information Bureau  
Government of India**

**Ministry of Defence**

*Wed, 17 March 2021 2:56PM*

## **Scheme for promotion of MSMEs**

Following measures have been taken for promotion of Micro, Small and Medium Enterprises (MSMEs) in defence production sector:-

- Cases with Acceptance of Necessity (AoN) cost < Rs 100 Crores are reserved for MSMEs, provided there are at least two or more MSMEs eligible to participate in the category.
- In order to encourage startups/MSMEs, procurement cases where the estimated cost is not exceeding Rs 100 crores/year based on delivery schedule at the time of seeking AoN or Rs 150 crores, whichever is higher, may be considered for issue of RFP without any stipulation of Financial parameters.
- Project under the Make categories, with procurement not exceeding Rs 100 crores/year based on delivery schedule at the time of seeking AoN are earmarked for MSMEs.
- Offset Policy has been revised in the year 2020, to provide a multiplier of 1.5 where Indian Offset Partner (IOP) is a MSME.

- Department of Defence Production (DDP) regularly conducts outreach programs in various parts of the country to interact with industry associations, industry especially MSMEs and academia, to spread awareness about the potential export opportunities. A scheme aimed to promote MSMEs in Defence has been accorded approval. Under this scheme, conclaves/seminars are organized in Tier II and Tier III cities across the country with strong industrial and MSME presence, with the support of DDP. Three state level conclaves and one national level conclave in form of webinar have been organized during last two years under the scheme.
- An innovation ecosystem for Defence titled Innovations for Defence Excellence (iDEX) has been launched in April, 2018. iDEX is aimed at creation of an ecosystem to foster innovation and technology development in Defence and Aerospace by engaging Industries including MSMEs, Start-ups, Individual Innovators, R&D institutes and Academia and provide them grants/funding and other support to carry out R&D which has potential for future adoption for Indian defence and aerospace needs.
- An indigenization portal namely SRIJAN has been launched in August, 2020 for Defence Public Sector Undertakings (DPSUs)/Ordnance Factory Board (OFB)/Services with an industry interface to provide development support to MSMEs/Startups/Industry for import substitution.
- Government has established two Defence Industrial Corridors, one each in Uttar Pradesh and Tamil Nadu to serve as an engine of economic development and growth of Indian defence industry including MSMEs.
- Ministry of MSMEs implement various schemes and programmes for promotion and development of MSMEs including defence sector MSMEs across the country. These include Prime Minister's Employment Generation Programme (PMEGP), Scheme of fund for Regeneration of Traditional Industries (SFURTI), A scheme for Promotion of Innovation, Rural Industries and Entrepreneurship (ASPIRE), Credit Guarantee scheme, Credit Linked Capital Subsidy and Technology Upgradation Scheme (CLCSSTUS), Technology Centre Systems Programme (TCSP), Micro and Small Enterprises-Cluster Development Programme (MSE-CDP), Procurement and Marketing Support Scheme etc. Ministry also reviews and monitors the progress of the implementation of the Public Procurement Policy for MSEs Order, 2012.

As per information provided by Ministry of MSMEs, the details of procurement in terms of value from MSEs in Defence Sector by the Defence Department/CPSEs in the last two years and current year are as under:-

Financial Year	Total Procurement (Rs in Crores)
2018-19	12112.03
2019-20	9090.618
2020-21 (As on 11.03.2021)	9293.812

Further, regular Vendor development programmes and webinars are organized for MSMEs by OFB and DPSUs for development of supply chain. However, during the COVID-19 pandemic, many webinars were conducted due to COVID-19 restrictions on physical accumulation.

This information was tabled in a written reply by Raksha Rajya Mantri Shri Shripad Naik to a question asked by Shri Parvesh Sahib Singh Verma in Lok Sabha today.

<https://pib.gov.in/PressReleasePage.aspx?PRID=1705442>





## Book titled “Battle Ready for 21st Century” Released at Centre for Land Warfare Studies (CLAWS)

A book titled “Battle Ready for 21st Century” co-edited by Lt Gen AK Singh, Distinguished Fellow CLAWS and Brig Narendra Kumar, Visiting Fellow CLAWS was released by Gen Bipin Rawat, CDS and Gen Deepak Kapoor, Former Chief of the Army Staff at Centre for Land Warfare Studies (CLAWS) on 17 March 2021.

The book “Battle Ready for the 21<sup>st</sup> Century” has endeavoured to postulate and define emerging areas of conflict, desired capabilities and doctrinal issues that need careful examination. The authors with hands-on experience and domain specialisation have endeavoured to define and suggest the ways and means necessary to secure India from emerging security challenges on land, air, sea, space, cyber domain and even cognitive domain. The book is



dwelling on future conflicts that India may face and need to build capabilities to dissuade and prevent accidental wars. The foreword is written by former Naval Chief Admiral Arun Prakash. Former Chief of the Army Staff Gen NC Vij and Prof Gautam Sen have commented on the book for empirically identifying future security challenges and the need for building capabilities.

The book lays down the conceptual framework for the strategic management of future conflicts. The conventional land forces in Indian context still remains irreplaceable to capture, hold and deny ground to the adversaries, as a result, focus remains on land forces especially while dealing with the threat from China and Pakistan. The essays have imaginatively covered grey zone conflict, urban warfare and mountain warfare, along with dynamic military strategies to secure India. The “Two Front” dilemma is no longer an illusion, but an ongoing reality. For too long the ISR domain has remained an Achilles heel for India, the author of this essay has identified the gaps and suggested pragmatic measures to overcome these. The important aspect of doctrinal innovation has rightly been linked to visionary leadership and aligned to professional military education. The book assumes significance in view of the restructuring of armed forces in integrated theatre commands and cross-domain operations. The book is a must-read for members of higher defence organisation, military professionals and academicians.

<https://pib.gov.in/PressReleasePage.aspx?PRID=1705463>



Wed, 17 March 2021 3:41PM

## "बैटल रेडी फ़ॉर ट्वेंटी फ़र्स्ट सेंचुरी" शीर्षक से पुस्तक सेंटर फ़ॉर लैंड वॉरफेयर स्टडीज़ (कलाज़) में लोकार्पित

सेंटर फ़ॉर लैंड वॉरफेयर स्टडीज़ (कलाज़) के प्रतिष्ठित फेलो लेफ्टिनेंट जनरल ए के सिंह एवं विजिटिंग फेलो ब्रिगेडियर नरेन्द्र कुमार द्वारा सह-संपादित पुस्तक "बैटल रेडी फ़ॉर ट्वेंटी फ़र्स्ट सेंचुरी" का विमोचन सीडीएस जनरल बिपिन रावत और पूर्व सेना प्रमुख जनरल दीपक कपूर ने दिनांक 17 मार्च 2021 को सेंटर फ़ॉर लैंड वॉरफेयर स्टडीज़ (कलाज़) में किया।

"बैटल रेडी फ़ॉर ट्वेंटी फ़र्स्ट सेंचुरी" शीर्षक से पुस्तक में संघर्ष के नवीन आयामों, उनके लिए वांछित क्षमताओं एवं उन सैद्धांतिक मुद्दों को परिभाषित करने का प्रयास किया गया है जिनको सावधानीपूर्वक परीक्षण की दरकार है। व्यावहारिक अनुभव एवं क्षेत्र में विशेषज्ञता वाले लेखकों ने भूमि, वायु, समुद्र, अंतरिक्ष, साइबर डोमेन और यहां तक कि संज्ञानात्मक डोमेन पर उभरती



सुरक्षा चुनौतियों से भारत को सुरक्षित करने के लिए आवश्यक तरीकों और साधनों को परिभाषित करने और सुझाव देने का प्रयास किया है। यह पुस्तक भविष्य के उन संघर्षों का जिक्र कर रही है जिनका सामना भारत कर सकता है और आकस्मिक युद्धों को रोकने के लिए क्षमताओं का निर्माण करने की आवश्यकता है। इसका प्राक्कथन पूर्व नौसेना प्रमुख एडमिरल अरुण प्रकाश ने लिखा है। पूर्व सेना प्रमुख जनरल एन सी विज और प्रो गौतम सेन ने भविष्य की सुरक्षा चुनौतियों और निर्माण क्षमताओं की आवश्यकता के लिए अनुभवजन्य रूप से पहचान करने के लिए पुस्तक पर टिप्पणी की है।

यह पुस्तक भविष्य के संघर्षों के रणनीतिक प्रबंधन के लिए वैचारिक ढांचे को निर्धारित करती है। भारतीय संदर्भ में पारंपरिक ज़मीनी बल इलाके में कब्ज़ा करने, अधिकारपूर्वक बने रहने तथा दुश्मन को कोई भी लाभ उठाने से रोकने में अब भी बेजोड़ हैं। नतीजतन, विशेष रूप से चीन और पाकिस्तान से खतरे से निपटने के दौरान ज़मीनी बलों पर ध्यान केंद्रित रहता है। इस संदर्भ में पुस्तक में लिखे गए लेखों में भारत को सुरक्षित करने के लिए गतिशील सैन्य रणनीतियों के साथ-साथ ग्रे जोन संघर्ष, शहरी युद्ध और पर्वतीय युद्ध को भी कल्पनाशीलता से शामिल किया गया है। "दो तरफ़ा युद्ध" की दुविधा अब भ्रम नहीं अपितु एक वास्तविकता है जो हमारे समक्ष बनी हुई है। बहुत लंबे समय से आईएसआर डोमेन भारत के लिए दुखती रग बना हुआ है, इस लेख के लेखक ने कमियों की पहचान की है और इन्हें दूर करने के लिए व्यावहारिक उपाय सुझाए हैं।

सैद्धांतिक नवाचार का महत्वपूर्ण आयाम दूरदर्शी नेतृत्व से सही तरीके से जोड़ा गया है तथा यह पेशेवर सैन्य शिक्षा से संबंधित है। यह पुस्तक इंटीग्रेटेड थियेटर कमानों के रूप में सशस्त्र बलों के पुनर्गठन तथा

क्रोस डोमेन ऑपरेशनों को देखते हुए काफी महत्वपूर्ण है। यह पुस्तक उच्च रक्षा संगठन के सदस्यों, सैन्य पेशेवरों और शिक्षाविदों के लिए अवश्य पढ़ने लायक है।

<https://pib.gov.in/PressReleasePage.aspx?PRID=1705554>



Thu, 18 March 2021

## Ordnance Factories Day 2021: आज मनाया जा रहा OFB का 219वां स्थापना दिवस, जानिए इसका इतिहास

*आज Ordnance Factory का 219वां स्थापना दिवस मनाया जा रहा है। भारत में सबसे पहले Ordnance Factory की शुरुआत 18 मार्च, 1802 में हुई थी। इस दिन पूरे भारत में प्रदर्शनियों में राइफलों, तोपों, तोपखाने, गोला-बारूद का प्रदर्शन किया जाता है।*

नई दिल्ली: आज देशभर में आयुध कारखाने Ordnance Factories Day मना रहे हैं। यह Ordnance Factory का 219वां स्थापना दिवस है। हर साल 18 मार्च को Ordnance Factories Day मनाया जाता है। भारत की सबसे पुरानी Ordnance Factory कोलकाता के कोसीपूर में है, जिसकी शुरुआत 18 मार्च, 1802 में हुई थी।

### पूरे भारत में लगगी प्रदर्शनी

इस दिन पूरे भारत में प्रदर्शनियों में राइफलों, तोपों, तोपखाने, गोला-बारूद आदि का प्रदर्शन किया जाता है। आमतौर पर प्रदर्शनियां आम जनता के लिए खुली होती हैं। समारोह एक परेड के साथ शुरू होती है और प्रदर्शनी में विभिन्न पर्वतारोहण अभियानों की तस्वीरों को भी प्रदर्शित किया जाता है।



### 41 Ordnance Factories का समूह है OFB

दरअसल Ordnance Factory देशभर में कुल 41 Ordnance Factories के एक समूह है। इसका मुख्यालय अयोध्या भवन, कोलकाता में Ordnance Factory Board (OFB) है। OFB साल 1979 में 02 अप्रैल के दिन नए अवतार में अस्तित्व में आया। वर्तमान में ओएफबी रक्षा उपकरण बनाने वाला विश्व का 37 वां सबसे बड़ा निकाय है।

DRDO और CSIR के साथ करते हैं रिसर्च

बता दें कि, OFB अपने नए उपकरण की रिसर्च के लिए रक्षा अनुसंधान और विकास संगठन (DRDO) और आईआईटी जैसे संस्थानों की मदद लेता है। इनके सहयोग से बड़े पैमाने पर रिसर्च और डेवलपमेंट के काम किए जाते हैं। इसके अलावा OFB ने उच्च श्रेणी की रिसर्च के लिए वैज्ञानिक और औद्योगिक अनुसंधान परिषद (CSIR) के साथ भी एक MoU पर साइन किया है।

<https://www.abplive.com/news/india/ordnance-factories-day-2021-219th-foundation-day-of-ofb-being-celebrated-today-1821565>

## Ultrafast intra-atom motion tracked using synchrotron radiation

Scientists in Japan have observed and interfered with the ultrafast motion of electron movement inside of a Xenon atom using the coherent pairs of short light waves in synchrotron radiation. Xenon, consisting of a nucleus surrounded by five nested shells containing a total of 54 electrons, is used in flash lamps, and it burns bright and fast. The luminescent electrons move there on a time scale of one billionth of a second. The fast electron movement is however six orders of magnitude slower than that the scientists observed. Using the synchrotron facility at Institute for Molecular Science, they tracked the electron movement in relaxation to shed energy by dropping from an outer shell to an inner shell. The process happens at a timescale of femtoseconds, or one millionth of a billionth of a second. A femtosecond is to a second as a second is to almost 32 million years. The ability to observe and control such ultrafast processes could open the door to next-generation experiments and applications, according to the researchers.

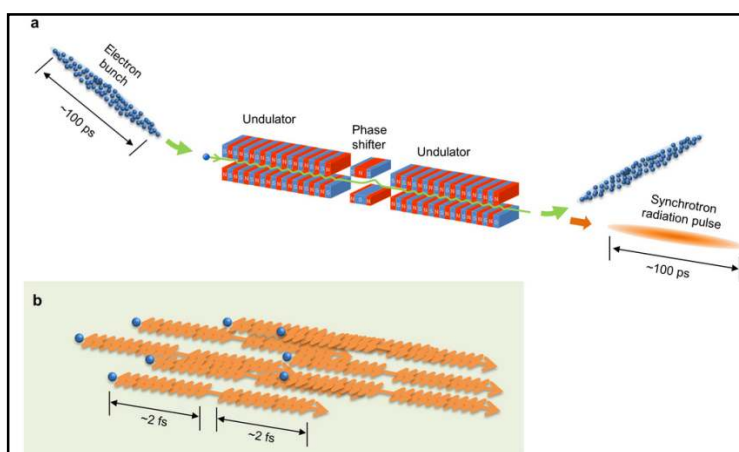
The results were published on March 17 in *Physical Review Letters*.

"Controlling and probing the electronic motion in atoms and molecules on their natural time scale of attoseconds—which are one-thousandth of a femtosecond—is one of the frontiers in atomic physics and attosecond physics," said paper author Tatsuo Kaneyasu, researcher at the SAGA Light Source, Kyushu Synchrotron Light Research Center in Japan. "In this study, we demonstrated that ultrashort processes in atoms and molecules can be tracked using the ultrashort property of the radiation wave packet."

Recent advances in laser technology enable us to produce ultraquick, or ultrashort, double light pulses that can interact with subatomic processes. This interference can be controlled by precisely tuning the time between each pulse. The pulse excites electrons, the motion of which is referred to as an electron wave packet. Kaneyasu and his team have achieved this technology using synchrotron radiation which has a great advantage in generating higher energy photons than those by lasers.

"This method, termed 'wave packet interferometry,' is now a fundamental tool for studying and manipulating the quantum dynamics of matter," Kaneyasu said. "In this study, the electron wave packet was produced by superimposing some electronic states in a xenon atom."

Much like two overlapping beams producing a more intense light than either individually gives off, two overlapping electron wave packets produce quantum effects.



(a) Schematic diagram of synchrotron radiation generation by undulators. Time widths of radiation pulses are determined by the spatial broadening of electron bunches. (b) The radiation pulse contains many short waves (wave packets) emitted by individual electrons. In the present study, two undulators are arranged in series to generate pairs of wave packets. Each wave packet oscillates only 10 times in 2 femtoseconds. Time intervals of the wave packet pairs are adjusted by detouring the electron bunches with a magnet between the two undulators. Credit: NINS/IMS

"The ultimate goal is controlling and probing the ultrafast electronic motion of a wide range of elements, not only in the gas-phase atoms and molecules but also in the condensed matters," Kaneyasu said. "This new capability of synchrotron radiation not only helps scientists study ultrafast phenomena in atomic and molecular processes, but may also open up new applications in the development of functional materials and electronic devices in the future."

**Journal information:** [Physical Review Letters](#)

<https://phys.org/news/2021-03-ultrafast-intra-atom-motion-tracked-synchrotron.html>

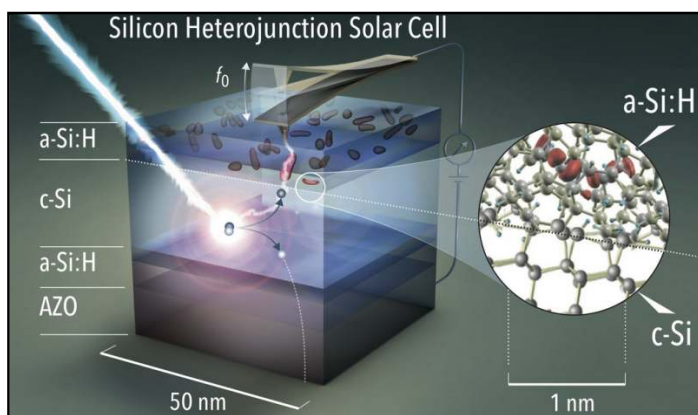


Thu, 18 March 2021

## Solar cells: Losses made visible on the nanoscale

Solar cells made of crystalline silicon achieve peak efficiencies, especially in combination with selective contacts made of amorphous silicon (a-Si:H). However, their efficiency is limited by losses in these contact layers. Now, for the first time, a team at Helmholtz-Zentrum Berlin (HZB) and the University of Utah, USA, has experimentally shown how such contact layers generate loss currents on the nanometre scale and what their physical origin is.

Silicon solar cells are now so cheap and efficient that they can generate electricity at prices of less than 2 cent/kWh. The most efficient silicon solar cells today are made with less than 10 nanometres thin selective amorphous silicon (a-Si:H) contact layers, which are responsible for separating the light-generated charges. Efficiencies of over 24% are achieved at HZB with such silicon heterojunction solar cells and are also part of a tandem solar cell that lead to a recently reported efficiency record of 29.15 % (A. Al-Ashouri, et al. *Science* 370, (2020)). The current world record from Japan for a single junction silicon solar cell is also based on this heterocontact (26.6%: K. Yoshikawa, et al. *Nature Energy* 2, (2017)).



conductive AFM tip is used to scan the sample surface of an a-Si:H/c-Si interface under ultra-high vacuum on the nm scale, revealing the transport channels of the charge carriers via defects in the a-Si:H (red states in the magnified section). Credit: Martin Künsting /HZB

There is still considerable efficiency potential related to such heterocontact systems, however, it is not yet understood in detail how these layers enable charge carrier separation and what their nanoscopic loss mechanisms are. The a-Si:H contact layers are characterized by their intrinsic disorder, which on the one hand enables excellent coating of the silicon surface and thus minimizes the number of interfacial defects, but on the other hand also has a small disadvantage: it can lead to local recombination currents and to the formation of transport barriers.

For the first time, a team at HZB and the University of Utah has experimentally measured on an atomic level how such leakage currents form between c-Si and a-Si:H, and how they influence the solar cell performance. In a joint effort, a team led by Prof. Christoph Boehme at the University of Utah, and by Prof. Dr. Klaus Lips at HZB, they were able to resolve the loss mechanism at the interface of the above mentioned silicon heterocontact on the nanometre scale using ultrahigh vacuum conductive atomic force microscopy (cAFM).

The physicists were able to determine with near atomic resolution where the leakage current penetrates the selective a-Si:H contact and creates a loss process in the solar cell. In cAFM these

loss currents appear as nanometre-sized current channels and are the fingerprint of defects associated with the disorder of the amorphous silicon network. "These defects act as stepping stones for charges to penetrate the selective contact and induce recombination, we refer to this" as trap-assisted quantum mechanical tunneling", explains Lips. "This is the first time that such states have been made visible in a-Si:H and that we were able to unravel the loss mechanism under working conditions of the a solar cell of highest quality," the physicist reports enthusiastically.

The Utah/Berlin team was also able to showed that the channeled dark current fluctuates stochastically over time. The results indicate that a short-term current blockade is present, which is caused by local charge that is trapped in neighboring defects which changes the energetic positioning of the tunneling states (stepping stones). This trapped charge can also cause the local photovoltage at a current channel to rise to above 1V, which is far above what one would be able to use with a macroscopic contact. "At this transition from the nano to the macro worldwe find the exciting physics of heterojunctions and the key on how to further improve the efficiency of silicon solar cells in an even more targeted way," says Dr. Bernd Stannowski, who is responsible for the development of industrial silicon heterojunction solar cells at HZB.

**More information:** Mandefro Y. Teferi et al, Imaging of Bandtail States in Silicon Heterojunction Solar Cells: Nanoscopic Current Effects on Photovoltaics, *ACS Applied Nano Materials* (2021). DOI: [10.1021/acsanm.0c02704](https://doi.org/10.1021/acsanm.0c02704)

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<https://phys.org/news/2021-03-solar-cells-losses-visible-nanoscale.html>

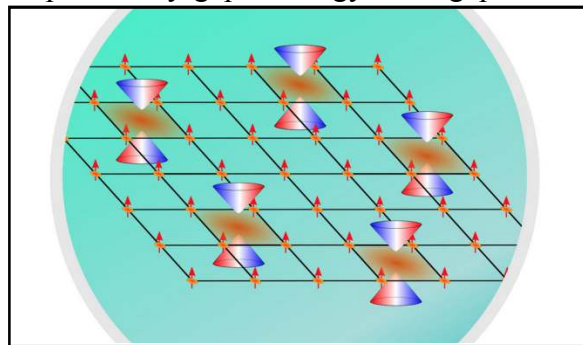


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## Magnetism meets topology on a superconductor's surface

Electrons in a solid occupy distinct energy bands separated by gaps. Energy band gaps are an electronic "no man's land," an energy range where no electrons are allowed. Now, scientists studying a compound containing iron, tellurium, and selenium have found that an energy band gap opens at a point where two allowed energy bands intersect on the material's surface. They observed this unexpected electronic behavior when they cooled the material and probed its electronic structure with laser light. Their findings, reported in the *Proceedings of the National Academy of Sciences*, could have implications for future quantum information science and electronics.

The particular compound belongs to the family of iron-based high-temperature superconductors, which were initially discovered in 2008. These materials not only conduct electricity without resistance at relatively higher temperatures (but still very cold ones) than other classes of superconductors but also show magnetic properties.



An illustration depicting a topological surface state with an energy band gap (an energy range where electrons are forbidden) between the apices of the top and corresponding bottom cones (allowed energy bands, or the range of energies electrons are allowed to have). A topological surface state is a unique electronic state, only existing at the surface of a material, that reflects strong interactions between an electron's spin (red arrow) and its orbital motion around an atom's nucleus. When the electron spins align parallel to each another, as they do here, the material has a type of magnetism called ferromagnetism. Credit: Dan Nevola, Brookhaven National Laboratory

"For a while, people thought that superconductivity and magnetism would work against each other," said first author Nader Zaki, a scientific associate in the Electron Spectroscopy Group of the Condensed Matter Physics and Materials Science (CMPMS) Division at the U.S. Department of Energy's (DOE) Brookhaven National Laboratory. "We have explored a material where both develop at the same time."

Aside from superconductivity and magnetism, some iron-based superconductors have the right conditions to host "topological" surface states. The existence of these unique electronic states, localized at the surface (they do not exist in the bulk of the material), reflects strong interactions between an electron's spin and its orbital motion around the nucleus of an atom.

"When you have a superconductor with topological surface properties, you're excited by the possibility of topological superconductivity," said corresponding author Peter Johnson, leader of the Electron Spectroscopy Group. "Topological superconductivity is potentially capable of supporting Majorana fermions, which could serve as qubits, the information-storing building blocks of quantum computers."

Quantum computers promise tremendous speedups for calculations that would take an impractical amount of time or be impossible on traditional computers. One of the challenges to realizing practical quantum computing is that qubits are highly sensitive to their environment. Small interactions cause them to lose their quantum state and thus stored information becomes lost. Theory predicts that Majorana fermions (sought-after quasiparticles) existing in superconducting topological surface states are immune to environmental disturbances, making them an ideal platform for robust qubits.

Seeing the iron-based superconductors as a platform for a range of exotic and potentially important phenomena, Zaki, Johnson, and their colleagues set out to understand the roles of topology, superconductivity and magnetism.

CMPMS Division senior physicist Genda Gu first grew high-quality single crystals of the iron-based compound. Then, Zaki mapped the electronic band structure of the material via laser-based photoemission spectroscopy. When light from a laser is focused onto a small spot on the material, electrons from the surface are "kicked out" (i.e., photoemitted). The energy and momentum of these electrons can then be measured.

When they lowered the temperature, something surprising happened.

"The material went superconducting, as we expected, and we saw a superconducting gap associated with that," said Zaki. "But what we didn't expect was the topological surface state opening up a second gap at the Dirac point. You can picture the energy band structure of this surface state as an hourglass or two cones attached at their apex. Where these cones intersect is called the Dirac point."

As Johnson and Zaki explained, when a gap opens up at the Dirac point, it's evidence that time-reversal symmetry has been broken. Time-reversal symmetry means that the laws of physics are the same whether you look at a system going forward or backward in time—akin to rewinding a video and seeing the same sequence of events playing in reverse. But under time reversal, electron spins change their direction and break this symmetry. Thus, one of the ways to break time-reversal symmetry is by developing magnetism—specifically, ferromagnetism, a type of magnetism where all electron spins align in a parallel fashion.

"The system is going into the superconducting state and seemingly magnetism is developing," said Johnson. "We have to assume the magnetism is in the surface region because in this form it cannot coexist in the bulk. This discovery is exciting because the material has a lot of different physics in it: superconductivity, topology, and now magnetism. I like to say it's one-stop shopping. Understanding how these phenomena arise in the material could provide a basis for many new and exciting technological directions."

As previously noted, the material's superconductivity and strong spin-orbit effects could be harnessed for quantum information technologies. Alternatively, the material's magnetism and strong spin-orbit interactions could enable dissipationless (no energy loss) transport of electrical

current in electronics. This capability could be leveraged to develop electronic devices that consume low amounts of power.

Coauthors Alexei Tsvelik, senior scientist and group leader of the CMPMS Division Condensed Matter Theory Group, and Congjun Wu, a professor of physics at the University of California, San Diego, provided theoretical insights on how time reversal symmetry is broken and magnetism originates in the surface region.

"This discovery not only reveals deep connections between topological superconducting states and spontaneous magnetization but also provides important insights into the nature of superconducting gap functions in iron-based superconductors—an outstanding problem in the investigation of strongly correlated unconventional superconductors," said Wu.

In a separate study with other collaborators in the CMPMS Division, the experimental team is examining how different concentrations of the three elements in the sample contribute to the observed phenomena. Seemingly, tellurium is needed for the topological effects, too much iron kills superconductivity, and selenium enhances superconductivity.

In follow-on experiments, the team hopes to verify the time-reversal symmetry breaking with other methods and explore how substituting elements in the compound modifies its electronic behavior.

"As materials scientists, we like to alter the ingredients in the mixture to see what happens," said Johnson. "The goal is to figure out how superconductivity, topology, and magnetism interact in these complex materials."

**More information:** Nader Zaki et al. Time-reversal symmetry breaking in the Fe-chalcogenide superconductors, *Proceedings of the National Academy of Sciences* (2021). DOI: [10.1073/pnas.2007241118](https://doi.org/10.1073/pnas.2007241118)

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<https://phys.org/news/2021-03-magnetism-topology-superconductor-surface.html>



### **Covid-19 reinfection rare, but more common in 65+: Large Danish study in Lancet**

*Most people who have had Covid-19 are protected from catching the virus again for at least six months, but elderly patients are more prone to reinfection, according to new research*

Pune: Most people who have had Covid-19 are protected from catching it again for at least six months, but elderly patients are more prone to reinfection, according to research published in The Lancet.

SARS-CoV-2, the cause of the Covid-19 epidemic, has resulted in over 117 million cases and over 2.6 million deaths worldwide as of March 7, 2021, as estimated by the World Health Organisation. However, the degree to which infection with SARS-CoV-2 confers protection towards subsequent reinfection is not well described.



In 2020, as part of Denmark's extensive, free-of-charge PCR-testing strategy, approximately 4 million individuals (69 per cent of the population) underwent tests. Using these national PCR-test data from 2020, researchers estimated protection towards repeat infection with SARS-CoV-2.

Large-scale assessment of reinfection rates in Denmark in 2020 confirms that only a small proportion of people (0.65%) returned a positive PCR test twice.

However, while prior infection gave those under the age of 65 years around 80 per cent protection against reinfection, for people aged 65 and older, it gave only 47 per cent protection, indicating that they are more likely to catch Covid-19 again.

The authors of the first large-scale study of its kind detected no evidence that protection against reinfection declined within a six-month follow-up period.

Their findings highlight the importance of measures to protect elderly people during the pandemic, such as enhanced social distancing and prioritisation for vaccines, even for those who have recovered from Covid-19. The analysis also suggests that people who have had the virus should still be vaccinated, as natural protection – particularly among the elderly – cannot be relied upon.

As of January 2021, Covid-19 had resulted in more than 100 million cases and over 2 million deaths worldwide. Recent studies have suggested that reinfections are rare and that immunity can last at least six months, however, the degree to which catching Covid-19 confers protection against repeat infection remains poorly understood.

Dr Steen Ethelberg, from the Statens Serum Institut, Denmark, said, "Our study confirms what a number of others appeared to suggest: reinfection with Covid-19 is rare in younger, healthy people, but the elderly are at greater risk of catching it again. Since older people are also more likely to experience severe disease symptoms, and sadly die, our findings make clear how important it is to implement policies to protect the elderly during the pandemic. Given what is at stake, the results emphasise how important it is that people adhere to measures implemented to keep themselves and others safe, even if they have already had Covid-19. Our insights could also inform policies focused on wider vaccination strategies and the easing of lockdown restrictions."

<https://indianexpress.com/article/explained/covid-19-reinfection-study-lancet-7233466/>

