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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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**Government of India**

**Ministry of Defence**

*Mon, 05 April 2021 12:39PM*

## **DRDO develops Advanced Chaff Technology to safeguard naval ships from missile attack**

Defence Research and Development Organisation (DRDO) has developed an Advanced Chaff Technology to safeguard the naval ships against enemy missile attack. Defence Laboratory Jodhpur (DLJ), a DRDO laboratory, has indigenously developed three variants of this critical technology namely Short Range Chaff Rocket (SRCR), Medium Range Chaff Rocket (MRCR) and Long Range Chaff Rocket (LRCR) meeting Indian Navy's qualitative requirements. The successful development of Advanced Chaff Technology by DLJ is another step towards Atmanirbhar Bharat.

Recently, Indian Navy conducted trials of all three variants in the Arabian Sea on Indian Naval Ship and found the performance satisfactory.

Chaff is a passive expendable electronic countermeasure technology used worldwide to protect naval ships from enemy's radar and Radio Frequency (RF) missile seekers. The importance of this development lies in the fact that very less quantity of chaff material deployed in the air acts as decoy to deflect enemy's missiles for safety of the ships.

The DRDO has gained the expertise to meet the futuristic threats from adversaries. The technology is being given to the industry for production in large quantities.

Raksha Mantri Shri Rajnath Singh has congratulated DRDO, Indian Navy and Industry for the achievement.

Secretary Department of Defence R&D & Chairman DRDO Dr G Satheesh Reddy appreciated the efforts of the teams involved in the indigenous development of this vital technology to safeguard Indian Naval Ships.

Vice Chief of Naval Staff Vice Admiral G Ashok Kumar has applauded DRDO efforts in developing strategically important technology indigenously in a short span and cleared for bulk production.

<https://www.pib.gov.in/PressReleasePage.aspx?PRID=1709617>



पत्र सूचना कार्यालय  
भारत सरकार

रक्षा मंत्रालय

Mon, 05 April 2021 12:39PM

## डीआरडीओ ने नौसैनिक पोतों को मिसाइल हमलों से बचाने के लिए आधुनिकतम चैफ़ प्रौद्योगिकी का विकास किया

रक्षा अनुसंधान एवं विकास संगठन (डीआरडीओ) ने नौसैनिक पोतों को शत्रु के मिसाइल हमलों से बचाने के लिए आधुनिकतम चैफ़डफ़भ प्रौद्योगिकी का विकास किया है। डीआरडीओ की प्रयोगशाला, रक्षा प्रयोगशाला जोधपुर (डीएलजे) ने इस अति महत्वपूर्ण प्रौद्योगिकी के तीन प्रकारों का स्वदेश में विकास किया है। ये हैं कम दूरी की मारक क्षमता वाला चैफ़ रॉकेट (एसआरसीआर), मध्यम रेंज चैफ़ रॉकेट (एमआरसीआर) और लम्बी दूरी की मारक क्षमता वाला चैफ़ रॉकेट (एलआरसीआर)। इन प्रकारों का विकास भारतीय नौसेना की गुणात्मक जरूरतों को पूरा करने के लिए किया गया है। रक्षा प्रयोगशाला जोधपुर द्वारा आधुनिकतम चैफ़ प्रौद्योगिकी का सफल विकास 'आत्मनिर्भर भारत' की दिशा में एक अन्य कदम है।

हाल में भारतीय नौसेना ने अरब सागर में भारतीय नौसैनिक पोतों से इन तीनों प्रकार के रॉकेटों का प्रायोगिक परीक्षण किया और इनके प्रदर्शन को संतोषजनक पाया।

चैफ़ एक अप्रतिरोधी विस्तार योग्य इलेक्ट्रॉनिक जवाबी प्रौद्योगिकी है जो विश्वभर में नौसैनिक पोतों को शत्रु के रडार और रेडियो फ्रीक्वेंसी मिसाइल साधकों से संरक्षण देती है। यह प्रौद्योगिकी इसलिए महत्वपूर्ण है कि इसमें नौसैनिक पोतों को शत्रु के मिसाइल हमले से बचाने के लिए बहुत कम मात्रा में चैफ़ सामग्री को प्रलोभन के तौर पर हवा में छोड़ा जाता है।

डीआरडीओ ने भविष्य में शत्रु से होने वाले खतरों से बचाव से हथियार निर्माण में विशेषज्ञता प्राप्त कर ली है। यह प्रौद्योगिकी बड़ी मात्रा में उत्पादन के लिए उद्योगों को सौंप दी गई है।

रक्षामंत्री श्री राजनाथ सिंह ने इस उपलब्धि के लिए डीआरडीओ, भारतीय नौसेना और उद्योगों को बधाई दी।

रक्षा अनुसंधान एवं विकास विभाग के सचिव और डीआरडीओ के अध्यक्ष डॉक्टर जी. सतीश रेड्डी ने भारतीय नौसैनिक पोतों की सुरक्षा के लिए अति महत्वपूर्ण इस प्रौद्योगिकी के स्वदेश में विकास से जुड़े समूहों के प्रयासों की प्रशंसा की।

नौसेना के वाइस चीफ ऑफ़ स्टाफ़ वाइस एडमिरल जी. अशोक कुमार ने बहुत कम समय में स्वदेशी तौर पर रणनीति के हिसाब से बेहद महत्वपूर्ण इस प्रौद्योगिकी के विकास के लिए और इसके बड़े पैमाने पर उत्पादन की स्वीकृति देने के लिए डीआरडीओ की प्रशंसा की।

<https://pib.gov.in/PressReleasePage.aspx?PRID=1709685>

## DRDO develops advanced chaff technology to safeguard Naval ships

### Synopsis

**Defence laboratory Jodhpur (DLJ), a DRDO laboratory, has indigenously developed three variants of this critical technology -- Short Range Chaff Rocket (SRCR), Medium Range Chaff Rocket (MRCR) and Long Range Chaff Rocket (LRCR) -- meeting Indian Navy's qualitative requirements, a DRDO statement said on Monday.**

The Defence Research and Development Organisation (DRDO) said it has developed an Advanced Chaff Technology to safeguard naval ships against enemy missile attack.

Defence laboratory Jodhpur (DLJ), a DRDO laboratory, has indigenously developed three variants of this critical technology -- Short Range Chaff Rocket (SRCR), Medium Range Chaff Rocket (MRCR) and Long Range Chaff Rocket (LRCR) -- meeting Indian Navy's qualitative requirements, a DRDO statement said on Monday.

Recently, Indian Navy conducted trials of all three variants in Arabian Sea on Indian Naval Ship and found the performance satisfactory, it said.

Chaff is a passive expendable electronic countermeasure technology used worldwide to protect naval ships from enemy's radar and RF missile seekers, the statement noted.

"The importance of this development lies in the fact that very less quantity of chaff material deployed in the air, acts as decoy to deflect enemy's missiles for safety of our ships", DRDO said.

DRDO said it has also gained the expertise to meet the futuristic threats from adversaries, which is a unique technology not available from outside.

The technology is being given to industries for production in large quantities, it said.

Vice Chief of Naval Staff Vice Admiral G Ashok Kumar has applauded DRDO efforts in developing strategically important technology indigenously in a short span and cleared for bulk production, the statement said.

Defence Minister Rajnath Singh congratulated DRDO, Indian Navy and Industry for the achievement, it said.

Secretary, Department of Defence R&D & Chairman, DRDO, Dr G Satheesh Reddy appreciated the efforts of teams involved in indigenous development of this vital technology to safeguard Indian Naval ships, it added.

"Successful development of Advanced Chaff Technology by DL Jodhpur is one more step towards 'Aatmanirbhar Bharat'", DRDO said.

<https://economictimes.indiatimes.com/news/defence/drdo-develops-advanced-chaff-technology-to-safeguard-naval-ships/articleshow/81911822.cms?from=mdr>



A file image of INS Kiltan (Representative image)

## **DRDO develops advanced technology to safeguard Indian Navy ships from enemy missiles**

*By Hemant Kumar Rout*

Bhubaneswar: The Defence Research and Development Organisation (DRDO) has developed Advanced Chaff Technology to safeguard Indian Navy ships from enemy missile attacks.

The Defence Laboratory Jodhpur (DLJ), a DRDO unit, has indigenously developed three variants of the critical technology -- Long Range Chaff Rocket (LRCR), Medium Range Chaff Rocket (MRCR) and Short Range Chaff Rocket (SRCR) -- meeting the Indian Navy's qualitative requirements.

The Indian Navy recently conducted trials of all three variants in the Arabian Sea and found the performance satisfactory.



**Long Range Chaff Rocket (LRCR) developed by DRDO**

A defence official said chaff is a passive expendable electronic countermeasure technology used worldwide to protect naval ships from enemy's radar and radio frequency missile seekers.

"The new development assumes significance as a very small quantity of chaff material deployed in the air acts as a decoy to deflect enemy missiles for the safety of our ships. DRDO has also gained the expertise to meet futuristic threats from adversaries. The technology is unique and not available elsewhere. It will be handed over to industries for production of chaff rockets in large quantities," he added.

Vice Chief of Naval Staff Vice Admiral G Ashok Kumar has applauded DRDO efforts in indigenously developing strategically important technology in a short span. The technology has been validated clearing the decks for bulk production, he added.

Secretary of the Department of Defence (Research and Development) and DRDO Chairman Dr G Satheesh Reddy appreciated the efforts of teams involved in indigenous development of this vital technology to safeguard Indian Navy ships.

"Successful development of Advanced Chaff Technology by DLJ is one more step towards Atmanirbhar Bharat," he said.

Defence Minister Rajnath Singh congratulated the DRDO, Indian Navy and the industry for the achievement.

<https://www.newindianexpress.com/nation/2021/apr/05/drdo-develops-advanced-technology-to-safeguard-indian-navy-ships-from-enemy-missiles-2286077.amp>

# नौसेना के जहाजों को मिला DRDO का कवच, हवा में ही दुश्मन की मिसाइल को रास्ते से भटका देगा रॉकेट

रक्षा अनुसंधान एवं विकास संगठन (डीआरडीओ) ने नौसेना के जहाजों को दुश्मन की मिसाइलों के निशाने से बचाने के लिए नया कवच तैयार किया है। हिंद महासागर में भारत को चुनौती को देखते हुए भारतीय नौसेना के लिए बड़ा उपहार है।

By Ramesh Mishra

बैंगलुरु: रक्षा अनुसंधान एवं विकास संगठन (डीआरडीओ) ने नौसेना के जहाजों को दुश्मन की मिसाइलों के निशाने से बचाने के लिए नया कवच तैयार किया है। एडवांस्ड चाफ टेक्नोलॉजी पर आधारित यह कवच दुश्मन के रडार को भ्रमित करेगा और जहाज की ओर बढ़ रही मिसाइलों की दिशा बदलने में मदद करेगा। डीआरडीओ ने इसे आत्मनिर्भर भारत की दिशा में एक अहम कदम बताया है।

## भारतीय नौसेना ने अरब सागर में किया परीक्षण

नौसेना की जरूरतों को देखते हुए डिफेंस लेबोरेटरी जोधपुर (डीएलजे) ने इस कवच को विकसित किया है। यह डीआरडीओ की प्रयोगशाला है। डीआरडीओ ने बताया कि डीएलजे ने इसके तीन वेरिएंट तैयार किए हैं, शॉर्ट रेंज चाफ रॉकेट, मीडियम रेंज चाफ रॉकेट और लांग रेंज चाफ रॉकेट। पिछले



दिनों भारतीय नौसेना ने अरब सागर में इनका परीक्षण किया, जहां इन्हें पूरी तरह कारगर पाया गया। रक्षा उद्योग से जुड़ी कंपनियों को यह टेक्नोलॉजी मुहैया कराई जा रही है, ताकि इनका उत्पादन बड़े पैमाने पर किया जा सके। रक्षा मंत्री राजनाथ सिंह ने डीआरडीओ, नौसेना और रक्षा उद्योग को इस उपलब्धि के लिए बधाई दी है। नौसेना के उप प्रमुख वाइस एडमिरल जी अशोक कुमार ने बहुत कम समय में ही रणनीतिक रूप से इस बेहद महत्वपूर्ण टेक्नोलॉजी को विकसित करने पर डीआरडीओ को बधाई दी है और बड़े पैमाने पर इसके उत्पादन को मंजूरी दी है। डिफेंस आरएंडडी डिपार्टमेंट के सचिव और डीआरडीओ के चेयरमैन डॉ. जी सतीश रेड्डी ने नौसैन्य जहाजों की हिफाजत के लिए अहम इस टेक्नोलॉजी को विकसित करने में लगी टीम के प्रयासों की सराहना की।

## बड़े काम की टेक्नोलॉजी

दुनियाभर में जहाजों की हिफाजत के लिए चाफ टेक्नोलॉजी का इस्तेमाल होता है। पहली बार द्वितीय विश्व युद्ध के दौरान इसका प्रयोग हुआ था। यह रडार काउंटरमेजर टेक्नोलॉजी है। इसके तहत किसी रॉकेट की मदद से हवा में चाफ मटेरियल का धुआं बना दिया जाता है। इसमें एल्युमीनियम, मेटलाइज्ड ग्लास फाइबर या प्लास्टिक आदि का इस्तेमाल होता है। यह धुआं दुश्मन के रडार पर उसके टारगेट की तरह दिखने लगता है। कई बार रडार पर एक साथ कई टारगेट नजर आने लगते हैं। दुश्मन की मिसाइल को इसकी मदद से आसानी से रास्ते से भटकाया जा सकता है।

## ऐसे होता है इस्तेमाल

जहाज पर चाफ मटेरियल से लैस रॉकेट तैनात रखे जाते हैं। किसी भी तरह के मिसाइल हमले का अंदेशा होते ही इसे चला दिया जाता है। रॉकेट से छूटे चाफ मटेरियल का धुआं दुश्मन की मिसाइल को निशाने से भटका देता है। डीआरडीओ ने कहा कि इस एडवांस्ड टेक्नोलॉजी की सबसे बड़ी खूबी यह है कि

हवा में चाफ मटेरियल की बहुत थोड़ी-सी मात्रा भी दुश्मन की मिसाइल को भरमाकर दूसरी ओर ले जाने के लिए काफी है। इससे हमारे जहाजों की सुरक्षा सुनिश्चित होगी।

<https://www.jagran.com/news/national-naval-ships-receive-drdo-armor-rocket-will-divert-enemy-missile-into-the-air-jagran-special-21530193.html>

**डेली न्यूज़**

Tue, 06 April 2021

## DRDO ने बनाया युद्ध पोतों के लिए कवच, छू भी नहीं सकेगी दुश्मन की Missile

**भारतीय रक्षा अनुसंधान एवं विकास संगठन (DRDO) ने एक ऐसी Missile बनाई है जो भारतीय नौसेना के युद्ध पोतों की दुश्मन की मिसालों से रक्षा करेगी।**

*By Anil Jangid*

नई दिल्ली: भारतीय रक्षा अनुसंधान एवं विकास संगठन (DRDO) ने एक ऐसी Missile बनाई है जो भारतीय नौसेना के युद्ध पोतों की दुश्मन की मिसालों से रक्षा करेगी। इस सिस्टम का नाम एडवांस्ड चाफ टेक्नोलॉजी (Advanced Chaff Technology) है। इसे डीआरडीओ के जोधपुर लेबोरेटरी ने विकसित किया है। इस टेक्नोलॉजी के तीन वैरिएंट बनाए गए हैं। छोटी दूरी, मध्यम दूरी और लंबी दूरी के चाफ रॉकेट।

जंगी जहाजों में चाफ रॉकेट लगाने का फायदा ये होता है कि ये जब लॉन्च किए जाते हैं तब दुश्मन का मिसाइल इनसे टकराकर हवा में ही फट जाता है। इससे जंगी जहाज बच जाते हैं। ये ठीक वैसा ही उपकरण होता है जैसा कि फाइटर जेट्स में एंटी-मिसाइल फ्लेयर सिस्टम होता है यानी मिसाइल को आते देख एंटी फ्लेयर सिस्टम जेट के पीछे आग के फव्वारे छोड़ता है। इनसे टकराकर मिसाइल नष्ट हो जाती है।

एंटी-मिसाइल फ्लेयर सिस्टम की तरह ही चाफ टेक्नोलॉजी के रॉकेट मिसाइल को आते देख हवा में उड़ जाते हैं। ये दुश्मन की मिसाइल को जंगी जहाज से काफी दूर ही नष्ट कर देते हैं। भारतीय नौसेना ने DRDO द्वारा बनाए गए चाफ रॉकेटों के तीनों वैरिएंट्स का परीक्षण अरब सागर में किया। सारे परीक्षण सफल रहे। इंडियन नेवी के अधिकारी इस टेक्नोलॉजी से संतुष्ट हैं क्योंकि दुश्मन के मिसाइलों से जंगी जहाजों को बचा सकता है।

एडवांस्ड चाफ टेक्नोलॉजी रॉकेट एक इलेक्ट्रॉनिक काउंटरमेजर टेक्नोलॉजी है। इसका उपयोग पूरी दुनिया में होता है। इसका कनेक्शन जहाज पर लगे मिसाइल ट्रैकर सिस्टम से होता है। जैसे ही दुश्मन की मिसाइल जहाज के नजदीक आने वाली होती है, ये हवा में उड़कर मिसाइल को नष्ट कर देता है।

एडवांस्ड चाफ टेक्नोलॉजी रेडियो फ्रिक्वेंसी को ट्रैक करके, या हीट सेंस करके या इन्फ्रारेड टेक्नोलॉजी को सेंस करने हमला करने वाली मिसाइलों को भी ध्वस्त कर देता है। रक्षामंत्री राजनाथ सिंह ने DRDO की टीम को बधाई दी है। यह टेक्नोलॉजी आत्मनिर्भर भारत मिशन के तहत विकसित की गई है।

Advanced Chaff Technology दुश्मन के हमलों को धोखा देने के काम आता है। यानी दुश्मन ने आप पर अगर किसी तरह का हवाई हमला यानी मिसाइल या रॉकेट छोड़ा तो आप इस टेक्नोलॉजी से उनका रुख मोड़ सकते हैं या फिर उन्हें टारगेट से पहले विस्फोट करा सकते हैं। इससे दुश्मन का हथियार बर्बाद चला जाता है।

<https://dailynews360.patrika.com/amp/news/drdo-advanced-chaff-technology-to-save-indian-navy-warships-68118.html>





# 'Moment of pride': Railway Minister Piyush Goyal announces completion of arc closure of Chenab Bridge, world's highest railway bridge

The Indian Railways on Monday completed the Arch closure of the iconic Chenab Bridge, the world's highest railway bridge, which is part of the Udhampur-Srinagar-Baramulla rail link project (USBRL).

Minister of Railways, Piyush Goyal released a video of the project on Twitter writing, "A moment of pride for India! The arch of Chenab bridge, connecting Kashmir to Kanyakumari has been completed. With an arch span of 467m, it is the world's highest railway bridge. PM Narendra Modi ji's vision to connect India has inspired the Railway family to scale new heights."

According to a statement issued by the ministry, the Arch closure was one of the most difficult parts of the bridge over Chenab and its completion is a major leap towards the completion of the 111 km-long winding stretch from Katra to Banihal.

It is arguably the biggest civil-engineering challenge faced by any railway project in India in recent history. The 5.6-meter last piece of metal was fitted at the highest point today and joined the two arms of the arch that currently stretch towards each other from both the banks of the river. This completed the shape of the arch that will then loom over the treacherous Chenab, flowing some 359 meters below, said the ministry in a statement.



The arch of Chenab bridgePC: [Twitter-@PiyushGoyal](#)

After the completion of the arch work, removal of the stay cables, filling of the concrete in the arch rib, erection of the steel trestle, launching of the viaduct, and track laying work will be taken up.

The Chenab Bridge -- having a length of 1.315 km -- will be the highest railway bridge in the world being 359m above the river bed level and will be 35 meters higher than the Eiffel Tower in Paris (France). It involves the fabrication of 28,660 metric tonnes of steel, 10 lakh cum earthwork, 66,000 cum concrete, and 26 km motorable roads.

"At present, it takes 12 hours via road (Katra-Banihal), but after completion of the bridge, distance via train would be halved. The completion is expected in two years," said. Northern Railway General Manager Ashutosh Gangal told ANI.

According to the ministry, the arch consists of steel boxes. Concrete will be filled in boxes of the Arch to improve stability. The overall weight of Arch is 10,619 MT. Erection of the members of the arch by overhead cable cranes was done for the first time on Indian Railways.

The most sophisticated 'Tekla' software and steel suitable for -10degC to 40degC temperature has been used for structural detailing, it said.

Enlisting the unique features of the bridge, the ministry said that it is designed for blast load in consultation with the DRDO for the first time in India and can withstand high wind speed up to 266 km per hour and bear earthquake forces of the highest intensity zone-V in India. It further said that the bridge will remain operational at a restricted speed of 30 km per hour even after the removal of one pier/trestle.

As per the ministry, for the first time on Indian Railways, a Phased Array Ultrasonic Testing machine used for testing welds and NABL accredited lab was established at the site for weld

testing, adding that 584km welding was done to join the different parts of the structure, which is to the tune of the distance between Jammu Tawi to New Delhi.

The height of the cable crane's pylon at Srinagar End is 127m, which is much taller than Qutub Minar's which is 72m.

This news has gone viral on Twitter. Citizens across the country are proud of this achievement and are applauding those who worked day and night for this.

<https://www.freepressjournal.in/india/moment-of-pride-railway-minister-piyush-goyal-announces-completion-of-the-arc-of-chenab-worlds-largest-railway-bridge>



Tue, 06 April 2021

## **IIT-Hyderabad research team develops an alternative to lithium-ion batteries**

*5V Dual Carbon Battery utilising self-standing carbon fiber mats do away with the requirement of toxic, costly and heavy transitional metals*

Sangareddy: The Electrochemical Energy Storage (EES) Lab at IIT-Hyderabad has developed a 5V Dual Carbon Battery utilising self-standing carbon fiber mats as both electrodes (cathode and anode). This new model sets aside the requirement of toxic, costly and heavy transitional metals.

Energy economy based on renewable sources has been put forward as a way out to reduce dependence on fossil fuel. Rechargeable lithium-ion batteries (LIBs) are projected to meet future electric mobility, electric aviation, and stationary grid energy storage targets by 2030.

However, LIBs need toxic and costly metals like cobalt, nickel, manganese and other materials to function. Geologically unsymmetrical distribution of lithium and cobalt along with geopolitics and unethical child labour centered on mining causes fluctuations in raw material cost. It affects market price stability of large LIB packs used in electric vehicles.

In the dual-carbon battery, both the electrodes consist of carbonaceous materials, and the ions from the electrolyte intercalate and de-intercalate into the electrode matrix.

The novel dual carbon battery consisting of zero transition metal may cut down the overall battery cost by 20-25% and is expected to curb the unpredictability in market price.

The use of ubiquitous carbon as electrode active material as well as current collector replacing heavy metals brings in the aspects of lightness and flexibility. The fabricated 5.0 voltage (nominal voltage 4.6 V) cell provides an energy density of 100-watt hour per kilogram approximately and can be extended up to 150-watt hour per kilogram with further modifications.

The research team believes that developed cells may find potential use in high voltage applications, sophisticated battery-run medical devices, regenerative braking systems in electric vehicles, and stationary grids.

“The study will be extrapolated to push the energy density limits further, and our broad vision includes introducing the dual carbon system as a cheaper LIB alternative to the Indian market,” said chemistry associate professor Surendra Kumar Martha, who led the research team. The research was carried out by Shuvajit Ghosh and Udita Bhattacharjee, PhD students at IIT Hyderabad, under the supervision of Mr Martha, in collaboration with Oak Ridge National Laboratory (USA) and Naval Materials Research Laboratory (Mumbai). Naval Research Board (DRDO) supported the project.

<https://www.thehindu.com/news/cities/Hyderabad/iit-hyderabad-research-team-develops-an-alternative-to-lithium-ion-batteries/article34248169.ece>



**Press Information Bureau**  
**Government of India**

**Ministry of Defence**

*Mon, 05 April 2021 1:12PM*

### **Indian Navy Ships and Aircraft to participate in exercise La Perouse**

Indian Navy Ships INS Satpura (with an integral helicopter embarked) and INS Kiltan alongwith P8I Long Range Maritime Patrol Aircraft are participating, for the first time; in multi-lateral maritime exercise La Pérouse, being conducted in the Eastern Indian Ocean Region from 05 to 07 Apr 2021. The Indian Navy ships and aircraft will exercise at sea with ships and aircraft of French Navy (FN), Royal Australian Navy (RAN), Japan Maritime Self Defence Force (JMSDF) and United States Navy (USN) during the three day exercise at sea.

The exercise La Pérouse, led by French Navy, has participation by FN Ships *Tonnerre*, an amphibious assault ship and frigate *Surcouf*. United States Navy is represented in the exercise by amphibious transport dock ship *Somerset*. Her Majesty's Australian Ships (HMAS) *Anzac*, a frigate and tanker *Sirius* have been deployed by RAN for participation in the exercise while Japan Maritime Self Defence Ship (JMSDF) is represented by the destroyer *Akebono*. In addition to the ships, integral helicopters embarked onboard ships will also participate in the exercise.

Exercise La Pérouse will witness complex and advanced naval operations including surface warfare, anti-air warfare and air defence exercises, weapon firing exercises, cross deck flying operations, tactical manoeuvres and seamanship evolutions such as replenishment at sea.

The exercise will showcase high levels of synergy, coordination and inter-operability between the friendly navies. Participation by the Indian Navy in the exercise demonstrates the shared values with friendly navies ensuring freedom of seas and commitment to an open, inclusive Indo-Pacific and a rules-based international order.

<https://www.pib.gov.in/PressReleasePage.aspx?PRID=1709626>





## पत्र सूचना कार्यालय भारत सरकार

### रक्षा मंत्रालय

Mon, 05 April 2021 1:12PM

## भारतीय नौसेना के जहाज और विमान ला पेरांस अभ्यास में भाग लेंगे

भारतीय नौसेना के जहाज आईएनएस सतपुड़ा (एक इंटीग्रल हेलीकॉप्टर के साथ) तथा पी 8। लॉन्ग रेंज मैरीटाइम पेट्रोल एयरक्राफ्ट के साथ आईएनएस किल्लान पहली बार बहुपक्षीय सामुद्रिक अभ्यास ला पेरांस में भाग ले रहे हैं जिसका संचालन 5 से 7 अप्रैल 2021 तक पूर्वी हिंद महासागर में किया जा रहा है।

भारतीय नौसेना के जहाज तथा विमान फ्रांस की नौसेना (एफएन), रॉयल ऑस्ट्रेलियन नेवी (आरएएन), जापान मैरीटाइम सेल्फ डिफेंस फोर्स (जेएमएसडीएफ) तथा यूनाइटेड स्टेट्स नेवी (यूएसएन) के जहाजों तथा विमान के साथ समुद्र में तीन दिनों के अभ्यास में भाग ले रहे हैं।

फ्रांस की नौसेना के नेतृत्व में ला पेरांस अभ्यास में पानी और स्थल दोनों जगह चलने वाले एक एसॉल्ट शिप एफएन शिप्स टोनेरे तथा फ्रिगेट सर्कोफ की भागीदारी है। अभ्यास में अमेरिकी नौसेना का प्रतिनिधित्व पानी और स्थल दोनों जगह चलने वाले ट्रांसपोर्ट डॉक शिप समरसेट द्वारा किया जा रहा है। अभ्यास में भाग लेने के लिए आरएएन द्वारा हर मेजेस्टी ऑस्ट्रेलियन शिप (एचएमएएस) एनजैक, एक फ्रिगेट तथा टैंकर सीरियस तैनात किया गया है, जबकि जापान मैरीटाइम सेल्फ डिफेंस फोर्स शिप (जेएमएसडीएफ) का प्रतिनिधित्व डेस्ट्रॉयर एकेबोनो द्वारा किया गया है। जहाजों के अतिरिक्त, अभ्यास में इंटीग्रल हेलीकॉप्टर जो ऑनबोर्ड जहाजों के साथ जुड़े हैं, भी भाग लेंगे।

ला पेरांस अभ्यास में सर्फिस वॉरफेयर, एंटी-एयर वॉरफेयर और एयर डिफेंस एक्सरसाइजेज, वीपन फायरिंग एक्सरसाइजेज, क्रॉस डेक फ्लाइंग ऑपरेशंस, सामरिक युद्धाभ्यास और समुद्र में फिर से ईंधन भरने जैसे नाविक कला विकास से जुड़े जटिल और उन्नत नौसेना अभ्यास देखने को मिलेगा।

यह अभ्यास मित्र देशों की नौसेनाओं के बीच उच्च स्तर के तालमेल, समन्वय और परस्पर-संचालन को प्रदर्शित करेगा। इस अभ्यास में भारतीय नौसेना द्वारा भाग लेना मैत्रीपूर्ण नौसेनाओं के साथ साझा मूल्यों को प्रदर्शित करता है और समुद्र की आजादी तथा एक खुली, समावेशी भारत-प्रशांत और एक नियम-आधारित अंतर्राष्ट्रीय व्यवस्था के प्रति उसकी प्रतिबद्धता सुनिश्चित करता है।

<https://pib.gov.in/PressReleasePage.aspx?PRID=1709658>





## Opening ceremony of multinational military exercise Shantir Ogroshena 2021

Multinational Military Exercise SHANTIR OGROSHENA 2021 (Front Runner of Peace) commenced on 04 April 2021 at Bangabandhu Senanibas, Bangladesh to commemorate the birth centenary of Bangladesh's 'Father of the Nation' Bangabandhu Sheikh Mujibur Rahman and mark glorious 50 years of liberation. Indian Army contingent of 30 personnel are participating along with contingent of Royal Bhutan Army, Sri Lankan Army and Bangladesh Army from 04 Apr to 12 Apr 2021. Military observers from USA, UK, Turkey, Kingdom of Saudi Arabia, Kuwait and Singapore will also be in attendance throughout the exercise.

The aim of the exercise is to strengthen the procedures and enhance interoperability amongst neighbourhood countries to ensure robust peace keeping operations in the region. The armies of all the participating nations will share their valuable experiences and refine their drills & procedures in Peace keeping operations.

<https://www.pib.gov.in/PressReleasePage.aspx?PRID=1709579>





पत्र सूचना कार्यालय  
भारत सरकार

रक्षा मंत्रालय

Mon, 05 April 2021 10:21AM

## बहुराष्ट्रीय सैन्य अभ्यास शांतीर ओग्रोशेना-2021 के उद्घाटन समारोह का आयोजन

मल्टीनेशनल मिलिट्री एक्सरसाइज शांतीर ओग्रोशेना (फ्रॉन्ट रनर ऑफ पीस) का आयोजन 04 अप्रैल 2021 को बंगबंधु सेनानीबास, बांग्लादेश में बांग्लादेश के राष्ट्रपिता 'बंगबंधु शेख मुजीबुर रहमान की जन्मशती मनाने और मुक्ति के 50 वर्षों के गौरवशाली अवसर पर शुरू की गई। रॉयल भूटान आर्मी, श्रीलंका की सेना और बांग्लादेश की आर्मी की टुकड़ी के साथ 04 अप्रैल से 12 अप्रैल 2021 तक 30 जवानों की भारतीय दल इस अभ्यास में भाग ले रही है। अभ्यास के दौरान संयुक्त राज्य अमेरिका, ब्रिटेन, तुर्की, सऊदी अरब, कुवैत और सिंगापुर के सैन्य पर्यवेक्षक भी उपस्थित रहेंगे।



इस सैन्य अभ्यास का उद्देश्य कार्यप्रणाली को मजबूत करना और पड़ोसी देशों के साथ पारस्परिकता को बढ़ावा देना है ताकि क्षेत्र में शांति बनाए रखी जा सके। सभी भाग लेने वाले देशों की सेनाएं अपने बहुमूल्य अनुभवों को साझा करेंगी और शांति बनाए रखने के कार्यों में अपनी जानकारी और कार्यपद्धति को परिष्कृत करेंगी।

<https://pib.gov.in/PressReleasePage.aspx?PRID=1709635>

## **General Bipin Rawat visits Karnataka's Karwar Naval Base, briefed about project Seabird**

*On August 1, 2002, the Government of India had accorded its approval in 1995 for the execution of the first phase of the Project Seabird at a revised completion cost of ₹ 1294.41 crore.*

Karwar (Karnataka): Chief of Defence Staff, General Bipin Rawat visited Naval Base in Karwar on Monday and was briefed about the ongoing works under Project Seabird. Later, he interacted with officers and sailors at the station.

"CDS General Bipin Rawat visited Karwar Naval Base today, April 5, 2021. The General was received by Vice Admiral, R Hari Kumar, CinC #WNC and was briefed on the progress of Project Seabird and the plan for future infrastructure. The CDS also interacted with officers and sailors in the station," tweeted PRO Defence, Mumbai.

INS Kadamba is an Indian Navy base located near Karwar in Karnataka. The first phase of construction of the base, code-named Project Seabird, was completed in 2005. Development of Phase II commenced in 2011. INS Kadamba is currently the third-largest Indian naval base, and is expected to become the largest naval base in the eastern hemisphere after completion of expansion Phase II.

On August 1, 2002, the Government of India had accorded its approval in 1995 for the execution of the first phase of the Project Seabird at a revised completion cost of ₹ 1294.41 crore.

The project completed by 2005. The project would enable 10 ships and 10-yard crafts for refit and maintenance.

<https://www.ndtv.com/india-news/general-bipin-rawat-visits-karnatakas-karwar-naval-base-briefed-about-project-seabird-2406986>



**Bipin Rawat Visits Karwar Naval Base, Briefed On Project Seabird.**

## AI can bring enormous changes in way we train and fight wars: IAF Chief

- *The chief of air staff said his force is also looking at using artificial intelligence in areas of data and intelligence fusion, maintenance as well as in its decision support system.*

The use of artificial intelligence can bring enormous changes in the way wars are fought and the Indian Force has started looking at its applications in a range of areas, including training and threat monitoring, Air Chief Marshal RKS Bhadauria said on Monday.

The chief of air staff said his force is also looking at using artificial intelligence (AI) in areas of data and intelligence fusion, maintenance as well as in its decision support system.

"These are huge areas of focus for our immediate future," he said at a FICCI seminar on use of AI for air warriors.

Air Chief Marshal Bhadauria also urged the industry to work on developing various military applications of AI.

"Smart technologies like AI have the potential to totally change the way we train and fight future wars. We are living through some interesting times," he said.

"It is the right time for all of us, the military operators, the industry, the think-tanks and all the AI specialists for creating next-generation AI enablers for air war," the IAF chief said.



Air Chief Marshal RKS Bhadauria also urged the industry to work on developing various military applications of AI. (ANI Photo)

He said it was time to plant a "robust tree" for development of AI in the country.

At the same time, he mentioned that different nations with different threat perceptions would have different requirements and this would have evolved over a period of time and experience.

"We have already embarked on an AI journey and having gone through some of the important automation projects in the recent past, we have started testing AI and AI- based applications on some projects which are in different stages," he added.

The air chief marshal elaborated that AI is being developed in multiple areas in the air domain to accrue diverse and asymmetrical operations benefits.

Air Chief Marshal Bhadauria added that currently AI has not matured to an extent where completely autonomous missions can be executed.

"However, there is a need to address some questions to this effect- whether algorithms can be trained to effectively execute mission planning behaviours in unpredictable scenarios; can machines be taught combat strategies; can sufficiently generalised representations be built to capture the richness of the planning problem itself across the threat matrix," he said.

"The answer to these questions will help us firm up our requirement specifications that will essentially be a starting document vis-a-vis the expected outcomes. If we tend to utilise AI heavily in combat aviation, we may need to redefine or even abandon certain traditional principles," he added.

The defence ministry has been focusing on application of AI in the three services.

<https://www.hindustantimes.com/india-news/ai-can-bring-enormous-changes-in-way-we-train-and-fight-wars-iaf-chief-101617632946203.html>



# Indian team to visit US for induction of key naval choppers

*By Rajat Pandit*

New Delhi: India will soon be sending a team to the US for induction of the MH-60 “Romeo” multi-mission helicopters, which will be a significant capability jump for the Navy in detecting and destroying enemy submarines prowling in the Indian Ocean Region (IOR).

The Navy will this year get at least three of the 24 heavy-duty helicopters, equipped with multi-mode radars and night-vision devices as well as armed with Hellfire missiles, MK-54 torpedoes and precision-kill rockets, under the Rs 15,157 crore (\$2.13 billion) contract inked with the US in February 2020.

The 140-warship Navy is currently grappling with just a handful of old anti-submarine warfare (ASW) helicopters like Kamov-28s and Sea Kings when the presence of Chinese nuclear and diesel-electric submarines is only going to further increase in the IOR.

“All the 24 MH-60R helicopters, which will operate from frontline warships including aircraft carrier INS Vikramaditya, will be inducted by end-2023 or so. It will somewhat plug the critical operational gap on this front. The team of pilots and technicians for training and induction of the MH-60Rs will be going to the US in May-June,” said a defence ministry source.

ASW choppers typically fly ahead of warships to “dunk” their sonars into deep waters, “ping” for enemy submarines, and then fire missiles, torpedoes and depth charges to clear the path for the fleet during hostilities. They can also undertake anti-ship strikes, over the horizon network-centric operations and electronic warfare missions.

The Navy, in fact, has also projected a long-term requirement for another 123 naval multi-role helicopters (NMRHs), after the 24 MH-60Rs, but the proposed “Make in India” project for them is still nowhere on the horizon. The MH-60Rs are a replacement for the older Sea King 42/42A helicopters that were retired in the 1990s. The case for the 24 choppers, incidentally, began way back in 2005.

Manufactured by Sikorsky-Lockheed Martin, the MH-60Rs will be the third type of iconic US helicopters to be inducted by Indian armed forces. The IAF has already inducted 22 Apache attack (for Rs 13,952 crore) and 15 heavy-lift Chinook (Rs 8,048 crore) choppers, both produced by Boeing. The Army, in turn, is slated to get six Apaches under a Rs 5,691 crore (\$796 million) deal, which was also inked during former US President Donald Trump’s visit to India in February last year. Overall, the US has bagged Indian arms deals worth over \$21 billion just since 2007. Several



**MH-60 'Romeo' Seahawk helicopters**

- India to buy 24 MH-60 Romeo helicopters from Lockheed Martin for the Indian Navy for \$ 2.6 billion
- Currently deployed with the US Navy as the primary anti-submarine warfare anti-surface weapon system
- Capable for hunting submarines, knocking out ships & conducting search-and-rescue operations at sea
- Will prove to be a very potent weapon against the rising Chinese presence in Indian Ocean region
- Will be armed with Hellfire missiles, precision kill weapon system and MK 54 torpedoes
- Would replenish India's aging fleet of British-made Sea King helicopters

more are in the pipeline. These include the \$1.8 billion acquisition of six more P-8I long-range maritime patrol aircraft, which will add to the 12 such planes already contracted for \$3.2 billion earlier.

<https://timesofindia.indiatimes.com/india/indian-team-to-visit-us-for-induction-of-key-naval-choppers/articleshow/81904360.cms>

## Science & Technology News



Tue, 06 April 2021

# Scientists achieve single-photon imaging over 200 kilometers

A research team led by Professor Pan Jianwei and Professor Xu Feihu from University of Science and Technology of China achieved single-photon 3D imaging over 200 km using high-efficiency optical devices and a new noise-suppression technique, which was commented on by the reviewer as an almost "heroic" attempt at single photon lidar imaging at very long distances.

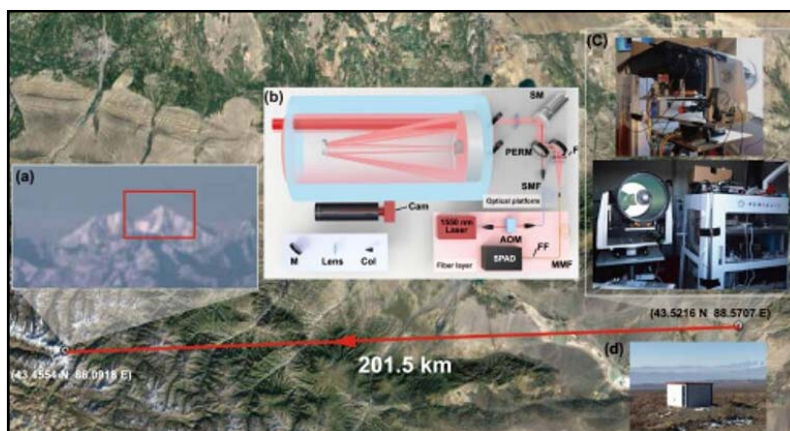
Lidar imaging technology has enabled high precision 3D imaging of target scenes in recent years. Single photon imaging lidar is an ideal technology for remote optical imaging with single-photon level sensitivity and picosecond resolution, yet its imaging range is strictly limited by the quadratically decreasing count of photons that echo back.

Researchers first optimized transceiver optics. The lidar system setup adopted a coaxial scanning design for the transmit and receive optical paths, which can align the transmitting and receiving spots more precisely and achieve higher-resolution imaging in comparison with traditional methods.

To differentiate weak echo signal from strong background noise, the team developed a single-photon avalanche diode detector (SPAD) with a 19.3% detection efficiency and a low dark count rate (0.1kHz). Further, researchers coated their telescope to achieve high transmission at 1550 nm. All these improvements achieved higher collection efficiency than before.

Researchers also adopted an efficient temporal filtering technique for noise suppression. The technique can reduce the total number of noise photon counts to about 0.4 KHz, which is at least 50 times smaller than previous work.

Experiment results showed that the system can achieve accurate 3D imaging at up to 201.5 km with single-photon sensitivity.



(a) Visible-band photograph of the mountains taken by a standard astronomical camera equipped with a telescope. The elevation is approximately 4500 m. (b) Schematic diagram of the experimental setup. (c) Photograph of the setup hardware, including the optical system (top and bottom left) and the electronic control system (bottom right). (d) View of the temporary laboratory where lidar was implemented at an altitude of 1770 m. Credit: LI Zhengping et al.

This work could provide enhanced methods for low-power, single-photon lidar for high-resolution active imaging and sensing over long ranges and open up a new road for the application of long-range target recognition and earth observation.

**More information:** Zheng-Ping Li et al, Single-photon imaging over 200 km, *Optica* (2021). DOI: [10.1364/OPTICA.408657](https://doi.org/10.1364/OPTICA.408657)

**Journal information:** *Optica*

<https://phys.org/news/2021-04-scientists-single-photon-imaging-kilometers.html>



Tue, 06 April 2021

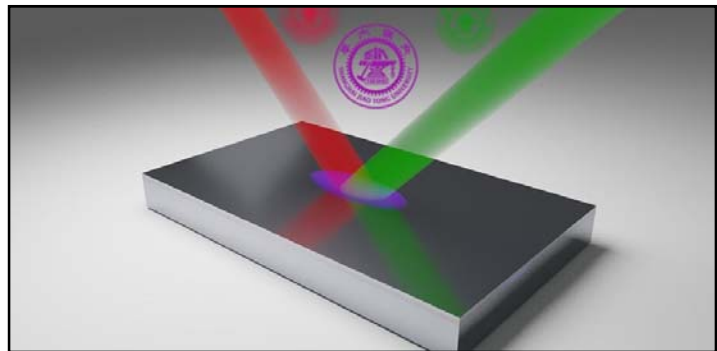
## Nonlinear wave mixing facilitates subwavelength imaging

The diffraction limit, also known as the Abbe diffraction limit in optics, poses a great challenge in many systems that involve wave dynamics, such as imaging, astronomy, and photolithography. For example, the best optical microscope only possesses resolution around 200 nm, but the physical size of the photolithography process with an excimer laser is around tens of nanometers. Meanwhile, physical sizes in current research and applications in biology and the semiconductor industry have scaled down to several nanometers, which is far beyond the ability of optical waves.

According to the Abbe theory, subwavelength features are usually associated with evanescent waves, which decay exponentially with distance from the target. In response to this problem,

researchers have developed many ways to bypass the Abbe limit, showing success in different applications. In one instance, the 2014 Nobel Prize in Chemistry was awarded to Eric Betzig, Stefan W. Hell, and William E. Moerner, for their contributions to the development of super-resolved fluorescence microscopy for life-sciences research.

Currently, there are two main approaches to overcoming the diffraction limit in optics: near-field and far-field. The near-field approach utilizes a nanosized tip scanning over the sample and directly interacts with those evanescent fields. As a scanning approach, it provides high-fidelity images but is always time-consuming. On the other hand, far-field approaches, such as stimulated emission depletion microscopy (STED), stochastic optical reconstruction microscopy (STORM), and structured illumination microscopy (SIM), are based on fluorescent labeling, restricting them from broader applications—for instance, in the semiconductor industry. A more fundamental approach is needed—one that is free from near-field scanning and nanofabrication as well as fluorophores. A team of researchers from Shanghai Jiao Tong University recently developed an alternative way to break the Abbe diffraction limit and realize subwavelength imaging in an all-optical manner. As reported in *Advanced Photonics*, they propose localized evanescent-wave illuminations, which are excited at the silicon surface by four-wave mixing, a third-order nonlinear optical process. Such excited waves help to realize super-resolution through the way that they scatter part of the evanescent fields of the target into the far field. By varying wave vectors of excited waves, parts of different orientations in Fourier spectrum can then be obtained. Combined with an iterative reconstruction technique called Fourier ptychography, these multiple Fourier-



Realization of far-field, label-free super-resolution imaging based on evanescent waves excited by nonlinear four-wave mixing. Credit: Zhou et al., doi 10.1117/1.AP.3.2.025001

spectral parts can be stacked together, recovering an enlarged Fourier spectrum that includes evanescent fields—thereby realizing super-resolution imaging in the far field.

Probing the evanescent waves around a target, the team realizes label-free, non-scanning subwavelength imaging in the far field. The authors note that their results also show promise for a new type of high-resolution photolithography mechanism: constructive interference of such excited near-field evanescent waves can focus light into tiny spots well below the diffraction limit.

**More information:** Zhihao Zhou et al, Far-field super-resolution imaging by nonlinearly excited evanescent waves, *Advanced Photonics* (2021). DOI: [10.1117/1.AP.3.2.025001](https://doi.org/10.1117/1.AP.3.2.025001)  
<https://phys.org/news/2021-04-nonlinear-subwavelength-imaging.html>



Tue, 06 April 2021

## Streamlining the process of materials discovery

Developing new materials and novel processes has continued to change the world. The M3I3 Initiative at KAIST has led to new insights into advancing materials development by implementing breakthroughs in materials imaging that have created a paradigm shift in the discovery of materials. The Initiative features the multiscale modeling and imaging of structure and property relationships and materials hierarchies combined with the latest material-processing data.

The research team led by Professor Seungbum Hong analyzed the materials research projects reported by leading global institutes and research groups, and derived a quantitative model using machine learning with a scientific interpretation. This process embodies the research goal of the M3I3: Materials and Molecular Modeling, Imaging, Informatics and Integration.

The researchers discussed the role of multiscale materials and molecular imaging combined with machine learning and also presented a future outlook for developments and the major challenges of M3I3. By building this model, the research team envisions creating desired sets of properties for materials and obtaining the optimum processing recipes to synthesize them.

"The development of various microscopy and diffraction tools with the ability to map the structure, property, and performance of materials at multiscale levels and in real time enabled us to think that materials imaging could radically accelerate materials discovery and development," says Professor Hong. "We plan to build an M3I3 repository of searchable structural and property maps using FAIR (Findable, Accessible, Interoperable, and Reusable) principles to standardize best practices as well as streamline the training of early career researchers."

One of the examples that shows the power of structure-property imaging at the nanoscale is the development of future materials for emerging nonvolatile memory devices. Specifically, the research team focused on microscopy using photons, electrons, and physical probes on the

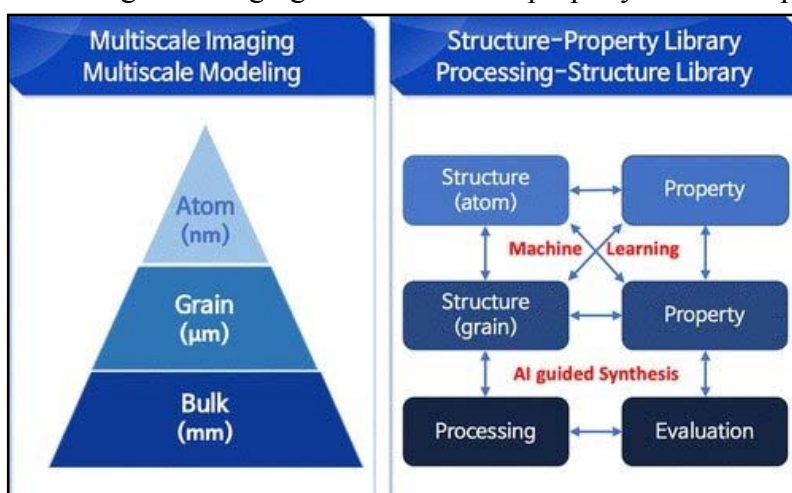


Figure 1. Schematic diagram of the M3I3 Flagship Project. This project aims to achieve the seamless integration of the multiscale "structure-property" and "processing-property" relationships via materials modeling, imaging, and machine learning. With the capability of artificial intelligence (AI)-guided automatic synthesis, M3I3 will provide expedited development of new materials in the near future. Credit: KAIST

multiscale structural hierarchy, as well as structure-property relationships to enhance the performance of memory devices.

"M3I3 is an algorithm for performing the reverse engineering of future materials. Reverse engineering starts by analyzing the structure and composition of cutting-edge materials or products. Once the research team determines the performance of our targeted future materials, we need to know the candidate structures and compositions for producing the future materials."

The research team has built a data-driven experimental design based on traditional NCM (nickel, cobalt, and manganese) cathode materials. With this, the research team expanded their future direction for achieving even higher discharge capacity, which can be realized via Li-rich cathodes.

However, one of the major challenges was the limitation of available data that describes the Li-rich cathode properties. To mitigate this problem, the researchers proposed two solutions: First, they should build a machine-learning-guided data generator for data augmentation. Second, they would use a machine-learning method based on 'transfer learning.' Since the NCM cathode database shares a common feature with a Li-rich cathode, one could consider repurposing the NCM trained model for assisting the Li-rich prediction. With the pretrained model and transfer learning, the team expects to achieve outstanding predictions for Li-rich cathodes even with the small data set.

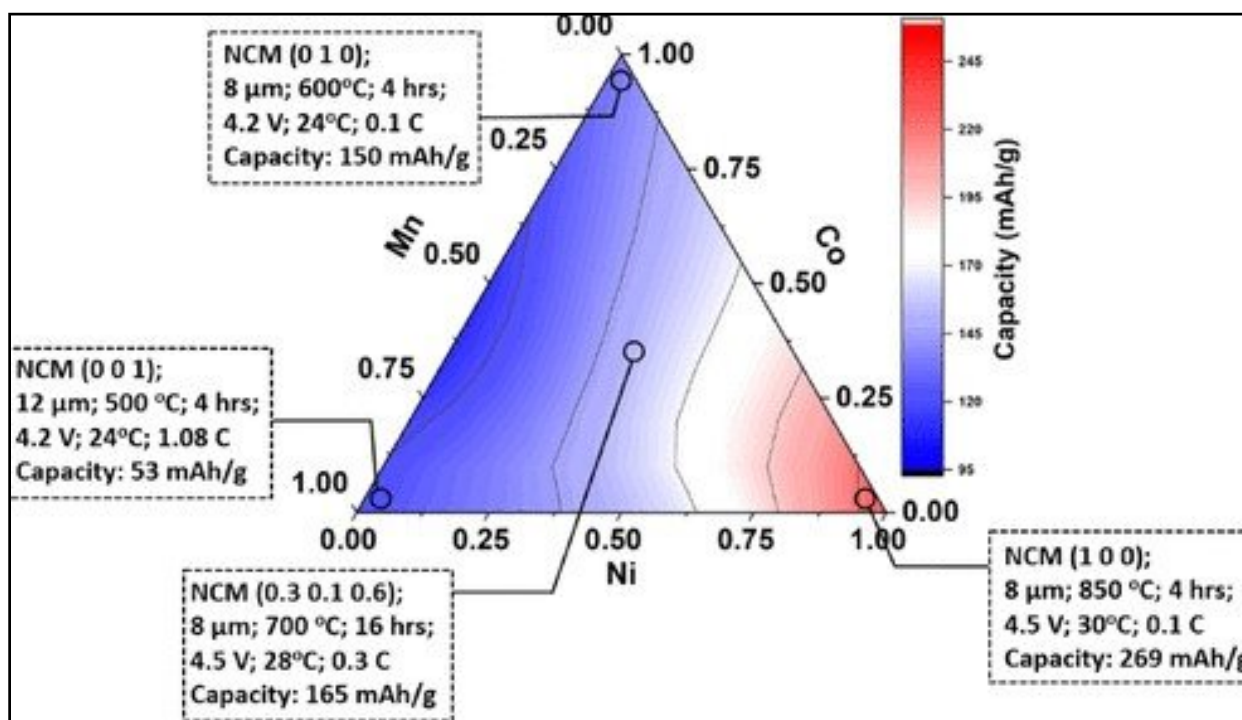


Figure 2. Capacity contour triangle plot as functions of composition (Ni, Co, and Mn), particle size, sintering temperature/time, measurement temperature, cutoff voltage, and C-rate. Credit: KAIST

With advances in experimental imaging and the availability of well-resolved information and big data, along with significant advances in high-performance computing and a worldwide thrust toward a general, collaborative, integrative, and on-demand research platform, there is a clear confluence in the required capabilities of advancing the M3I3 Initiative.

Professor Hong said, "Once we succeed in using the inverse "property-structure-processing" solver to develop cathode, anode, electrolyte, and membrane materials for high energy density Li-ion batteries, we will expand our scope of materials to battery/fuel cells, aerospace, automobiles, food, medicine, and cosmetic materials."

**More information:** Seungbum Hong et al, Reducing Time to Discovery: Materials and Molecular Modeling, Imaging, Informatics, and Integration, *ACS Nano* (2021). DOI: [10.1021/acsnano.1c00211](https://doi.org/10.1021/acsnano.1c00211)

**Journal information:** [ACS Nano](https://doi.org/10.1021/acsnano.1c00211)

<https://phys.org/news/2021-04-materials-discovery.html>



Tue, 06 April 2021

## Covid mutants multiply as Scientists race to decode variations

- *While the virus continues to evolve in the short term, one of the most hopeful scenarios is that it may run out of big moves it can make to evade antibodies that make the current vaccines work*

When Bette Korber, a biologist at Los Alamos National Laboratory, spotted the first significant mutation in the Covid-19 virus last spring, some scientists were skeptical. They didn't believe it would make the virus more contagious and said its rapid rise might just be coincidence.

Now, 11 months later, the D614G mutation she helped discover is ubiquitous worldwide, featured in the genomes of fast-spreading variants from the U.K., South Africa and Brazil. Meanwhile, new mutations are popping up in increasingly complicated patterns, spurring a drive by top biologists to devise new ways to track a fire hose of incoming genomic data.

The goal: Quickly detect variants that can lessen the effectiveness of vaccines for a pathogen that's unlikely to be eradicated any time soon. The SARS-CoV-2 virus could settle down and become a mere nuisance like the common cold. Or much like influenza, it could retain its ability to cause severe disease in some segments of the population, a scenario that could require regular booster shots.

"By watching it carefully, we can stay ahead of the virus and that is what everyone is scrambling to do right now," said Korber, who is working to create new mathematical tools for spotting medically significant variants.

The flood of new genome data is so great that the Los Alamos lab had to upgrade its servers to deal with the incoming data. Meanwhile, Korber is on four Zoom calls a week with experts worldwide to devise criteria for deciding when mutations are concerning enough to merit detailed laboratory follow-up on how they may impact vaccines.

A key mystery plumbed early-on by top scientists has been what type of virus the coronavirus will prove to be. So far, it looks more similar to influenza, which shape-shifts all the time and requires annual revaccination, than it does measles, a virus so intolerant of mutation that one vaccine regimen lasts a lifetime.

"Does it mean we need to make a new vaccine every year?" said Paul Duprex, who heads the University of Pittsburgh's Center for Vaccine Research. "We don't know."

For one thing, mRNA vaccines for Covid-19 have efficacy rates above 90%, much higher than the 60% rate for flu shots in a good year. But vaccine makers Moderna Inc. and Pfizer Inc., along with its partner BioNTech SE, aren't taking any chances. Just in case, they're already starting trials of booster shots aimed at B.1.351, the antibody-evading strain first spotted in South Africa.

When viruses replicate and copy their genomes, errors can erupt the long string of RNA or DNA "letters" that determine how viral proteins are developed. Many of the errors have no effect, or they can even make the virus less fit. But a tiny percentage of these changes can give the virus an advantage, making it more infectious or giving it the ability to evade the immune system.

The HIV virus is notorious for its rapid mutation rate. In comparison, SARS-CoV-2 mutates at a much slower rate, partly due to a proof-reading enzyme that limits changes. But with more than 125 million infections worldwide, some errors are bound to slip through.

At the same time, the virus has found devious ways that may avoid its proof-reading mechanism, University of Pittsburgh researchers have found. Rather than making changes in individual RNA letters, it deletes groups of several letters at a time, apparently undercutting the ability of the virus's natural spell-check systems to see the change.

### **74-Day Bout**

Some of the first deletions were seen in an immunocompromised cancer patient treated at the University of Pittsburgh Medical Center who died after a 74-day bout with Covid-19. In that time, multiple immune-escaping deletions developed, according to the University of Pittsburgh's Duprex, who reported on the cancer patient's deletions in November.

"If the damn thing is gone you are not going to be able to fix it," Duprex said.

What makes SARS-CoV-2's future so hard to predict is that viral evolution is like a three dimensional chess game. It's not just the individual mutations that matter, but also the order and combinations in which they occur. A single mutation may alter the virus in subtle ways that change the impact of others down the line, according to Mark Zeller, a scientist at the Scripps Research Institute in San Diego.

### **Shared Mutations**

Both the B.1.351 strain common in South Africa and the P.1 strain that's battering Brazil share several mutations in the spike protein that the virus uses to gain entry into cells. This includes the D614G mutation discovered by Korber, which makes the spike more stable, and the E484K mutation, which is thought to reduce the ability of some antibodies to bind to the spike.

Yet so far, for reasons not fully understood, it's the B.1.351 that's appears to have more impact on Pfizer's and Moderna's vaccines, at least in laboratory tests.

Overall, the track record for eliminating viruses has been poor, with smallpox being the main example. Even pockets of polio are still around in some countries, despite efforts to eliminate it. That doesn't bode well for the current virus, according to Jesse Bloom, a researcher at the Fred Hutchinson Cancer Research Center who studies viral evolution.

"Vaccination is going to take the edge off this pandemic in a very substantial way," Bloom said. "But I don't think we are going to eradicate SARS-CoV-2."

Bloom predicts it will take "a number of years" for the virus to acquire enough mutations to fully escape existing vaccines. Of the roughly 100,000 possible single letter mutations for the virus, fewer than 1% are likely to help the virus evade antibodies, he said.

### **A Hopeful Scenario**

While the virus continues to evolve in the short term, one of the most hopeful scenarios is that it may run out of big moves it can make to evade antibodies that make the current vaccines work. Under this scenario, there may be a practical limit to how much the virus can mutate and remain fit to invade our cells.

The spike protein must retain a shape that allows it to efficiently latch to its human receptor, according to Shane Crotty, a researcher at the La Jolla Institute for Immunology.

"There is not an infinite number of possibilities," he said. "It is like putting your foot in a shoe. It still has to be basically the right shape and size and it still has to be recognizable as a shoe."

Still, evidence from other common cold coronaviruses indicates they can mutate to evade the immune system over time.

In a recent study, Bloom and his colleagues compared the 1984 version of a common cold coronavirus called 229E to a version of the same strain that circulated in 2016, three decades later. Fully 17% of RNA letters in a key part of the spike protein that binds the virus to cells had been swapped out due to mutations. To test what this meant for human immunity, they obtained patient blood samples from the 1980s that could neutralize the 1984 viral strain. These people likely had been exposed to the 1984 virus and developed protective antibodies against it.

## **Faded Protections**

When the researchers tested the samples against strains of the 229E virus that appeared in the 1990s or later, the protection had faded: Only 2 of 8 blood samples were able to neutralize the 2016 strain, and those two showed vastly reduced activity against the most recent virus.

That provides some hints for how much could change in the future, given enough time. "It's pretty clear that human coronaviruses undergo substantial antigenic evolution," Bloom said in an interview.

However, it remains unknown whether the virus can retain its ability to cause severe disease as it mutates and more people gain immunity through infections or vaccines.

In research published in January in the journal *Science*, disease modelers at Emory University found that a key factor will be whether protection against severe illness lasts significantly longer than protection against mild or asymptomatic reinfections, something that's typical of coronaviruses that cause common colds.

While the study was done before the current variants emerged, its basic conclusions hold up, according to Jennie S. Lavine, a postdoctoral researcher at Emory University.

"What we see with Covid-19 on a molecular and cellular level is not inconsistent with what we see with endemic coronaviruses," said Lavine, who was the paper's lead author. "Immunity wanes, but not all of it wanes fast."

<https://www.livemint.com/science/health/covid-mutants-multiply-as-scientists-race-to-decode-variations-11617616553045.html>



