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# समाचार पत्रों से चयित अंश Newspapers Clippings

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Wed, 27 Oct 2021

## India's Stealthy Unmanned Combat Air Vehicle Demonstrator Breaks Cover

*India is jumping into the stealthy drone game, but it will take time to catch up with its rival China's robust pursuits in this arena*

*By Thomas Newdick*

India's unmanned combat air vehicle (UCAV) subscale drone demonstrator has appeared for the first time, revealing details of the flying wing design. The unmanned aerial vehicle, known as the SWiFT, is intended to serve as a proof-of-concept for a planned production combat drone, the Ghatak, which is reportedly being developed primarily as an unmanned bomber.



Photos and video of the SWiFT — which stands for Stealth Wing Flying Testbed — appeared yesterday, apparently showing taxi trials of the demonstrator drone that were likely conducted at the Chitradurga Aeronautical Test Range in the southern state of Karnataka. So far, there has been no official statement from the Indian Ministry of Defense or from the Defense Research and Development Organization (DRDO), the latter of which is in overall charge of the project.

In terms of appearance, the SWiFT corresponds, broadly, with previous artist's concepts and scale models of the drone and, more generally, of those of the Ghatak, with which it shares a flying-wing planform and an engine intake located above the forward fuselage. While the trailing edge of the drone is difficult to make out, it appears to have a classic tailless flying wing profile, providing an overall arrowhead shape, rather than the highly cranked wing found on other stealthy drones, such as the Northrop Grumman X-47B. Its trailing edge is less swept than other designs, like Russia's S-70, for instance.

In terms of size, the SWiFT is estimated to be around 13 feet long, with a wingspan of somewhat over 16 feet, and is thought to weigh approximately 2,300 pounds.

The landing gear on the SWiFT is notably large, likely a reflection of this being essentially a scaled-down demonstrator for the Ghatak, rather than a full-size UCAV in its own right. Previous concept artwork suggested that the drone would incorporate some kind of internal weapons bay, although whether that has been included on this smaller demonstrator is unclear. An array of airdrops and a sensor fairing can be seen on top of the fuselage, but these are certainly related to test work rather than being mission-optimized.

The powerplant for the SWiFT is understood to be a Russian-made NPO Saturn 36MT, a small turbofan otherwise used to power cruise missiles. A view of the drone from the rear suggests that, unlike the Okhotnik in its current form, the design seems to include some kind of shrouded design for the engine exhaust, which would reduce infrared and radar signature from this aspect. Low observable exhausts can be among the most challenging aspects of stealthy designs like this.

What little we know about the highly classified SWiFT and the Ghatak programs comes from unofficial Indian accounts, of which those from the *Livefist* defense website appear to be the most authoritative, but which are also based on off-the-record statements and involve a degree of speculation.

*Livefist* first revealed the existence of the Ghatak program more than a decade ago and, in 2018, published images showing a six-foot scale model of the SWiFT at the Indian Institute of Technology in Kanpur, or IIT-K. This organization is responsible for much of the basic research into these flying wing drones, working alongside the government's Aeronautical Development Establishment (ADE) in Bengaluru.

Back in 2018, it was reported that the SWiFT could make its first flight in 2019 or 2020, but that has clearly been pushed back — a reflection, perhaps, of the considerable ambition behind a program that seeks to provide India with a stealthy unmanned combat air vehicle with an emphasis on extended-range strike capabilities, a class of UAV beyond the reach of all but the leading aerospace powers.

*Livefist* provided the following account of the kinds of mission that the future Ghatak drone might be expected to undertake:

In the broadest sense, the Ghatak is intended to be an aircraft launched covertly near or over hostile territory, evading enemy sensors by virtue of its stealth, and destroying identified targets with air-to-ground weapons. In a broader sense, such stealth could also be used to gather electronic intelligence or covertly conduct airborne surveillance. Primarily though, the Ghatak is simply being developed as an unmanned bomber.

It's been reported that the planned Ghatak drone will be around eight times the size of the SWiFT, although it's not clear if this is in terms of dimensions or weight. A wingspan eight times larger than that of the SWiFT would be in the region of 128 feet, making it roughly twice the size of the Okhotnik. Manufacturing a production drone so much bigger than this initial concept demonstrator would be an enormous undertaking just in terms of process, and there is no guarantee that the Indian aerospace industry will be capable of making that leap, at least without any kind of incremental steps along the way. Furthermore, the aircraft's engine layout and its overall design are not evidentiary of that size of an aircraft. It is far more likely that Ghatak's size will end up being scaled up accordingly, bringing it more in line with designs like the Okhotnik and other UCAV concepts, or even a bit smaller or even larger based on the IAF's requirements.

Whatever its eventual size, the Ghatak project is clearly an enormously important one that could bring a significant regional and even strategic advantage to the Indian Air Force, if realized.

Importantly, however, India is now playing serious catchup to China when it comes to developing combat drones of this type. China, which is increasingly becoming a major regional antagonist to India, already has developed the Sharp Sword stealthy flying wing UCAV, with later iterations of what the People's Liberation Army designates the GJ-11 also featuring refined low-observable features, including a stealthier exhaust. This is not the only flying-wing combat drone developed by China, with the broadly similar CH-7 and the significantly smaller Tian Ying also having been offered for export, among others. With that in mind, India's efforts to field a similar system may also simply be about achieving some kind of parity with China.

Admittedly, India has so far made limited progress in fielding indigenous drones, armed or otherwise, with the country currently primarily fielding Israeli-supplied surveillance UAVs and loitering munitions.

More recently, though, there have been concerted efforts toward developing more advanced homegrown drone technologies, including a loyal-wingman-type program, the Hindustan Aeronautics Limited (HAL) Combat Air Teaming System (CATS) Warrior.

CATS Warrior is planned as part of a family of loyal wingman aircraft and associated systems, including small swarming drones, a remote weapons carrier launched by manned fighters, and even a drone control aircraft based on the HAL Tejas fighter jet, the Mothership for Air-teaming eXploitation (MAX). While the CATS Warrior also employs a stealthy design, the Ghatak, as

planned, will apparently be larger by an order of magnitude — an altogether more ambitious undertaking.

In 2018, it was predicted that the full-size Ghatak could take to the air in 2024 or 2025, but that would seem unlikely if, in fact, SWiFT just commenced taxi trials. The video could be of a past test, as well, although a date stamp indicates it was from this summer. What's more, with a stated ambition to develop all the critical technologies for the Ghatak in India, any potential for delay is significant. As well as limited experience of indigenous combat drones of any size, India has also never previously produced a stealthy aircraft either, with earlier plans to collaborate on a version of the Russian Sukhoi Su-57 advanced fighter having been abandoned.

It had been predicted that the indigenous Kaveri engine would power the Ghatak, but with that powerplant having faced a catalog of problems and delays, a foreign engine might still emerge as a more realistic option.

There also have been reports that France's Dassault may provide assistance for the Ghatak, perhaps leveraging the work it has already done on its nEUROn stealthy combat drone demonstrator.

Then there is the question of budget. While a flagship "Made in India" project like this one is clearly a matter of prestige, there is a real operational need for such a system. With the growing threat posed by China, a survivable unmanned attack aircraft with a robust range could be key in dismantling air defenses and hitting critical fixed targets during the opening stages of a conflict. There is no shortage of Chinese combat mass along India's northern border and it's only growing with each day.

Meanwhile, the Indian Air Force is firmly focused on addressing its aging manned fighter fleet and its dwindling number of operational fighter squadrons. On top of that, the Ghatak could face competition for funds from the indigenous HAL Advanced Medium Combat Aircraft (AMCA) fifth-generation manned fighter program, which is also intended to feature stealth technologies.

In 2018, the Ghatak program was said to be operating on "a shoe-string budget." Two years later, it was said to be "a fully funded and sanctioned national defense project," but the cloak of secrecy around the project means little more than that is known.

Only time will tell whether the Ghatak project results in anything approaching an unmanned bomber. In the meantime, however, the start of meaningful tests of the SWiFT demonstrator is an important step toward establishing an indigenous capacity to develop high-end combat drones of the type now proliferating in China and elsewhere.

<https://www.thedrive.com/the-war-zone/42875/indias-secretive-stealthy-unmanned-combat-air-vehicle-demonstrator-breaks-cover>

# Defence Strategic: National/International



Press Information Bureau  
Government of India  
Ministry of Defence

*Tue, 26 Oct 2021 11:11AM*

## Indo-Pacific regional dialogue 2021: 27 to 29 Oct 2021

First conducted in 2018, the Indo-Pacific Regional Dialogue (IPRD) is the apex international annual conference of the Indian Navy, and is the principal manifestation of the navy's engagement at the strategic-level. The National Maritime Foundation is the navy's knowledge partner and chief organiser of each edition of this annual event. The aim of each successive edition of the IPRD is to review both opportunities and challenges that arise within the Indo-Pacific. IPRD-2018 focussed on four main sub-themes: maritime trade; regional connectivity; pan-regional challenges such as those of persistent maritime surveillance, the increasing digitisation of the maritime space, and cyber-malevolence within the maritime domain; and, the role of industry in enhancing holistic maritime security. IPRD 2019 built upon the excellent foundation laid by the inaugural edition and examined five themes: practical solutions for achieving cohesion in the region through maritime connectivity; measures to attain and maintain a free and open Indo-Pacific; examining a regional approach to Blue Economy; opportunities from Maritime-Industry 4.0; and, regional opportunities arising from SAGAR and SAGARMALA.

IPRD 2021 is being held as a three-day online event on 27, 28, and 29 October 2021. This year's IPRD will focus on eight specific sub-themes under the broad theme of "Evolution in Maritime Strategy during the 21st Century: Imperatives, Challenges, and, Way Ahead". Panel-discussions on these sub-themes would be spread over eight sessions on three successive days thereby providing ample scope for varied perspectives to be considered. The aim is to encourage a free flow of ideas and views. The eight sub-themes are:

1. Evolving Maritime Strategies within the Indo-Pacific: Convergences, Divergences, Expectations and Apprehensions.
2. Adaptive Strategies to Address the Impact of Climate Change upon Maritime Security.
3. Port-led Regional Maritime Connectivity and Development Strategies.
4. Cooperative Maritime Domain Awareness Strategies.
5. Impact of the Increasing Recourse to Lawfare upon a Rules-based Indo-Pacific Maritime Order.
6. Strategies to Promote Regional Public-Private Maritime Partnerships.
7. Energy-Insecurity and Mitigating Strategies.
8. Strategies to Address the Manned-Unmanned Conundrum at Sea.

The sessions will be preceded by addresses by the Hon'ble Raksha Mantri, the Hon'ble External Affairs Minister, and the Hon'ble Minister for Petroleum and Natural Gas.

Through this annual dialogue, the Indian Navy and the National Maritime Foundation, continue to provide a platform for incisive discussions pertaining to the geopolitical developments affecting the maritime domain of the Indo-Pacific.

<https://pib.gov.in/PressReleasePage.aspx?PRID=1766500>



## हिन्द-प्रशांत क्षेत्रीय संवाद 2021 का 27 से 29 अक्टूबर, 2021 तक आयोजन

वर्ष 2018 में पहली बार आयोजित होने वाला हिन्द-प्रशांत क्षेत्रीय संवाद (आपीआरडी) भारतीय नौसेना का सर्वोच्च अंतर्राष्ट्रीय वार्षिक सम्मेलन और सामरिक स्तर पर नौसेना की सक्रियता प्रकट करने का प्रमुख माध्यम है। नेशनल मैरीटाइम फाउंडेशन, भारतीय नौसेना का ज्ञानाधारित साझेदार है और इस कार्यक्रम का वार्षिक रूप से आयोजन करने में मुख्य भूमिका निभाता है। आईपीआरडी के हर आयोजन का उद्देश्य हिन्द-प्रशांत क्षेत्र में उभरने वाली चुनौतियों और अवसरों का जायजा लेना है। आईपीआरडी-2018 ने चार उप-विषयों पर विशेष ध्यान दिया था: समुद्री व्यापार, क्षेत्रीय संपर्कता, पूरे क्षेत्र की चुनौतियां, जिनमें लगातार समुद्री निगरानी, समुद्री गतिविधियों के डिजीटलीकरण को बढ़ाना, समुद्री क्षेत्र के भीतर साइबर खतरे और समुद्री सुरक्षा के आमूल विकास में उद्योगों की भूमिका शामिल थी। आईपीआरडी-2019 का आयोजन इस सम्मेलन के पहले आयोजन की शानदार बुनियाद पर हुआ था। इस दौरान पांच विषयवस्तुओं पर चर्चा की गई थी: समुद्री संपर्कता के जरिये क्षेत्र में आपसी जुड़ाव के लिये व्यावहारिक समाधान, हिन्द-प्रशांत को मुक्त रखने के उपाय, नील अर्थनीति (ब्लू इकोनॉमी) के मद्देनजर क्षेत्रीय संभावनाओं की पड़ताल, समुद्री-उद्योग 4.0 से उत्पन्न अवसर और सागर तथा सागरमाला से उत्पन्न क्षेत्रीय संभावनायें।

आईपीआरडी-2021 का आयोजन ऑनलाइन किया जा रहा है। यह तीन दिन का कार्यक्रम है, जो 27, 28 और 29 अक्टूबर, 2021 तक होगा। इस साल के आईपीआरडी का फोकस आठ विशेष उप-विषयों पर है, जो एक विस्तृत विषयवस्तु "इवोल्यूशन इन मैरीटाइम स्ट्रेटजी ड्यूरिंग दी ट्वेंटी-फर्स्ट सेंचुरी: इम्पैरेटिव्स, चैलेंजेस एंड वे अहेड" (21वीं शताब्दी के दौरान सामुद्रिक रणनीति का क्रमिक विकास: अनिवार्यतायें, चुनौतियां और आगे की राह) के तहत रखे गये हैं। इन उप-विषयों पर आठ सत्रों में पैनल चर्चा होगी, जो तीन दिन चलेगी। इस तरह विभिन्न परिप्रेक्ष्यों में चर्चा करने का पर्याप्त अवसर मिलेगा। ये आठ उप-विषय हैं:-

1. हिन्द-प्रशांत क्षेत्र में सामुद्रिक रणनीति का विकास: समरूपतायें, भिन्नतायें, अपेक्षायें और आशंकायें
2. सामुद्रिक सुरक्षा पर जलवायु परिवर्तन के दुष्प्रभाव के समाधान के लिये अनुकूल रणनीतियां
3. बंदरगाह सम्बंधी क्षेत्रीय सामुद्रिक संपर्कता और विकास रणनीतियां
4. सहयोगात्मक सामुद्रिक कार्यक्षेत्र जागरूकता रणनीतियां
5. नियम-आधारित हिन्द-प्रशांत सामुद्रिक प्रणाली को मद्देनजर रखते हुये शत्रु भावना के तहत कानूनी प्रक्रियाओं और सिद्धांतों की अवहेलना के बढ़ते चलन का दुष्प्रभाव
6. क्षेत्रीय सार्वजनिक-निजी सामुद्रिक साझेदारी को प्रोत्साहन देने वाली रणनीतियां
7. ऊर्जा-असुरक्षा और उसे कम करने वाली रणनीतियां
8. मानवकृत और स्वयमेव उत्पन्न समुद्री समस्याओं का समाधान करने वाली रणनीतियां

सत्रों के बाद रक्षामंत्री, विदेश मंत्री और पेट्रोलियम एवं प्राकृतिक गैस मंत्री संबोधित करेंगे।

इस वार्षिक संवाद के जरिये भारतीय नौसेना और नेशनल मैरीटाइम फाउंडेशन लगातार एक ऐसा मंच प्रदान कर रहे हैं, जहां हिन्द-प्रशांत के सामुद्रिक क्षेत्र को प्रभावित करने वाली भू-राजनीतिक गतिविधियों पर सघन चर्चा हो सके।

<https://pib.gov.in/PressReleasePage.aspx?PRID=1766541>



*Tue, 26 Oct 2021 5:40PM*

## **Sea phase of India-UK maiden Tri-Service exercise 'Konkan Shakti 2021' in full swing**

The sea phase of maiden Tri-Service exercise 'Konkan Shakti 2021' between the Armed Forces of India and United Kingdom (UK) is being held off the Konkan coast in the Arabian Sea. On completion of harbour planning phase, the sea phase of the exercise commenced on October 24, 2021. It will continue till October 27, 2021.

All participating units were split into two opposing forces with the aim of achieving sea control to land Army ground-troops at a pre-designated site. One force was led by the Flag Officer Commanding Western Fleet and comprised the flag ship INS Chennai, other warships of the Indian Navy and HMS Richmond, the Royal Navy's Type 23 frigate. The other force operated under the UK Carrier Strike Group comprising aircraft carrier, HMS Queen Elizabeth, other UK and Netherland naval ships and Indian warships.

The two forces integrated within their groups with exercises such as replenishment at sea approaches, air direction and strike operations by fighter aircraft (MiG 29Ks and F35Bs), cross control of helicopters (Sea King, Chetak and Wildcat), transiting through war-at-sea scenarios and gun shoots on expendable air targets. The simulated induction of Army troops was also undertaken, followed by setting up of a joint command operations centre. Thereafter, the two forces effected a rendezvous at sea with advanced air and sub-surface exercises.

The air operations included strikes on the combined formation by Indian maritime patrol aircraft (MPA) Dornier, fighters of the Indian Navy (MiG 29Ks), Royal Navy (F35Bs) and Indian Air Force (SU-30 and Jaguars) as well as a composite fly past over the formation. Sub-surface exercises with an Indian Scorpene class submarine and underwater remote controlled vehicle EMATT, operated by the Royal Navy, were undertaken through the night. Indian MPA, P8I also participated in the exercise.



<https://pib.gov.in/PressReleasePage.aspx?PRID=1766666>



## Navy, top ministers to brainstorm on Indo-Pacific strategy

*IPRD-2021 will focus on eight specific sub-themes, including evolving maritime strategies within the Indo-Pacific region, port-led regional maritime connectivity, development strategies, adaptive strategies to address the impact of climate change and cooperative maritime domain awareness strategies.*

*By Anish Kumar*

The Indian Navy and the National Maritime Foundation will commence the third edition of the Indo-Pacific Regional Dialogue from Wednesday in a virtual format to discuss the maritime strategies and the geopolitical developments affecting the maritime domain in the region.

The objective of the three-day online event, which will be attended and addressed by Defence Minister Rajnath Singh, External Affairs Minister S Jaishankar and Petroleum and Natural Gas Minister Hardeep Singh Puri, will be to encourage a free flow of ideas and views through a range of panel discussions. The theme of IPRD-2021 is 'Evolution in Maritime Strategy during the 21st Century: Imperatives, Challenges, and, Way Ahead'.



IPRD-2021 will focus on eight specific sub-themes, including evolving maritime strategies within the Indo-Pacific region, port-led regional maritime connectivity, development strategies, adaptive strategies to address the impact of climate change and cooperative maritime domain awareness strategies.

Panel discussions will also be held on the impact of the increasing recourse to lawfare upon a rules-based Indo-Pacific order, to promote regional public-private maritime partnerships, energy-insecurity and mitigating strategies and to address the manned-unmanned conundrum at sea. Through this annual dialogue, the Indian Navy and the National Maritime Foundation provide a platform for incisive discussions pertaining to the geopolitical developments affecting the maritime domain of the Indo-Pacific.

Conceptualised in 2018, the IPRD is the apex international annual conference of the Indian Navy and is the principal manifestation of the navy's engagement at the strategic level. Last year, India had reiterated its commitment to meaningfully contribute to the creation and consolidation of an Indo-Pacific built upon five key pillars which included Peace, prosperity, respect, dialogue and cooperation.

<https://newsable.asianetnews.com/india-defence/navy-top-ministers-to-brainstorm-on-indo-pacific-maritime-strategy-r11792>

Wed, 27 Oct 2021

## Chief of General Staff of British Army meets General MM Naravane

New Delhi [India], October 26 (ANI): Chief of the General Staff of the British Army General Sir Mark Carleton-Smith called on Indian Army Chief General MM Naravane on Tuesday and exchanged views on enhancing the bilateral defence cooperation between the two armies.

Taking to Twitter, Additional Directorate General of Public Information- Indian Army said, "General Sir Mark Carleton-Smith, Chief of the General Staff, British Army called on General MM Naravane COAS and exchanged views on further enhancing the bilateral defence cooperation between two Armies. Defence Cooperation India UK Friendship" Earlier in the day, General Carleton-Smith laid a wreath at National War Memorial and received a Guard of Honour at the South Block.



The British officer is on a four-day visit to India. (ANI)

<https://www.aninews.in/news/national/general-news/chief-of-general-staff-of-british-army-meets-general-mm-naravane20211026233209/>

## THE TIMES OF INDIA

Wed, 27 Oct 2021

## Pune: Army Chief General MM Naravane to review NDA parade

*By Sandip Dighe*

Pune: The chief Of Army staff General MM Naravane will review the passing out parade of 141th course of the National Defence Academy on October 29 at Khadakwasla.

The chief, who is alumni of the NDA and belongs to the 56th course, as a reviewing officer of the parade will address the cadets and give awards to the meritorious passing out cadets on the occasion.

This will be the fourth passing out parade which will be conducted under strict Covid - 19 norms. The academy had not invited parents, guests and media for the last three parades due to the pandemic restrictions.

The parade marks the completion of the three years rigorous training at the academy for the passing out cadets.

The passed out army cadets join the Indian Military Academy (IMA), Dehradun, Air Force Academy in Dundigal and Indian Naval Academy in Ezhimala in Kerala for completion of one more year of military training before commissioning into the respective forces.

Two batches /courses of the cadets pass out from the NDA every year. Each batch contains over 300 cadets including foreign national cadets.

<https://timesofindia.indiatimes.com/city/pune/pune-army-chief-general-mm-naravane-to-review-nda-parade/articleshow/87286605.cms>



Army chief General MM Naravane (File photo)

## Navy ready to push Predator drone acquisition with Modi govt

*Defence minister Rajnath Singh and external affairs minister S Jaishankar will meet their US counterparts, secretary of state Antony Blinken and defense secretary Lloyd Austin, in December in Washington with both sides on verge of finalisation of dates.*

*By Shishir Gupta*

New Delhi: With the India-US two plus two dialogue scheduled in December, all eyes are on the Indian Navy to move the Defence Acquisition Council (DAC) for possible announcement of the \$3 billion procurement of armed Predator drones from Washington to strengthen India's beyond the horizon capabilities.

According to officials based in New Delhi and Washington, defence minister Rajnath Singh and external affairs minister S Jaishankar will meet their US counterparts, secretary of state Antony Blinken and defense secretary Lloyd Austin, in December in Washington with both sides on verge of finalisation of dates.



Prime Minister Narendra Modi had met the CEO of General Atomics during his visit to Washington on September 23. (File Photo)

While the stabilisation of drought facing Taliban-ruled Afghanistan and the Indo-Pacific in light of Chinese aggressive postures will be top of the agenda, there is a possibility of the two sides announcing the Predator deal provided the due government processes are completed. It is understood that the Indian Navy is ready to move the DAC for Acceptance of Necessity (AON) for acquisition of 30 MQ 9A Predator drones from General Atomics with each of the three services getting 10 Hell-Fire missile firing drones. As the Indian Navy is already operating two leased Predator drones for maritime domain awareness beyond the Straits of Malacca to Gulf of Aden, the acquisition process is being handled by them for both the Indian Air Force and the Indian Army. Despite initial reservations of the Indian Air Force, all services are on board on Predator acquisition.

“The process is on. It involves the concurrence of the Cabinet Committee on Security (CCS) after DAC clearance. The announcement can be done provided the process is complete before the two plus two dialogue or else it will be announced later,” said a top South Block official with the Indian Navy confirming that the US had clarified to their satisfaction about the project.

Incidentally, Prime Minister Narendra Modi had met the CEO of General Atomics, which is the leading US manufacturer of armed drones, during his visit to Washington on September 23.

In the context of the US getting permission to use Pakistani air space for maintaining beyond the horizon capabilities to target terrorists in Afghanistan, India also needs to strengthen its drone capabilities as the indigenous development of armed drones has miles to go. “Pakistan denial on allowing the US the use of its air space for beyond the horizon operations in Afghanistan must be taken with a pinch of salt, just as its denial of the presence of al Qaeda chief Osama bin Laden in the past. One of the key reasons why the US did not want India to respond to Islamabad after the Parliament and Kaluchak terror attacks was due to the presence of US special forces in Pakistan after the 9/11 attacks. This was conveyed by then defense secretary Donald Rumsfeld to India in 2002,” said a Pakistan watcher.

The Indian requirement for Predator armed drones has grown with China not only acquiring the capability but selling the Wing Loong armed drone to Pakistan, which can launch up to 12 air to surface missiles. Islamabad close ally Turkey has also acquired the armed drone capability with

Bayraktar series of drones being used in Libya and Syria theatres and by Azerbaijan against Armenia in the 2020 Nagorno-Karabakh war.

<https://www.hindustantimes.com/india-news/navy-ready-to-push-predator-drone-acquisition-with-modi-govt-101635223209305.html>



Wed, 27 Oct 2021

## How \$3 billion contract for 30 Predator drones with the US will help India

*The drone deal comes after Prime Minister Narendra Modi met Vivek Lall, CEO of General Atomics, during his visit to Washington on 23 September*

If all goes as planned, India will ink a \$3 billion deal with the United States for 30 MQ-9 Reaper or Predator B armed drones when the two countries sit down for the 2+2 dialogue scheduled for December.

Defence Minister Rajnath Singh and External Affairs Minister S Jaishankar will meet their US counterparts,



Secretary of State Antony Blinken and Defence Secretary Lloyd Austin, in December in Washington where the final contract will be signed.

As India prepares to include the MQ-9 Reaper in its arsenal, take a look at the drone and how it will benefit Indian Armed Forces.

### What Are Predator Drones?

Named as 'MQ-9 Reaper' by the US Air Force and Royal Air Force customers, the Predator B is a Remotely Piloted Aircraft (RPA).

The MQ-9 is the first hunter-killer UAV designed for long-endurance, high-altitude surveillance.

The Reaper has a 950-shaft-horsepower (712 kW) turboprop engine, allowing it to carry 15 times more ordnance payload and cruise at about three times the speed of its predecessor.

The craft can be flown for over 27 hours in the air at a maximum altitude of 50,000 feet.

According to defence contractors General Atomics, the drones possess the capabilities to be used for long-endurance intelligence, surveillance and reconnaissance missions over a wide-area. Easy configuration of the drone makes it easier to operate the aircraft during missions.

### India's Predator Deal

The Predator deal first took root in the erstwhile Trump administration. In 2017, when Narendra Modi had visited the US, the two heads had discussed the deal after the Indian Army had shown interest in purchasing General Atomics Avenger UAV.

However, the deal didn't materialise then.

It was then announced in March of 2021 that the Indian Navy, Army and Air Force would finally jointly procure 30 armed versions of the American unmanned aerial system in what could be a \$3 billion deal.

The procurement is being done as India faces a war-like situation on two fronts — Pakistan and China.

It's important for India to acquire these armed drones as its own indigenous capability is limited.

Meanwhile, both Beijing and Islamabad operate Chinese-made armed drones. Pakistan is also eyeing to acquire some armed drones from Turkey.

The news of the acquisition comes on the heels of Narendra Modi meeting Vivek Lall, the Chief Executive at General Atomics Global Corporation, during his September visit to Washington.

### India's Recent Leased Drones

India is the third largest importer of (military grade) UAVs, with 6.8 percent share of the total UAV transfers or deliveries reported across the globe ending 2020, according to Stockholm International Peace Research Institute's (SIPRI) Arms Transfers database.

India's first UAV import was reported in 1998 from Israel, as per SIPRI's records. Most of the country's imported drones are surveillance and reconnaissance types.

Recently, India also signed a lease with Israel for four advanced Heron surveillance drones, which will be deployed along the Line of Actual Control with China for long surveillance missions.

### Importance of Drones in Future Warfare

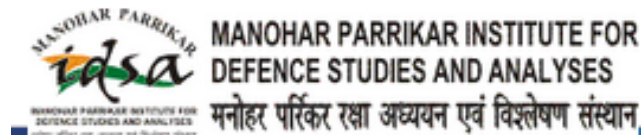
Drones have become an integral part of warfare. Indian Army Chief, General Manoj Mukund Naravane, in a webinar organised by Centre for Land Warfare Studies, also highlighted the role of drones in military warfare.

The Indian Army Chief said that everyone has seen how the very imaginative and offensive use of drones in Idlib and then in Armenia-Azerbaijan, challenged the traditional prima donnas: the tanks, the artillery and the dug-in infantry.

Naravane also said that swarm drones could overwhelm and effectively suppress an enemy's air defence capability, creating windows of opportunities for strike elements. "It is also no longer necessary to score a physical hit to destroy a target.

"Offensive capabilities in the digital domain can effectively neutralise satellites and networks, denying them at critical juncture to decisively alter the course of the conflict," he had stated.

<http://www.indiandefensenews.in/2021/10/how-3-billion-contract-for-30-predator.html>



Wed, 27 Oct 2021

## Evolving idea of the Quad: Emerging Technology

*By Niranjana Chandrashekar Oak*

Over the years, the Quadrilateral Security Dialogue (Quad) has expanded its agenda to adapt itself to face the gen-next threats in the Indo-Pacific, most notably the emerging technology. The Quad was created as an ad hoc group to help the Indo-Pacific littoral states in the aftermath of the Tsunami in 2004. Although the first iteration of the Quad in 2007 was short-lived, the latest iteration promises that Quad is here to stay for decades to come. This inference can be reached based on the expansive agenda that the Quad has drawn for itself, which looks beyond narrow security calculations in the region. The first in-person summit of the Quad leaders delved upon not only the security situation in the Indo-Pacific but also multiple areas, including the supply of COVID-19 vaccines, climate crisis, terrorism and emerging technology. By making the emerging technology one of the cornerstones of the grouping, the Quad has shown its resilience to stay relevant in the fast-changing strategic environment of the Indo-Pacific. Therefore, it is pertinent to look at the



evolution of the second iteration of the Quad and how the minilateral is seamlessly synergising technology with its original agenda of security.

### **Evolution of the Quad**

Amid the belligerent behaviour of China in the maritime continuum of the Indo-Pacific and growing trust and comfort between the four democracies<sup>1</sup>, the Quad re-emerged on the sidelines of the 31st Association of Southeast Asian Nations (ASEAN) Summit and 12th East Asia Summit in Manila, 2017. Four working-level meetings—November 2017, June 2018, November 2018 and May 2019—involving officials from the foreign ministries of Delhi, Washington, Tokyo and Canberra focused on “a free, open, prosperous and inclusive Indo-Pacific region” benefitting all in the region and the world at large.<sup>2</sup> They also touched upon connectivity, sustainable development, counter-terrorism, non-proliferation, humanitarian assistance and disaster relief (HADR), cyber security and ASEAN centrality.<sup>3</sup> The separate statements from the four capitals also mentioned about the respect for sovereignty, equality and territorial integrity of all nations in a transparent, economically viable and financially responsible manner.<sup>4</sup>

In September 2019, the working-level meeting of the Quad was elevated to the ministerial-level meeting when the United States (US) Secretary of State Mike Pompeo hosted his counterparts from India, Japan and Australia in New York. Although the leaders did not issue a joint statement post meeting, the issues raised were similar to those raised during the working-level meetings.<sup>5</sup> The first ministerial meeting saw a limited expansion of the agenda as the Quad countries “conducted a tabletop counter-terrorism exercise in November 2019 and convened a meeting of cyber experts the following month”.<sup>6</sup> As COVID-19 gripped the world in early 2020, the senior officials’ consultation of the four countries “underscored the importance of enhancing the resilience of supply chains” and added pandemic and best practices to deal with the same in the agenda of the meeting.<sup>7</sup> The second ministerial meeting of the Quad in Tokyo, held in October 2020, discussed “post COVID-19 international order” and issues related to “the resilience of supply chains” in addition to the maritime security issues of the Indo-Pacific.

### **Emergence of Technology as a Cornerstone**

COVID-19 and the subsequent behaviour of China raised many questions regarding China’s commitment to rise as a responsible international player. China’s tendency to weaponise trade and technology became obvious. China punished Australia in the domain of trade as the latter demanded a fair enquiry into the origin of COVID-19. Moreover, reports emerged about the Chinese quest to snoop the foreign governments by using 5G mobile network technology<sup>8</sup> and meddle in the country’s internal affairs<sup>9</sup>. Earlier, in 2017, China enacted the National Intelligence Law that made it mandatory for the Chinese firms to cooperate with its intelligence agencies by giving free access to their data within and without China.<sup>10</sup> Thus, the law violated the digital sovereignty of the nations where Chinese firms had market access in accordance with the international law. In view of the Chinese threat in the realm of emerging technologies, the Quad proved deft enough to adapt to the new reality.

The joint statement following the Quad leaders’ virtual summit in March 2021 mentioned “critical technologies” three times. The leaders resolved that the Quad “will begin cooperation on the critical technologies of the future to ensure that innovation is consistent with a free, open, inclusive, and resilient Indo-Pacific”.<sup>11</sup> The minilateral group also launched “a critical- and emerging-technology working group to facilitate cooperation on international standards and innovative technologies of the future”.<sup>12</sup> Building on the spirit of technological cooperation, the Quad took a holistic view of the emerging technologies and associated issues. In the realm of 5G mobile networks, the Quad, during the first-ever in-person summit in September 2021, decided to deploy “secure, open, and transparent 5G and beyond-5G networks” from trustworthy vendors. The statement exuded confidence about coming up with the “open, standards-based 5G technology”. Individually, the Quad countries devised formal and informal policies to deny entry to untrustworthy telecom vendors.<sup>13</sup> The leaders also announced sector-specific contact groups to develop technical standards for emerging technologies. They launched the Quad Principles on

Technology Design, Development, Governance, and Use with the purpose of “guiding not only the region but the world towards responsible, open, high-standards innovation”.<sup>14</sup>

Sensing the vulnerabilities in the supply chains, the Quad leaders decided “to map the supply chain of the critical technologies and materials”<sup>15</sup> and diversify the same. Further, India, Japan and Australia launched Supply Chain Resilience Initiative (SCRI) to counter Chinese dominance of the supply chains in the region.<sup>16</sup> The need to diversify the supply chains away from China was felt intensely in the light of deteriorating relations between China and members of Quad. As Amitendu Palit has argued, the repositioning of strategic supply chains, especially in the field of semiconductors and telecommunications, was part of a broader strategy to decouple from China and “to develop a coalition of like-minded countries for taking on an assertive China in the Indo-Pacific”.<sup>17</sup> In the realm of Artificial Intelligence, the Quad countries are working with other like-minded countries for an initiative titled “Global Partnership on Artificial Intelligence”<sup>18</sup> under the auspices of the Organisation for Economic Co-operation and Development (OECD) that promotes inclusive and responsible use of Artificial Intelligence.

Domestically, India is taking baby steps to shape the rules and norms *vis-à-vis* emerging technologies such as 5G and Artificial Intelligence on international platforms. The country is debating the issues related to data sovereignty vigorously. It has also come up with an Approach Document on Artificial Intelligence.<sup>19</sup> Bilaterally, India is collaborating with like-minded countries in the field of emerging technologies. India and Japan signed a Memorandum of Understanding in January 2021, to enhance cooperation in Information and Communications Technologies, covering 5G technologies, telecom security, submarine optical fibre cable system to islands of India, and spectrum management, among others.<sup>20</sup> Similarly, India and Australia have set up the India–Australia Joint Working Group on Cyber Security Cooperation.<sup>21</sup> The two countries have also signed the Memorandum of Understanding on critical minerals.<sup>22</sup> India is also cooperating with ASEAN for capacity building and knowledge sharing in the areas of Internet of Things (IoT) and 5G, among others, to achieve the ASEAN Digital Masterplan 2025 (ADM2025).<sup>23</sup> Separately, India and the US have resolved to “revive the High Technology Cooperation Group (HTCG) in early 2022, to accelerate high technology commerce in key areas”.<sup>24</sup> In October 2020, India joined Japan and Five Eyes Alliance countries to demand access to end-to-end encrypted communication from big tech companies.<sup>25</sup>

Thus, in addition to its existing agenda of securing free and open Indo-Pacific, the Quad is fast embracing the emerging technology as a critical area to build upon. By spindling around the emerging technologies, the Quad is successfully expanding horizontally. Similarly, with the initiatives such as the Quad plus—which included the foreign secretary-level meeting of New Zealand, Vietnam, South Korea and the foreign ministers-level meeting of Brazil, South Korea, Israel to discuss COVID-19—the Quad is stretching laterally. As authoritarian societies are better equipped to extract data from their citizens than free societies<sup>26</sup>, the Quad is trying to offer an alternative model different from the coercive vision of the authoritarian states in the Indo-Pacific. With the emerging technology intruding into our daily lives and changing how nations create power and wield it against one another<sup>27</sup>, the Quad is proving to be a prudent minilateral to cope with the technological churn in the Indo-Pacific.

*Views expressed are of the author and do not necessarily reflect the views of the Manohar Parrikar IDSA or of the Government of India.*

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## India, UK conduct mega tri-services wargame in Arabian Sea

New Delhi: India and the UK are carrying out a series of complex military drills as part of a tri-services wargame in the Arabian Sea, billed as the most ambitious exercise by the two countries ever.

The UK's Carrier Strike Group (CSG) led by its largest warship HMS Queen Elizabeth and several other frontline ships of the two navies are participating in the week-long 'Konkan Shakti' exercise that began on October 21, officials said.

A carrier battle group or carrier strike group is a mega naval fleet comprising an aircraft carrier, accompanied by a large number of destroyers, frigates and other ships.

The UK is only the third country after the US and Russia with which India is conducting a tri-services exercise.

Indian Navy's MiG 29K jets, the Royal Navy's F-35B aircraft and Indian Air Force's SU-30 and Jaguar fighters were among the key assets deployed for the exercise, the officials said.

Indian Navy Spokesperson Commander Vivek Madhwal said the sea phase of the maiden tri-service exercise commenced off the Konkan coast in the Arabian Sea on Sunday after the completion of an exhaustive harbour phase.

The British High Commission said personnel of all three services from both countries were participating in the tri-service exercise and described it as the "most ambitious conducted by the two countries to date".

It said the exercise is another step in deepening bilateral defence and security ties and boosting strategic cooperation in the Indo-Pacific region.

The high commission said the exercise provides an opportunity for the armed forces of two outward-looking, confident democracies to work in synergy and uphold our shared commitment to peace and security.

"The CSG's engagement with India showcases the deepening comprehensive strategic partnership. Both the Indian and the Royal Navy are blue-water, multi-carrier navies, which places us in a very exclusive club," said First Sea Lord Admiral and Chief of Naval Staff of the UK Admiral Tony Radakin.

"Our growing interactions are a testimony to the shared commitment to a rules-based international system, a belief in the values of open trade, and in the importance of the freedom of the high seas- a right conveyed on all nations," he said.

Elaborating on the sea phase of the exercise, Commander Madhwal said all participating units were split into two opposing forces with the aim of achieving 'sea control' to land Army ground-troops at a pre-designated site.

He said one force comprised INS Chennai, other warships of the Indian Navy as well as HMS Richmond, the Royal Navy's Type 23 frigate.

The other force was operated under the UK's Carrier Strike Group comprising aircraft carrier HMS Queen Elizabeth, other UK and Netherland naval ships, and Indian warships.

"The two forces integrated within their groups with exercises such as replenishment at sea approaches, air direction and strike operations by fighter aircraft (MiG 29Ks and F35Bs), cross



Aircraft flying in a formation over HMS Queen Elizabeth during the 'Exercise Konkan Shakti 2021' of Indian & UK Armed Forces (ANI)

control of helicopters (Sea King, Chetak and Wildcat), transiting through war-at-sea scenarios," he said.

The official said the simulated induction of Army troops was also undertaken and was followed by the setting up of a joint command operations centre. The two forces thereafter effected a rendezvous at sea with advanced air and sub-surface exercises.

The air operations included strikes on the combined formation by Indian maritime patrol aircraft (MPA) Dornier, fighters of the Indian Navy MiG 29Ks, Royal Navy's F35Bs and Indian Air Force's SU-30 and Jaguar jets, he said.

Commander Madhwal said sub-surface exercises with an Indian Scorpene-class submarine and underwater remote-controlled vehicle EMATT, operated by the Royal Navy, were undertaken through the night.

He said the superior level of interoperability displayed during the exercise reflected the high standards of professionalism and preparedness of both navies.

"It is also reflective of a high level of mutual trust and understanding that has been built over a period of many years," the official said.

<https://timesofindia.indiatimes.com/india/india-uk-conduct-mega-tri-services-wargame-in-arabian-sea/articleshow/87277736.cms>

## FINANCIAL REVIEW

Wed, 27 Oct 2021

### **Why the world is focused on hypersonic missiles**

*The US still attracts the world's best minds, but China's latest test of military hardware shows it is very much in the nuclear arms race*

*By Jeremy Cliffe*

On October 16, the *Financial Times* reported that China had on July 27 and August 13 this year successfully tested two nuclear-capable hypersonic missiles. This development, the newspaper reported, "stunned" US officials and "caught US intelligence by surprise" (China officially denies the tests took place).

The shock was compounded by the news, on October 21, that the US had delayed its own latest hypersonic missile test due to rocket failure. Though the booster rocket in question did not involve the hypersonic technology, it added to the sense of Beijing having stolen a march on Washington in this decisive new field of competition.

The race for hypersonic missile technology is significant in itself. The US, China and Russia have in recent years all been locked in a competition to master it. The term "hypersonic" implies speeds between Mach 5 and Mach 10 (so five to 10 times the speed of sound).

But the three traits that set such technology apart from conventional intercontinental ballistic missiles (ICBMs) are not about speed but direction: they glide, travel in a low orbit and are more manoeuvrable than ICBMs, all of which makes them harder to track and destroy. If China masters such missiles, that gives it capabilities that the US lacks.

James Black, defence researcher at RAND, says: "The ability to change the flight path, potentially multiple times, rather than follow a predictable arc like a typical ballistic missile or rocket does, means you can more easily avoid detection, evade defensive counter-measures or seek to conceal your intended target until relatively close to impact."

But the news also captures a wider and more fundamental story. For most of the Cold War, the US and USSR economies were pitted against each other in the quest to build the biggest stockpiles of broadly similar weapons. In the contest between the US and China, the goal is not to be the

wealthiest, but something distinct: to have weapons of a totally superior degree of sophistication to those of one's opponent.

### **Hyper-power status**

Black says: "If reports of China making progress in development and testing of such systems are accurate, this could signal the latest move in an ongoing race for technological advantage between China's People's Liberation Army, on the one hand, and the US military and its allies, on the other."

As Adam Tooze wrote in the *New Statesman* last month: "The US was raised to the status of a hyper-power not by the genius of its soldiers, or the qualitative superiority of its weapons, but through its economic supremacy... Now, the goal of the Pentagon planners is to loosen that link between economic performance and military force. They aim to secure US military dominance even as the centrifugal effect of global economic growth reduces America's relative weight in the world economy. Ultra-advanced technology, not GDP, will be the decisive factor."

The Pentagon's assumption, as Tooze puts it, is that the US – with its remarkable and unique ability to attract the world's brightest scientists and harness their work – has a natural superiority in this new contest of brains over brawn. But there is another vision of the future, in which a ruthless China beats the US in this race.

Take *2034: A Novel of the Next World War*, published in March, which imagines the US military being overwhelmed by a technologically superior China in the Pacific in the mid-2030s. What the thriller lacks in literary merit it makes up for in insight into the US elite's darkest fears: one of its two co-authors is James Stavridis, a former US admiral and a bastion of the American military establishment. The book neatly documents that establishment's worst nightmares.

Beijing's hypersonic missile test is just one instance of China leading on one form of technology. There are still strong reasons to believe that the US, with its dynamic, agile society and its ability to attract and fund the world's best minds, has the best chances in this new age of technological competition.

And China has its own often-underestimated internal weaknesses, demonstrated by its current property market and energy crises. Yet the news that it has beaten its US counterparts in this particular area is a sobering reminder that the race remains competitive – and for an often complacent West, perilously so.

— New Statesman

<https://www.afr.com/policy/foreign-affairs/why-the-world-is-focused-on-hypersonic-missiles-20211026-p5939b>



Press Information Bureau  
Government of India

Ministry of Science & Technology

Tue, 26 Oct 2021 3:21PM

## Security ink based on nano-materials that spontaneously emits light can combat counterfeiting

Indian Scientist has developed a highly stable and non-toxic security ink from nano-materials that spontaneously emit light (luminescent) due to its unique chemical properties to combat the counterfeiting of branded goods, bank-notes, medicine, certificates, currency.

Counterfeiting of branded goods, bank-notes, medicine, certificates, currency, and other important documents is very common all over the world, and it has become a serious issue. Luminescent ink is generally used as covert tags to combat the counterfeiting. Most of the security inks available today are based on luminescent materials that absorb a high energy photon and emit low energy photon, technically called downshifting, where covert tag is invisible under daylight, and it becomes visible under UV light. However, these single emission-based tags are prone to replication. To overcome this, luminescent ink with excitation-dependent luminescent properties (downshifting and upconversion) are advised. This is because increasing the number of parameters required to decode the tag decreases the possibility of decoding and replication. However, most of the materials reported recently for this purpose are based on fluorides which are less stable and highly toxic.

To address this challenge, Dr. Sanyasinaidu Boddu's research group from the Institute of Nano Science and Technology, Mohali, an autonomous institute under the Department of Science & Technology, Government of India, has developed non-toxic metal phosphate-based ink with excitation dependant luminescent properties which are highly stable under practical conditions such as temperature, humidity and light, etc. This work has been published in the journals 'Crystal Growth and Design' and 'Materials Today Communications'.

The luminescent security ink developed by the researcher is based on lanthanide ions ( $\text{Ln}^{3+}$ ) doped  $\text{Gd}_{1-x}\text{Bi}_x\text{PO}_4$  nano-materials. It showed very strong downshifting as well as upconversion luminescence properties. Also, the downshifting luminescence colour of the ink is highly dependent on the excitation wavelength making it difficult to decode the covert tag.

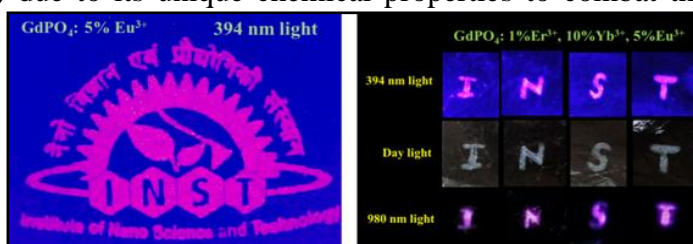


Figure 1. Digital photograph of (left) INST logo printed with security ink under 394 nm UV light, (right) I, N, S, T letters written with security ink on black paper under 394 nm UV light, daylight, and 980 nm NIR light.

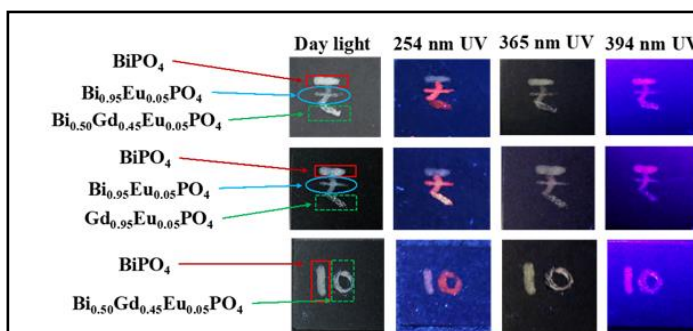


Figure 2. Digital photographs of Indian rupee symbol '₹' and '10' written with security ink on black paper under daylight, 254, 365, and 394 nm UV light.

These luminescent nanomaterials were synthesized via simple co-precipitation method. A composite was made with these nanoparticles and commercially available PVC gold medium ink. The composite ink was used to print patterns and letters on black paper. The patterns of this ink under different excitation wavelengths were found to be stable against various conditions which may occur during practical applications.

Dr. Boddu explains that ‘Trivalent lanthanide ions have very rich energy levels which help to exhibit both downshifting (absorb a high energy photon and emit low energy photon) and upconversion (absorb two low energy photon and emit a high energy photon) luminescent properties. Energy transfer between bismuth and lanthanide ions results in excitation dependent downshifting emission.’

“Lanthanide ions are known for their excellent downshifting and upconversion luminescent properties. We thought that if these materials are applied for anti-counterfeiting, it will give better encoding, decoding capacity and thereby improve the security ability,” he added.

The developed ink has huge potential to combat counterfeiting. A common man can find out easily that the document/product is original or fake.

<https://pib.gov.in/PressReleasePage.aspx?PRID=1766593>



Wed, 27 Oct 2021

## Magnetic material 3D-printed from nonmagnetic powder

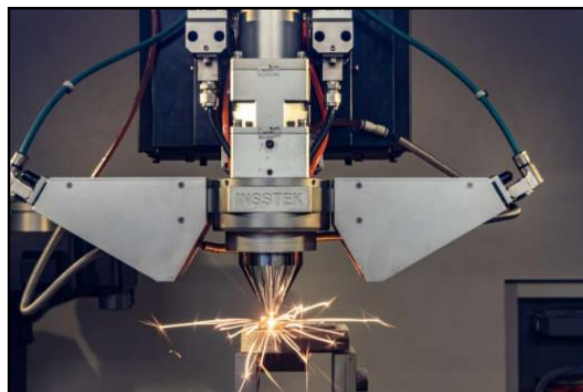
Scientists from Skoltech and their colleagues have used a 3D printer to fuse two materials in an alloy whose composition continuously changes from one region of the sample to the other, endowing the alloy with gradient magnetic properties. Despite the nonmagnetic nature of the constituent materials, the alloy exhibits magnetic properties. Published in the *Journal of Materials Processing Technology*, the study also offers a theoretical explanation for the phenomenon.

Once perceived as a mere novelty tool for rapid prototyping, 3D printing has grown into a full-blown industrial technology used to produce airplane parts, patient-matched implants and prosthetics, jewelry, and custom-fit shoes, among other things.

The main advantage of 3D printing is the ability to produce objects with very complex shapes that are impossible or too expensive to make with conventional manufacturing techniques, such as casting, rolling, and stamping. The technology also enables faster and riskier prototyping, and greater flexibility in terms of product customization and how many items are produced. And then there's the added benefit of reduced waste.

One of the limitations of 3D printing is that it tends to use one homogeneous material or mixture throughout the entire item produced. By varying the composition from one part of the item to another, it could be endowed with properties that continuously change.

An example of this would be a rod made of an alloy of two metals whose ratio changes from 100% metal A to fifty-fifty, to 100% metal B, and so on. Provided that the metals in question mix well, without giving rise to defects, the rod's gradient properties—including magnetic ones—could



The 3D printer used in the study. Credit: Oleg Dubinin et al./The Journal of Materials Processing Technology

be technologically useful, for example, for motor rotors, strips for magnetic encoders, or transformers.

The authors of a recent Skoltech-led study published in the *Journal of Materials Processing Technology* report an experiment where they produced such an alloy. Its two components—the metals A and B above—are themselves alloys: aluminum bronze (copper, aluminum, and iron) and marine-grade stainless steel (mostly iron, chromium, and nickel). Both are technically known as paramagnetic, or "nonmagnetic" in layman's terms. That is, they don't stick to a magnet. Yet when they are mixed in equal proportions, the resulting alloy turns out to be a "soft" ferromagnet. That is, it is attracted to "hard" ferromagnets—like the one on the fridge—but does not itself become one.

"We used these two paramagnetic materials to create a gradient alloy with an InssTek MX-1000 3D printer. It employs a technique called directed energy deposition, which involves depositing powdered material from a nozzle and simultaneously melting it with a laser. The resulting alloy exhibited ferromagnetic properties to an extent that depended on the ratio between the two constituent materials," said the study's lead author Oleg Dubinin from the Additive Manufacturing Lab at Skoltech.

"Our study also provides a theoretical explanation of the emergence of ferromagnetic properties in the alloy in terms of its atomic structure," the researcher went on. "While the two initial materials have a so-called face-centered cubic crystal structure, their combination results in a body-centered cubic structure."

In the former, metal atoms sit in the corners of imaginary cubes and on their faces. In the latter, there are metal atoms at the centers of the invisible cubes instead of on their faces. This second arrangement gives the material its ferromagnetic properties.

"Gradient soft magnetic alloys could find applications in machine engineering, for example, in electrical motors," commented PI Stanislav Evlashin, a leading research scientist at Skoltech. "Our findings show that directed energy deposition is not just a way to 3D-print gradient materials, but also a way to discover new alloys. Besides that, the technology is highly efficient and suitable for manufacturing even large-size parts quickly."

**More information:** O.N. Dubinin et al, Gradient soft magnetic materials produced by additive manufacturing from non-magnetic powders, *Journal of Materials Processing Technology* (2021). DOI: [10.1016/j.jmatprotec.2021.117393](https://doi.org/10.1016/j.jmatprotec.2021.117393)  
<https://phys.org/news/2021-10-magnetic-material-3d-printed-nonmagnetic-powder.html>



Wed, 27 Oct 2021

## Making short-wave infrared light visible with a single component

Infrared (IR) light is invisible to humans. However, some animals, such as rattlesnakes or bloodsucking bats, can perceive IR radiation and use it to find food. But even for humans, the ability to see in the short-wave IR (SWIR) range would sometimes be useful. With the help of starlight alone, one could see quite sharply at night. Mechanics would be able to see the heat of a soldering tip at a glance. And fruit merchants could detect damaged produce even before the rotting process begins.

But IR light has a "problem": It is weaker than visible light and than UV light on the other side of the light spectrum. So while UV light makes white shirts and dancers' teeth glow blueish in a club—all it takes is a fluorescent dye in the laundry detergent—IR light is difficult to make visible for the human eye. This is because dyes can convert high-energy light directly into low-energy light, but not the other way around.

## An entire IR camera on a chip

So IR cameras require sophisticated electronics to capture IR light, an electronic amplifier, and finally a screen to display the artificially generated image. This is expensive. Today's standard SWIR cameras for industrial use cost around 7,000 Swiss francs.

Empa researchers Roland Hany, Karen Strassel, Wei-Hsu and Michael Bauer have now succeeded in capturing SWIR light—and making it visible—with a single component. The device developed at Empa is basically an OLED display with three additional layers (see graphic). IR light falls through an electrically conductive glass pane onto a dye layer in a photodetector. Therein, electrons begin to migrate, their motion being amplified by an electrical voltage. The electrical charges then migrate into the OLED layer, where they produce a green light spot. Electronic signal processing by a computer is not necessary: The incoming (invisible) SWIR light is amplified in an "analog" way, so to speak, and displayed directly on the screen. The color of the emitted visible light—blue, green, yellow or red—can be adjusted by selecting the dye in the OLED.

### Useful for night vision—and for sorting beans

SWIR light is useful for many applications in the food industry, logistics or crafts. For example, one can visualize the temperature of soldering tips or monitor the cooling of newly manufactured jars and bottles. SWIR light makes moist objects appear darker, which is useful for sorting coffee beans or black olives: Stones and metal objects as impurities shine brightly among all the dark (moist) fruit on a conveyor belt.

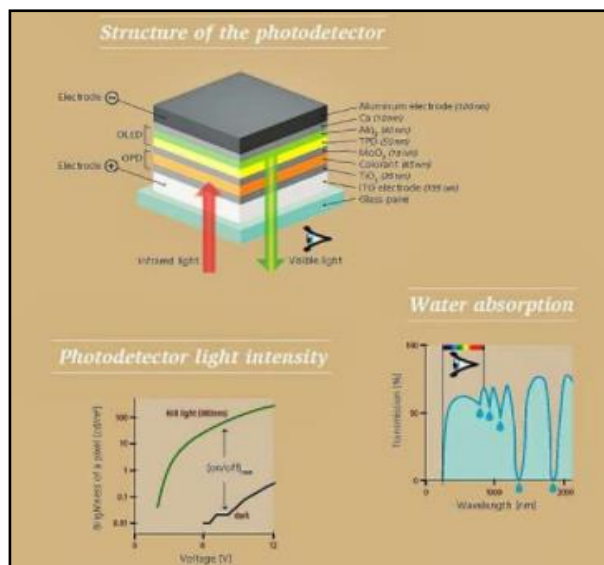
The key to Roland Hany's SWIR screen is special dyes that he and his colleagues have been investigating for quite a while, so-called squaraines. The name comes from the basic structure of the chemical molecule, squaric acid. This class of dyes was first discovered in the 1960s and is characterized by deep colors and a high temperature stability. The researchers chemically modified the squaric acid so that it absorbs in the range of SWIR light. "Right now, we're working with dyes that absorb at just under 1000 nanometers," Hany says. "But we're already working on shifting the absorption to longer wavelengths, further into the IR range. If we succeed, our sensor will be able to detect water and moisture much better than it does now."

### In search of an industrial partner

Hany likes to call the module he developed with his group OUC, or organic upconversion device. That's because it converts weak IR light into stronger, visible light ("upconversion") and works by using thin layers of dye made from carbon-based chemistry ("organic"). One problem is that the know-how to manufacture organic optoelectronic devices on an industrial scale is mainly located in Asia. Hany is confident, however, that his discovery will soon come to fruition: "Right now, we're working on increasing the sensitivity of the module and improving its long-term stability."

**More information:** Karen Strassel et al, Shortwave infrared-absorbing squaraine dyes for all-organic optical upconversion devices, *Science and Technology of Advanced Materials* (2021). DOI: [10.1080/14686996.2021.1891842](https://doi.org/10.1080/14686996.2021.1891842)

**Journal information:** [Science and Technology of Advanced Materials](https://phys.org/news/2021-10-short-wave-infrared-visible-component.html)  
<https://phys.org/news/2021-10-short-wave-infrared-visible-component.html>



The infrared (IR) photodetector resembles a sandwich of several layers. IR light is absorbed in the organic photodetector (OPD), creating electrical charges. Credit: Empa

# Dynamical scaling of entanglement entropy and surface roughness in random quantum systems

In physics, "universality" refers to properties of systems that are independent of their details. Establishing the universality of quantum dynamics is one of the key interests of theoretical physicists. Now, researchers from Japan have identified such a universality in disordered quantum systems, characterized by a one-parameter scaling for surface roughness and entanglement entropy (a measure of quantum entanglement).

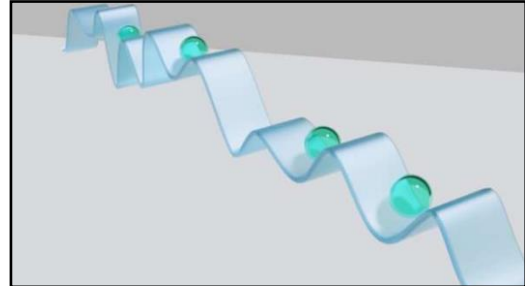


Image of a random quantum system. Credit: Kazuya Fujimoto

Many-particle systems in the real world are often imbued with "disorder" or "randomness." This, in turn, leads to the occurrence of phenomena unique to such systems. For instance, electrons in strongly disordered systems can become localized due to destructive interference, a phenomenon known as "Anderson localization."

Anderson localization has been studied extensively in terms of one-parameter scaling, where system properties are scaled based on one specific parameter. But while most studies have focused on static properties, disorder can also significantly influence quantum dynamics such as entanglement dynamics and transport phenomena.

In a recent study published in *Physical Review Letters*, a team of physicists led by Prof. Kazuya Fujimoto from Nagoya University has now demonstrated numerically a dynamical one-parameter scaling called "Family-Vicsek (FV) scaling" for disordered quantum systems. "While the FV scaling is originally known from classical surface growth, we found the scaling in random quantum systems by introducing a 'quantum surface height operator,'" explains Prof. Fujimoto.

In their study, the physicists considered a system of non-interacting spinless fermions in a disordered one-dimensional potential for three common models. They found that the surface roughness followed FV scaling characterized with three exponents. Further numerical analysis showed that the surface roughness could be related to the entanglement entropy (EE), thus indicating an FV-type scaling for EE. In addition, they observed anomalous scaling exponents for one of the models and attributed it to the presence of localized states in a delocalized phase, a classic signature of quantum disordered systems.

Importantly, surface roughness can be measured experimentally for cold-atomic systems using microscopy techniques, which makes the experimental estimation of EE viable in non-interacting fermions.

"These findings will deepen our understanding of nonequilibrium physics and provide a novel viewpoint to classify the universal non-equilibrium phenomena emerging in random quantum systems," says Prof. Fujimoto.

While the findings of the study do not have a direct influence on our daily lives, they certainly pave the way for a better understanding of real-world quantum systems.

**More information:** Kazuya Fujimoto et al, Dynamical Scaling of Surface Roughness and Entanglement Entropy in Disordered Fermion Models, *Physical Review Letters* (2021). DOI: [10.1103/PhysRevLett.127.090601](https://doi.org/10.1103/PhysRevLett.127.090601)

**Journal information:** [Physical Review Letters](https://phys.org/news/2021-10-dynamical-scaling-entanglement-entropy-surface.html)

<https://phys.org/news/2021-10-dynamical-scaling-entanglement-entropy-surface.html>



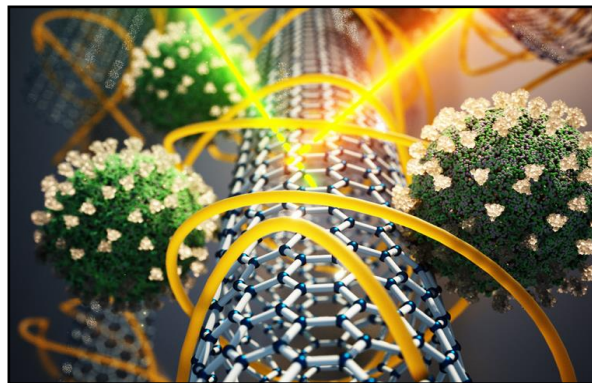
## Carbon nanotube-based sensor can detect SARS-CoV-2 proteins

*The technology could be developed as a rapid diagnostic for Covid-19 or other emerging pathogens.*

*By Anne Trafton |*

Using specialized carbon nanotubes, MIT engineers have designed a novel sensor that can detect SARS-CoV-2 without any antibodies, giving a result within minutes. Their new sensor is based on technology that can quickly generate rapid and accurate diagnostics, not just for Covid-19 but for future pandemics, the researchers say.

“A rapid test means that you can open up travel much earlier in a future pandemic. You can screen people getting off of an airplane and determine whether they should quarantine or not. You could similarly screen people entering their workplace and so forth,” says Michael Strano, the Carbon P. Dubbs Professor of Chemical Engineering at MIT and the senior author of the study. “We do not yet have technology that can develop and deploy such sensors fast enough to prevent economic loss.”



The diagnostic is based on carbon nanotube sensor technology that Strano’s lab has previously developed. Once the researchers began working on a Covid-19 sensor, it took them just 10 days to identify a modified carbon nanotube capable of selectively detecting the viral proteins they were looking for, and then test it and incorporate it into a working prototype. This approach also eliminates the need for antibodies or other reagents that are time-consuming to generate, purify, and make widely available.

MIT postdoc Sooyeon Cho and graduate student Xiaojia Jin are the lead authors of the paper, which appears today in *Analytical Chemistry*. Other authors include MIT graduate students Sungyun Yang and Jianqiao Cui, and postdoc Xun Gong.

### **Molecular recognition**

Several years ago, Strano’s lab developed a novel approach to designing sensors for a variety of molecules. Their technique relies on carbon nanotubes — hollow, nanometer-thick cylinders made of carbon that naturally fluoresce when exposed to laser light. They have shown that by wrapping such tubes in different polymers, they can create sensors that respond to specific target molecules by chemically recognizing them.

Their approach, known as Corona Phase Molecular Recognition (CoPhMoRe), takes advantage of a phenomenon that occurs when certain types of polymers bind to a nanoparticle. Known as amphiphilic polymers, these molecules have hydrophobic regions that latch onto the tubes like anchors and hydrophilic regions that form a series of loops extending away from the tubes.

Those loops form a layer called a corona surrounding the nanotube. Depending on the arrangement of the loops, different types of target molecules can wedge into the spaces between the loops, and this binding of the target alters the intensity or peak wavelength of fluorescence produced by the carbon nanotube.

Earlier this year, Strano and InnoTech Precision Medicine, a Boston-based diagnostics developer, received a National Institutes of Health grant to create a CoPhMoRe sensor for SARS-CoV-2 proteins. Researchers in Strano's lab had already developed strategies that allow them to predict which amphiphilic polymers will interact best with a particular target molecule, so they were able to quickly generate a set of 11 strong candidates for SARS-CoV-2.

Within about 10 days of starting the project, the researchers had identified accurate sensors for both the nucleocapsid and the spike protein of the SARS-CoV-2 virus. During that time, they also were able to incorporate the sensors into a prototype device with a fiber optic tip that can detect fluorescence changes of the biofluid sample in real time. This eliminates the need to send the sample to a lab, which is required for the gold-standard PCR diagnostic test for Covid-19.

This device produces a result within about five minutes, and can detect concentrations as low as 2.4 picograms of viral protein per milliliter of sample. In more recent experiments done after this paper was submitted, the researchers have achieved a limit of detection lower than the rapid tests that are now commercially available.

The researchers also showed that the device could detect the SARS-CoV-2 nucleocapsid protein (but not the spike protein) when it was dissolved in saliva. Detecting viral proteins in saliva is usually difficult because saliva contains sticky carbohydrate and digestive enzyme molecules that interfere with protein detection, which is why most Covid-19 diagnostics require nasal swabs.

"This sensor shows the highest range of limit of detection, response time, and saliva compatibility even without any antibody and receptor design," Cho says. "It is a unique feature of this type of molecular recognition scheme that rapid design and testing is possible, unhindered by the development time and supply chain requirements of a conventional antibody or enzymatic receptor."

### **Quick response**

The speed with which the researchers were able to develop a working prototype suggests that this approach could prove useful for developing diagnostics more quickly during future pandemics, Strano says.

"We're able to go from someone handing us viral markers to a working fiber optic sensor in an extremely short amount of time," he says.

Sensors that rely on antibodies to detect viral proteins, which form the basis of many of the rapid Covid-19 tests now available, take much longer to develop because the process of designing the right protein antibody is so time-consuming.

The researchers have filed for a patent on the technology in hopes that it could be commercialized for use as a Covid-19 diagnostic. Strano also hopes to further develop the technology so that it could be deployed quickly in response to future pandemics.

The research was funded by a National Institutes of Health Rapid Acceleration of Diagnostics (RADx) grant.

<https://news.mit.edu/2021/carbon-nanotube-covid-detect-1026>

