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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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*Wed, 28 Oct 2020*

## **India, Russia to develop advance version of BrahMos missiles especially for targeting AWACS – Reports**

India and Russia are planning to develop an advanced version of Indo-Russian cruise missile BrahMos, which will be capable of shooting down Airborne Warning and Control System (AWACS).

In a first, India-Russia will be transforming large, high-speed, sea-skimming anti-ship missile into a long-range air-to-air missile (AAM).

Alexander Maksichev, the co-director of Russo-Indian company Brahmos Aerospace, which produces the Brahmos missile, has told the Russian media that a variant of the missile designed to engage airborne early-warning and control aircraft would be ready by 2024. The company's plans also include the development of the hypersonic version of the BrahMos.

"We are expanding the range of targets for the BrahMos missiles," Maksichev said speaking to Russian news agency RIA Novosti in September, adding that it will be capable of destroying air targets in a few years.

"That means that the platform will remain the same only with some modernization, but it will have different 'brains', that is, a different target seeking device to destroy a radar, that is, contrast target."

AWACS is a mobile, long-range radar surveillance and control center capable of detecting and tracking incoming fighters, cruise missiles and drones at a distance of 370 km (200 nautical miles) and high-level targets at much greater distances. Called the "Eye in the Sky", it also can track maritime traffic, and it operates in any weather over any terrain.

Currently, Brahmos anti-ship missile is in service with the Indian Navy and its land-attack variant is in service with the army. The air-launched variant, BrahMos-A, for the Indian Air Force is under production and will enter its inventory before the end of 2020.

A spur in India's interest to acquire this class of weapons maybe because of the increasing numbers of AWACS with China's People's Liberation Army Air Force (PLAAF) and Pakistan.

India and China have been in a military stand-off in the Himalayas along the Line of Actual Control for almost seven months, with no signs of disengagement of troops in sight despite several rounds of negotiations and talks at both military and diplomatic level.

On the northern border, India is engaged with China and its Western border in the Jammu and Kashmir region continues to witness ceasefire violations along the Line of Control from Pakistan. With both China and Pakistan being partners in the region, it is essential for India to have domination in the air domain.

Especially when PLAAF and PLA Naval Aviation together operate 29 AEW&C aircraft, including four KJ-2000 Mainring in the air force, and around 30 tanker aircraft, as per the Military Balance+ database. On the other hand, Pakistan only has ten AEW&C aircraft.

Douglas Barrie, a Senior Fellow for Military Aerospace, however, doesn't find designing and developing a new missile for such a limited number of targets as a good idea. "With the associated cost might be a less attractive option than first trying to adapt, or at least use elements of, an already in-service system," he writes in Military Balance+.

He further writes: "Brahmos airframe is less than ideal, with an annular intake placing greater limitations on the seeker size than a conventionally designed AAM. It does, however, use a ramjet sustainer motor, which provides the missile with a comparatively high cruise speed. Furthermore, the missile would remain powered for far longer than if it used a simple solid-rocket motor".

<https://eurasianimes.com/india-russia-to-develop-advance-version-of-brahmos-missiles-especially-for-targeting-awacs-reports/>



Wed, 28 Oct 2020

## Indian Air Force to get a big Rafale boost, 16 fighters to land by April

*Three more Rafales will arrive in January, another three in March and seven in April, taking the total number of fighters handed over to the IAF to 21 single-seat fighters and seven twin-seat trainer fighters*

*By Shishir Gupta*

New Delhi: The Indian Air Force's strike capability is set for a boost with 16 omni-role Rafale jet fighters to be inducted into the Golden Arrows squadron by April 2021 and with France's biggest jet engine maker Safran ready to make fighter engines and ancillaries in India, people familiar with the matter said on Tuesday.

Five Rafale jets flew to the Ambala airbase via Abu Dhabi on July 29 and have already been inducted into the IAF's Squadron 17. The next batch of three Rafales will arrive in Ambala on November 5 directly from the Bordeaux-Merignac facility (there will be no stop as they will be fuelled mid-air), according to senior government officials. Seven Rafale fighters are already being used for IAF fighter pilot training in France.



Five Rafale jets flew to the Ambala airbase via Abu Dhabi on July 29(Dassault aviation)

Three more Rafales will arrive in January, another three in March and seven in April, taking the total number of fighters handed over to the IAF to 21 single-seat fighters and seven twin-seat trainer fighters. This means that by April next year, the Golden Arrows squadron will be complete with 18 fighters and the remaining three can be sent to the Hashimara airbase in north Bengal's Alipurduar to counter the threat posed by China on the eastern front. All the fighters are equipped with Mica and Meteor air-to-air missiles along with Scalp air-to-ground cruise missiles. India has now requested Safran for the air-to-ground modular weapon known as Hammer with a 250kg warhead.

While France is willing to offer more Rafale fighters to India, Safran's offer of making the Snecma M88 engines in India, four years from the day the contract is signed, is a welcome proposal, said the officials cited above.

Not only will the M-88 engines be used by Rafale fighters but these can also be deployed to power Light Combat Aircraft Mark II and twin-engine advanced multi-role combat aircraft developed by the Defence Research and Development Organisation (DRDO). The IAF plans to buy 83 LCA Mark I A jets, taking the total number of Tejas variants ordered to 123. Safran is said to be willing to offer engines with no third-country spare parts so that no additional approvals are needed, and with 100% indigenisation. The French offer may come up for discussion during foreign secretary Harsh Shringla's visit to France, the UK and Germany, starting from Paris this Thursday. While DRDO can continue developing its own fighter engine, the Safran engine will fill the gap between development and manufacture.

Only the US, Russia and France have the capacity to produce fighter jet engines, with China still using the Russian RD-93 and RD-33 engines to power its jet fighters such as the J-31 and the JF-17.

<https://www.hindustantimes.com/india-news/indian-air-force-to-get-a-big-rafale-boost-16-fighters-to-land-by-april/story-Ezh1Pt1Co5frHnWI89LK7M.html>

## Defence News

### Defence Strategic: National/International



Wed, 28 Oct 2020

## CDS Gen Bipin Rawat takes integrity pledge to mark Vigilance Awareness Week

New Delhi: Chief of Defence Staff General Bipin Rawat took the integrity pledge and swore to follow the rule of law and perform tasks in an honest and transparent manner to mark the beginning of the Vigilance Awareness Week on Tuesday. General Rawat, during his pledge, reiterated to lead by example exhibiting integrity in personal behaviour and always act in the public interest. These attributes are imbibed in every soldier and officer of the Indian Armed Forces from the start of their service life.

He also swore to perform tasks in an honest and transparent manner, which are the qualities synonymous with the morals and tradition of the Indian Armed Forces. The Central Vigilance Commission (CVC), in its efforts to ensure a policy of 'Zero Tolerance towards Corruption', has decided that Vigilance Awareness Week will be observed from October 27 to November 2.

The observance of the week started with the Integrity Pledge being taken by members of all Ministries and Departments at 11 am on October 27. The Indian armed forces also observed Vigilance Awareness Week to maintain core values of honesty and integrity. The theme of the week is 'Satark Bharat, Samriddh Bharat (Vigilant India, Prosperous India)'. (ANI)



CDS Gen Bipin Rawat takes integrity pledge to mark Vigilance Awareness Week

<https://www.aninews.in/news/national/general-news/cds-gen-bipin-rawat-takes-integrity-pledge-to-mark-vigilance-awareness-week20201027135115/>

## भारतीय सेना के शीर्ष अधिकारियों ने लिया ईमानदारी का संकल्प

### हाईलाइट

- **भारतीय सेना के शीर्ष अधिकारियों ने लिया ईमानदारी का संकल्प**

नई दिल्ली: चीफ ऑफ डिफेंस स्टाफ जनरल बिपिन रावत, भारतीय सेना प्रमुख जनरल एम.एम. नरवणे और बल के सभी कमांडरों ने मंगलवार को कानून के शासन का पालन करने, ईमानदार और पारदर्शी तरीके से कार्य करने के लिए ईमानदारी का संकल्प लिया।

सेना के सभी कमांडर सम्मेलन में हिस्सा लेने के लिए 4 दिनों से दिल्ली में हैं। इस दौरान सेना के वरिष्ठ नेतृत्व ने व्यक्तिगत व्यवहार में ईमानदारी बरतने के कई उदाहरण दिए। अभी भारतीय सेना की ईमानदारी और अखंडता के मूल मूल्यों को बनाए रखने के लिए सतर्कता जागरूकता सप्ताह चल रहा है।

सूत्रों ने बताया कि राजनाथ सिंह ने कमांडरों के सम्मेलन को मंगलवार को होने वाला अपना संबोधन स्थगित कर दिया है। अब वो बुधवार को संबोधित करेंगे। इससे पहले मंगलवार को सेना के कमांडरों और दिल्ली में मौजूद रेजिमेंटों के कर्नल ने इन्फैंट्री दिवस के मौके पर इंडिया गेट पर राष्ट्रीय युद्ध स्मारक पर माल्यार्पण किया।

इन्फैंट्री दिवस पर इस साल युद्ध स्मारक पर औपचारिक कार्यक्रम में हिस्सा लेने आए सैनिक 13 कुमाऊं के थे, जिन्होंने 1962 की सर्दियों में रेजांगला की लड़ाई में अंतिम दौर की लड़ाई लड़ी थी। रेजांगला दक्षिण पेंगोग सो झील का वही क्षेत्र है जिस पर भारत-चीन सीमा पर चल रहे गतिरोध के बीच हाल ही में भारतीय सैनिकों ने कब्जा जमाया।

भारतीय सेना का 26 अक्टूबर से 4 दिवसीय कमांडरों का सम्मेलन चल रहा है, जहां सभी सामरिक और मानव संसाधनों पर विचार-विमर्शकिया जा रहा है। यह सम्मेलन शीर्ष स्तर का द्वैवार्षिक समारोह है, जिसमें कॉलेजियम विचार-विमर्श के जरिए महत्वपूर्ण नीतिगत निर्णय करती है। इस बार के सम्मेलन में चीन के साथ चल रही सीमा स्थिति चर्चा का मुख्य केंद्र बिंदु होगी।

<https://www.bhaskarhindi.com/national/news/top-officials-of-indian-army-pledge-honesty-178833>



## चीन-अमेरिका की तर्ज पर गठित होगी भारतीय सेना, 2022 तक हो सकता है 5 थिएटर कमांड्स का पुनर्गठन

भारतीय सेना का साल 2022 तक पुनर्गठन किया जा सकता है। सेना को 5 थिएटर कमांड्स में पुनर्गठित करने की योजना है। ऐसी व्यवस्था केवल चीन और अमेरिका की सेना में है।

By Raghavendra Shukla

**हाइलाइट्स:**

- भारतीय सेना का साल 2022 तक हो सकता है पुनर्गठन
- भारतीय सेना का 5 थिएटर कमांड्स में वर्गीकरण का प्रस्ताव
- सिर्फ चीन और अमेरिका में है सेनाओं थिएटर कमांड्स

नई दिल्ली: भारत की सीमाओं पर तनाव की मौजूदा स्थितियों को देखते हुए भारत सरकार देश की सेनाओं के एकीकरण को लेकर गंभीर हो गई है। माना जा रहा है कि साल 2022 तक भारतीय सेनाओं को पांच थिएटर कमांड्स में पुनर्गठित कर दिया जाएगा। भौगोलिक और रणनीतिक क्षेत्रों के हिसाब से थिएटर कमांड्स का वर्गीकरण किया जाएगा। कैबिनेट से क्लियरेंस मिलने के बाद से ही मिलिट्री मामलों के विभाग के पास भी अडिशनल और जॉइंट सेक्रेट्री होंगे।

बताया गया कि काफी गंभीर विचार-विमर्श के बाद सेना के एकीकरण और उनसे पुनर्गठन का फैसला लिया गया है। नरेंद्र मोदी सरकार ने सेना को थिएटर कमांड्स में वर्गीकृत करने की जिम्मेदारी चीफ ऑफ डिफेंस स्टाफ जनरल विपिन रावत को सौंपी है। योजना के मुताबिक, पांच कमांड्स में उत्तरी कमांड लद्दाख में कराकोरम दर्रे से शुरू होकर अरुणाचल प्रदेश की सबसे आखिरी पोस्ट किबिथू तक होगी। यह कमांड चीन से लगी तकरीबन 3 हजार 488 किमी लंबी लाइन ऑफ ऐक्चुअल कंट्रोल की रखवाली करेगा। इसका मुख्यालय लखनऊ में होने की संभावना है।

### ऐसे होगा कमांड्स का पुनर्गठन

पश्चिमी कमांड का क्षेत्र सियाचिन ग्लेशियर में इंदिरा कॉल से शुरू होकर गुजरात के आखिरी छोर तक होगा। इसका हेडक्वार्टर राजस्थान की राजधानी जयपुर में हो सकता है। तीसरा कमांड प्रायद्वीपीय कमांड होगा। वहीं चौथा एक पूर्ण वायुरक्षा कमांड होगा और पांचवा समुद्री कमांड होगा। प्रायद्वीपीय कमांड का मुख्यालय केरल की राजधानी तिरुवनंतपुरम में हो सकता है। हवाई कमांड देश के हवाई हमलों को तो गति देगा ही, साथ ही यह भारत की आकाशीय सीमाओं की सुरक्षा के लिए भी जिम्मेदार होगा।

बता दें कि भारतीय सेना प्रमुख एमएम नरवणे भी थिएटर कमांड के गठन को जरूरी बता चुके हैं। बीते दिनों उन्होंने कहा था कि तीनों सेनाओं का एकीकरण करने से जरूरी परिस्थितियों में तालमेल बिठाने और संसाधनों के उचित तरीके से इस्तेमाल में मदद मिलेगी। माना जा रहा है कि सीडीएस विपिन रावत की देखरेख में साल 2022 तक सेना का पांच थिएटर कमांड्स में पुनर्गठन कर दिया जाएगा।

### क्या है थिएटर कमांड?



सांकेतिक तस्वीर

जानकारी के मुताबिक, हर थिएटर कमांड में भारत की तीनों सेनाओं नौसेना, वायुसेना और थल सेना की टुकड़ियां शामिल होंगी। सुरक्षा चुनौती की स्थिति में तीनों सेनाएं साथ मिलकर लड़ेंगी। थिएटर कमांड का नेतृत्व केवल ऑपरेशनल कमांडर के हाथ में होगा। भारत के भौगोलिक और रणनीतिक स्थिति को देखते हुए थिएटर कमांड्स का गठन किया जाएगा। मौजूदा समय में थल, नौसेना और वायुसेना के अपने-अपने कमांड्स हैं। बता दें कि सेना के थिएटर कमांड्स की व्यवस्था सिर्फ चीन और अमेरिका में है। अगर साल 2022 तक यह व्यवस्था यहां भी लागू हो जाती है तो भारत ऐसा करने वाला तीसरा देश हो जाएगा।

<https://navbharattimes.indiatimes.com/india/indian-army-to-be-reorganised-in-theater-commands-like-as-america-and-china/articleshow/78886768.cms>



Wed, 28 Oct 2020

## India to get 5 military theatre commands, one each for China and Pak

*According to military and national security planners, the northern command's remit will begin from the Karakoram Pass in Ladakh and continue up to the last outpost Kibithu in Arunachal Pradesh, with the military mandate of guarding the 3,488 kilometre of Line of Actual Control (LAC) with China*

*By Shishir Gupta*

New Delhi: The Indian military is expected to be reorganised under five theatre commands by 2022 with defined areas of operation and a seamless command structure for synchronised operations.

With the department of military affairs soon to have additional and joint secretaries after Cabinet clearance, the task of reorganisation of the three services under theatre commands has begun with a China specific Northern Command and Pakistan specific Western command under serious consideration. India's Chief of Defence Staff Gen Bipin Rawat has been given the mandate by the Narendra Modi government to create theatre commands much like the ones China and the US currently have.



India's Chief of Defence Staff Gen Bipin Rawat has been given the mandate by the Narendra Modi government to create theatre commands much like the ones China and the US currently have.(PTI)

According to military and national security

planners, the northern command's remit will begin from the Karakoram Pass in Ladakh and continue up to the last outpost Kibithu in Arunachal Pradesh, with the military mandate of guarding the 3,488 kilometre of Line of Actual Control (LAC) with China. The HQ of this command could be Lucknow.

The western command's remit will be from Indira Col on Saltoro Ridge in the Siachen Glacier region to the tip of Gujarat with its HQ likely in Jaipur.

The third theatre command will be the Peninsular Command; the fourth, a full-fledged air defence command; and the fifth, a maritime command. The likely HQ of the Peninsular command could be Thiruvananthapuram. The air defence command will not only spearhead the country's aerial attack but also be responsible for defending Indian airspace through multi-role fighters with all anti aircraft missiles under its control.



Currently, the Indian Army, Indian Air Force and the Indian Navy all defend Indian airspace on separate communication frequencies and without synergy. This is despite the fact that all Indian Army Corps Headquarters are located next to an air base as a result of which there is duplication of effort and wasteful expenditure.

The planners said there is option of extending this to an aerospace command as per future requirements.

India will have only one maritime command with a possibility that the tri-service Andaman and Nicobar Islands Command being merged with this . The task of the maritime command will be to protect the Indian Ocean and India's Island territories as well as keep the sea lanes free and open from any outside pressure.

Although in a nascent stage, the Indian Navy's maritime assets will be placed in Karwar on the western seaboard, Vishakhapatnam on the eastern seaboard and in the Andaman and Nicobar Islands. With China emerging as a threat, the possible headquarters of the Maritime Command could be Andhra Pradesh's new capital with Port Blair emerging as another major base for naval operations.

Theaterisation refers to placing units of the army, air force, and navy under a single Theatre Commander. The operational command of such combinations will be under one officer drawn from one of the three services.

“Theaterisation of commands is imperative to integrate resources of the three services for maximising impact in any war. The geographical expanse of theatres in India demands unified commands for strategic decisions and critical outcomes that will be possible in concentrated employment of resources,” said former army vice chief Lt Gen AS Lamba (retd).

According to senior officials familiar with the matter, all five commands will be headed by Lt General or equivalent rank commanders, who will be the first among equals with the heads of the present commands reporting to them. The task of the Chief of Staff of Army, Chief of Air Staff and Chief of Naval Staff will not be operational but involve mobilising resources to the theatre commanders as it is in the US military.

If the Andamans and Nicobar Command goes under the maritime command as is being visualised, then the CDS will have the Armed Forces Special Operation Division, Cyber Command and the Defence Intelligence Agency under him with manpower drawn from all the three services.

<https://www.hindustantimes.com/india-news/india-to-get-5-military-theatre-commands-one-each-for-china-and-pak/story-UzFJNollsvpj3tcUetWVNM.html>

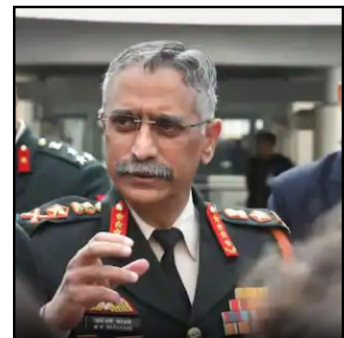
## Indian Army Chief General Naravane to Visit Nepal from November 4-6

*Continuing a tradition of friendship between the two militaries, Gen Naravane will be conferred with the honorary rank of General of the Nepal Army' by President Bidya Devi Bhandari during a special ceremony at the Rastrapati Bhawan, the statement said*

Indian Army chief General M M Naravane will arrive in Kathmandu on November 4 on a three-day official visit during which he will meet Prime Minister K P Sharma Oli, who is also holding the defence portfolio. Gen Naravane will be visiting Nepal from November 4 to November 6 at the official invitation of the Nepalese Army chief, according to a statement issued by the Nepal Army headquarters here.

Continuing a tradition of friendship between the two militaries, Gen Naravane will be conferred with the honorary rank of General of the Nepal Army' by President Bidya Devi Bhandari during a special ceremony at the Rastrapati Bhawan, the statement said. The tradition, which started in 1950, reflects the strong ties between the two militaries.

General Naravane is also scheduled to meet Prime Minister Oli, who is holding the defence portfolio, on the final day of his visit. He will also pay homage at the martyrs' memorial in the Army Pavilion, receive a guard of honour, hold official meeting with his counterpart General Purna Chandra Thapa and address the student officers at the Army Command and Staff College, Shivapuri, the statement added.



Army Chief General MM Naravane. (PTI)

The ties between the two countries came under strain after Defence Minister Rajnath Singh inaugurated an 80-km-long strategically crucial road connecting the Lipulekh pass with Dharchula in Uttarakhand on May 8. Nepal protested the inauguration of the road claiming that it passed through its territory. Days later, Nepal came out with the new map showing Lipulekh, Kalapani and Limpiyadhura as its territories.

In the midst of the row, Gen Naravane said that there were reasons to believe that Nepal objected to the road at the behest of "someone else", in an apparent reference to a possible role by China in the matter. The comments triggered angry reactions from Nepal. India too had published a new map in November 2019 showing the areas as its territories.

After Nepal released the map, India reacted sharply, calling it a "unilateral act" and cautioning Kathmandu that such "artificial enlargement" of territorial claims will not be acceptable to it. In June, Nepal's Parliament approved the new political map of the country featuring areas which India maintains belong to it. In its reaction, after Nepal's lower house of parliament approved the bill, India termed as untenable the "artificial enlargement" of territorial claims by the neighbouring country. India said Nepal's action violates an understanding reached between the two countries to resolve the boundary issues through talks.

Nepalese Prime Minister Oli has been asserting that Lipulekh, Kalapani and Limpiyadhura belong to his country and vowed to "reclaim" them from India. The Lipulekh pass is a far western point near Kalapani, a disputed border area between Nepal and India. Both India and Nepal claim Kalapani as an integral part of their territory – India as part of Uttarakhand's Pithoragarh district and Nepal as part of Dharchula district.

<https://www.news18.com/news/india/indian-army-chief-general-naravane-to-visit-nepal-from-november-4-6-3013445.html>

## Why India's latest Defence Agreement with the United States may prove a costly bargain

*The Modi government has simply not given thought to the implications signing BECA will have on war-preparedness at a time when external threats have multiplied*

*By Pravin Sahney*

By signing the Basic Exchange and Cooperation Agreement (BECA), India has potentially mortgaged the digitised military capability of its three services – army, air force and navy – to the United States. If this sounds startling, it is.

Working in tandem with the Communication, Compatibility and Security Agreement (COMCASA) signed in 2018, BECA too is much more than just “developing inter-operability” – i.e. the ability to fight together against a common enemy – as background briefings and media reports based on those briefings are fond of saying. As if that were not bad enough, through the twin-routes of datasets (given under BECA) and systems (given under COMCASA), India's indigenous kill-chains (sensor-to-shooter networks working through a command centre) would potentially be under US control through its massive cyber capabilities.



External affairs minister Dr S Jaishankar and Defence minister Rajnath Singh with US counterparts, the secretaries of state and defense, Mike Pompeo and Mark Esper. Photo: [Twitter/@MEAIndia](https://twitter.com/MEAIndia).

What prompted the Modi government to take this mindlessly suicidal extreme step, considering India is neither a US military ally nor has it received any commitment that the US military would fight its wars? Tanvi Madan, a senior fellow at the Brookings Institution, suggests the answer. On the eve of the BECA signing, she tweeted, “Arguably without Doklam and Ladakh crisis, India would not have got to yes on COMCASA or reportedly BECA.”

The reality is India has cut off its nose to spite the Chinese by flaunting untested strategic ties with the US, in the hope that US geospatial intelligence and real-time images datasets would help the accuracy of India's long range firepower comprising its cruise missiles, multi barrel rocket systems and probably the Russian S-400 air defence missile system once it joins the inventory.

By signing the ‘India-specific’ COMCASA, India was given highly encrypted classified security equipment, and by signing BECA, the US would share its military Geographic Information System (GIS) comprising topography, terrain and weather information for mission planning. India would also get US satellite imagery (data and video), GPS military resolutions and datasets from its airborne assets.

The huge volume of US datasets from diverse sensors would come to Indian command centres through the special COMCASA equipment. Since good quality, real-time datasets are the new ammunition of digitised warfare, this can be platformed quickly (perhaps using US-assisted Artificial Intelligence) to both the armed drones being procured from the US as well as other weapon platforms with the three services for precise stand-off firepower.

On the face of it, this would be great. But deep down, India has created space for the US to exercise widespread malafide activities on the cyber front, should it so decide. Malicious cyber activities do not happen only through cyberspace, but through systems too. These include computer software, embedded processors, routers, all wired and wireless transmission, controllers and so on. While systems are accessed through cyberspace, there are other paths that cyber warriors can use to introduce egregious errors into computer systems without using the internet.

For instance, America's COMCASA equipment could have embedded cyber logic bombs. These are nano malware (malicious software) codes that start functioning when certain conditions are met, or outside instructions are given after months or even years. They could then start deleting datasets files or corrupt them inducing malfunctions in the kill-chain, leading to missiles going awry if not running amok. To be sure, the best ballistic, cruise or hypersonic missiles in the world depend on the robustness of the kill-chain supporting it. This explains why major power like US, China and Russia pay special attention to having cyber and electronic hardened kill-chains.

Since US (cyber) experts would be authorised COMCASA system users, they could corrupt datasets on command for as long as they want. Or there could be dataset poisoning; it could be falsified or corrupted. The US could even overwrite Indian short-range, point to point radio frequency connections by long-range high-powered signals from beyond physical parameters. Moreover, the US has developed impressive nano weapons capable of transiting through cyberspace to disrupt or destroy physical infrastructure.

A case in point is the world's first known cyberweapon with nanotechnology – the Stuxnet computer worm used to attack Iran's nuclear programme in 2010. The US was suspected to be behind this weapon, which linked the cyber domain with the physical one. The US has numerous cyber weapons, techniques and capabilities, including installing information mines, information reconnaissance, changing network data, dumping information garbage, disseminating propaganda, applying information deception, releasing clone information, establishing network spy stations and so on.

It is no one's case that the US is likely to carry out malevolent cyber activities against India, a country it regards as its strategic ally. However, the important issue is *capability* and not intention. By signing COMCASA and BECA, the Modi government has given the US entry into the Indian military's growing digitised space, something no nation other than a US military ally – all of whom have excellent indigenous cyber capabilities – would do.

The problems regarding interoperability would be no less. Given the centrality of data, the then US chairman joint chiefs of staff committee, General Martin Dempsey suggested in 2010 that the US Air Force should now use a 'data to decision' cycle rather than the traditional 'sensor to shooter' cycle that it does with its military allies through the Link-16 network. So, what is underway is the introduction of tactical cloud architecture to replace Link-16. Of 1970s vintage, Link-16 has limited bandwidth which can do only voice transmission, is complex to plan for each mission, has high latency and suffers from cyber and electronic vulnerabilities. Allied militaries – all of which have signed BECA and CISMOA (Communication, interoperability and security memorandum agreement, equivalent of the India-specific COMCASA) – which use the tactical cloud are thus tied in to fighting a common enemy.

After the signing of these 'foundational' military agreements, Indo-US joint exercises are now likely to graduate to advanced and operational manoeuvres from the tactical exercises thus far. The Indian defence forces would be introduced to and trained in new data-centric war concepts under cloud architecture.

So far, so good but the questions which remain unanswered are: What good are these advanced war concepts when the Indian forces would eventually fight with different war concepts, capabilities, and capacities? Will there be two sets of warfighting concepts, one when exercising with the US, and another when India prepares itself to fight with China and Pakistan?

Can India afford to divide its limited high-profile assets, especially in the absence of a vibrant defence industrial complex, to support its warfighting capabilities, on twin-training war concepts that are generations apart?

Has the Modi government even applied itself to the implications of signing BECA and the earlier COMCASA on war-preparedness at a time when external threats have multiplied?

Finally, all this would also not be lost on China and India's friend, Russia – which still provides the bulk of Indian fighting platforms.

<https://thewire.in/security-security/beca-india-usa-comcasa-defence-data-sharing>

## **BECA: The deal that will make Indian missiles deadlier has finally been signed**

### *Synopsis*

*The agreement will enable India to gain access to extremely accurate geo-spatial data. This is going to have major implications for a range of military aspects, such as giving Indian missiles a killer edge.*

The Basic Exchange and Cooperation Agreement for Geo-Spatial Cooperation or BECA, long in the making, has finally been signed by India and the US.

The agreement will enable India to gain access to extremely accurate geo-spatial data. This is going to have major implications for a range of military aspects, such as giving Indian missiles a killer edge.

Here are some key things about the agreement that what it will bring about.

### **What is this all about?**

BECA is the last of the pacts that America signs with close partners. The pact basically facilitates interoperability of forces and exchange of sensitive and classified information.

India and the US have already signed three key foundational agreements — General Security of Military Information Agreement (GSOMIA) in 2002, the Logistics Exchange Memorandum of Agreement (LEMOA) in 2016 and Communications Compatibility and Security Agreement (COMCASA) in 2018.

Supplemented by highly accurate US satellites, this geospatial information can help in navigation and, more importantly, in targeting military assets.

### **The information shared**

The information shared could be either digital or printed.

According to an ET story, the information that is shared include maps, nautical and aeronautical charts, commercial and other unclassified imagery, geodetic, geophysical, geomagnetic and gravity data.

A majority of this data is usually unclassified and aimed at facilitating standardisation. There, however, are provisions for sharing classified data also. While sharing classified info, safeguards are put in place to make sure that no third party gets access.

### **What took it this long?**

The pact was under discussion for more than a decade. The UPA government had initially blocked it owing to fears raised by security forces on "protection of classified information and access to classified laboratories in India".

Most of these fears have been addressed over many rounds of talks. Also, increasing trust between India and the US played a major part.

The agreement on sharing military logistics, which spawned the most political concerns, had been reached a while ago.

### **How it changes things for India**

Although both sides will share sensitive information under BECA, the agreement is likely to benefit India more. It will give India access to military-grade data "that can help draw up target coordinates".

In essence, these military-grade coordinates can help direct missiles of air-launched bombs to a terror location in the neighbourhood with high accuracy.

It will primarily help in long-range navigation and missile-targeting with increased accuracy. Given the current geopolitical situation, this data will be relevant on both the northern and western



borders of India, said Captain Vikram Mahajan (retired), director, Aerospace and Defence at USISPF.

<https://economictimes.indiatimes.com/news/defence/beca-the-deal-that-will-make-indian-missiles-deadlier-has-finally-been-signed/articleshow/78885862.cms>

## Science & Technology News



Wed, 28 Oct 2020

# Tailoring 2-D materials to improve electronic and optical devices

*By Sarah Small*

New possibilities for future developments in electronic and optical devices have been unlocked by recent advancements in two-dimensional (2-D) materials, according to Penn State researchers.

The researchers, led by Shengxi Huang, assistant professor of electrical engineering and biomedical engineering at Penn State, recently published the results of two separate but related discoveries regarding their success with altering the thin 2-D materials for applications in many optical and electronic devices. By altering the material in two different ways—atomically and physically—the researchers were able to enhance light emission and increase signal strength, expanding the bounds of what is possible with devices that rely on these materials.

In the first method, the researchers modified the atomic makeup of the materials. In commonly used 2-D materials, researchers rely on the interaction between the thin layers, known as van der Waals interlayer coupling, to create charge transfer that is then used in devices. However, this interlayer coupling is limited because the charges are traditionally distributed evenly on the two sides of each layer.

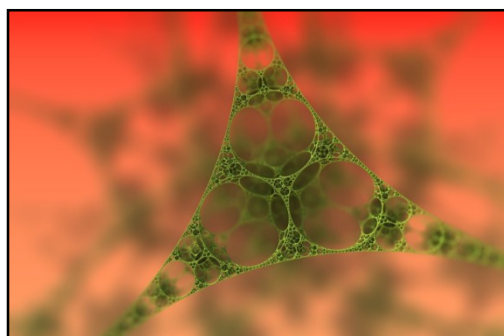
In order to strengthen the coupling, the researchers created a new type of 2-D material known as Janus transition metal dichalcogenides by replacing atoms on one side of the layer with a different type of atoms, creating uneven distribution of the charge.

"This [atomic change] means the charge can be distributed unevenly," Huang said. "That creates an electric field within the plane, and can attract different molecules because of that, which can enhance light emission."

Also, if van der Waals interlayer coupling can be tuned to the right level by twisting layers with a certain angle, it can induce superconductivity, carrying implications for advancements in electronic and optical devices.

In the second method of altering 2-D materials to improve their capabilities, the researchers strengthened the signal that resulted from an energy up-conversion process by taking a layer of MoS<sub>2</sub>, a common 2-D material that is usually flat and thin, and rolling it into a roughly cylindrical shape.

The energy conversion process that takes place with the MoS<sub>2</sub> material is part of a nonlinear optical effect where, if a light is shined into an object, the frequency is doubled, which is where the energy conversion comes in.



Credit: CC0 Public Domain

"We always want to double the frequency in this process," Huang said. "But the signal is usually very weak, so enhancing the signal is very important."

By rolling the material, the researchers achieved a more than 95 times signal improvement.

Now, Huang plans to put these two advances together.

"The next step for our research is answering how we can combine atomic engineering and shape engineering to create better optical devices," she said.

A paper on the research of the atomic structure, "Enhancement of van der Waals Interlayer Coupling through Polar Janus MoSSe," was recently published in the *Journal of the American Chemical Society* (ACS). The paper on the research of rolling the materials, "Chirality-Dependent Second Harmonic Generation of MoS2 Nanoscroll with Enhanced Efficiency," was published recently in *ACS Nano*.

**More information:** Kunyan Zhang et al. Enhancement of van der Waals Interlayer Coupling through Polar Janus MoSSe, *Journal of the American Chemical Society* (2020). [DOI: 10.1021/jacs.0c07051](https://doi.org/10.1021/jacs.0c07051)

Qingkai Qian et al. Chirality-Dependent Second Harmonic Generation of MoS2 Nanoscroll with Enhanced Efficiency, *ACS Nano* (2020). [DOI: 10.1021/acsnano.0c05189](https://doi.org/10.1021/acsnano.0c05189)

**Journal information:** [Journal of the American Chemical Society](https://pubs.acs.org) , [ACS Nano](https://pubs.acs.org)  
<https://phys.org/news/2020-10-tailoring-d-materials-electronic-optical.html>



Wed, 28 Oct 2020

## Solid-state technology for big data in particle physics

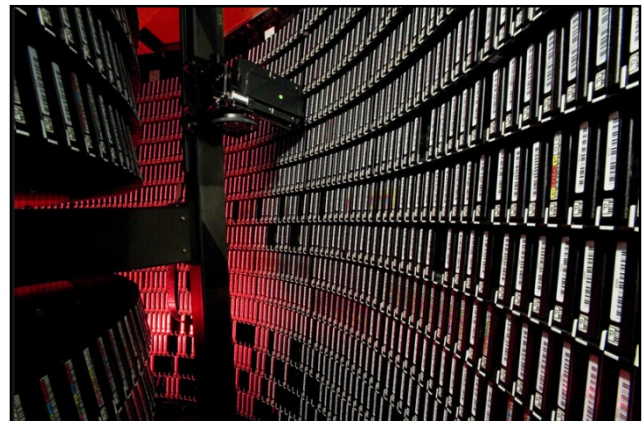
By Jerald Pinson

At CERN's Large Hadron Collider, as many as 40 million particle collisions occur within the span of a single second inside the CMS particle detector's more than 80 million detection channels. These collisions create an enormous digital footprint, even after computers winnow it to the most meaningful data. The simple act of retrieving information can mean battling bottlenecks.

CMS physicists at the U.S. Department of Energy's Fermi National Accelerator Laboratory, which stores a large portion of LHC data, are now experimenting with the use of NVMe, or nonvolatile memory express, solid-state technology to determine the best way to access stored files when scientists need to retrieve them for analysis.

### The trouble with terabytes

The results of the CMS experiment at CERN have the potential to help answer some of the biggest open-ended questions in physics, such as why there is more matter than antimatter in the universe and whether there are more than three physical dimensions.



When scientists need to access the stored files to perform analyses, a long robotic arm descends from the ceiling, selects a tape, and transfers the data it stores to a hard drive. Credit: Reidar Hahn, Fermilab

Before scientists can answer such questions, however, they need to access the collision data recorded by the CMS detector, much of which was built at Fermilab. Data access is by no means a trivial task. Without online data pruning, the LHC would generate 40 terabytes of data per second, enough to fill the hard drives of 80 regular laptop computers. An automated selection process

keeps only the important, interesting collisions, trimming the number of saved events from 40 million per second to just 1,000.

"We care about only a fraction of those collisions, so we have a sequence of selection criteria that decide which ones to keep and which ones to throw away in real time," said Fermilab scientist Bo Jayatilaka, who is leading the NVMe project.

Still, even with selective pruning, tens of thousands of terabytes of data from the CMS detector alone have to be stored each year. Not only that, but to ensure that none of the information ever gets lost or destroyed, two copies of each file have to be saved. One copy is stored in its entirety at CERN, while the other copy is split between partnering institutions around the world. Fermilab is the main designated storage facility in the U.S. for the CMS experiment, with roughly 40% of the experiment's data files stored on tape.

### **A solid-state solution**

The Feynman Computing Center at Fermilab houses three large data libraries filled with rows upon rows of magnetic tapes that store data from Fermilab's own experiments, as well as from CMS. If you were to combine all of Fermilab's tape storage capacity, you'd have roughly the capability to store the equivalent of 13,000 years' worth of HD TV footage.

"We have racks full of servers that have hard drives on them, and they are the primary storage medium that scientists are actually reading and writing data to and from," Jayatilaka said.

But hard drives—which have been used as storage devices in computers for the last 60 years—are limited in the amount of data they can load into applications in a given time. This is because they load data by retrieving it from spinning disks, which is the only point of access for that information. Scientists are investigating ways to implement new types of technology to help speed up the process.

To that end, Fermilab recently installed a single rack of servers full of solid-state NVMe drives at its Feynman Computing Center to speed up particle physics analyses.

Generally, solid state drives use compact electrical circuits to quickly transfer data. NVMe is an advanced type of solid-state drive that can handle up to 4,000 megabytes per second. To put that into perspective, the average hard drive caps at around 150 megabytes per second, making solid-state the obvious choice if speed is your main goal.

But hard drives haven't been relegated to antiquity just yet. What they lack in speed, they make up for in storage capacity. At present, the average storage limit in solid-state drives is 500 gigabytes, which is the minimum amount of storage you'd commonly find available on modern hard drives. Determining whether or not Fermilab should replace more of their hard drive memory storage with solid-state drives will thus require a careful analysis of cost and benefits.

### **Undertaking an analysis**

When researchers analyze their data using large computer servers or supercomputers, they typically do so by sequentially retrieving portions of that data from storage, a task well-suited for hard drives.

"Up until now, we've been able to get away with using hard drives in high-energy physics because we tend to handle millions of events by analyzing each event one at a time," Jayatilaka said. "So at any given time, you're asking for only a few pieces of data from each individual hard drive."

But newer techniques are changing the way scientists analyze their data. Machine learning, for example, is becoming increasingly common in particle physics, especially for the CMS experiment, where this technology is responsible for the automated selection process that keeps only the small fraction of data scientists are interested in studying.

But instead of accessing small portions of data, machine learning algorithms need to access the same piece of data repeatedly—whether it's stored on a hard drive or solid-state drive. This wouldn't be much of a problem if there were only a few processors trying to access that data point,

but in high-energy physics calculations, there are thousands of processors that are vying to access that data point simultaneously.

This can quickly cause bottlenecks and slow speeds when using traditional hard drives. The end result is slower computing times.

Fermilab researchers are currently testing NVMe technology for its ability to reduce the number of these data bottlenecks.

### **The future of computing at Fermilab**

Fermilab's storage and computing power are much more than just a powerhouse for the CMS experiment. The CMS computing R&D effort is also setting the foundations for the success of the upcoming High-Luminosity LHC program and enabling the international, Fermilab-hosted Deep Underground Neutrino Experiment, both of which will start taking data in the late 2020s.

Jayatilaka and his team's work will also allow physicists to prioritize where NVMe drives should be primarily located, whether at Fermilab or at other LHC partner institutions' storage facilities.

With the new servers in hand, the team is exploring how to deploy the new solid-state technology in the existing computing infrastructure at Fermilab.

Provided by [Fermi National Accelerator Laboratory](https://phys.org/news/2020-10-solid-state-technology-big-particle-physics.html)

<https://phys.org/news/2020-10-solid-state-technology-big-particle-physics.html>



*Wed, 28 Oct 2020*

## **The experimental demonstration of entanglement between mechanical and spin systems**

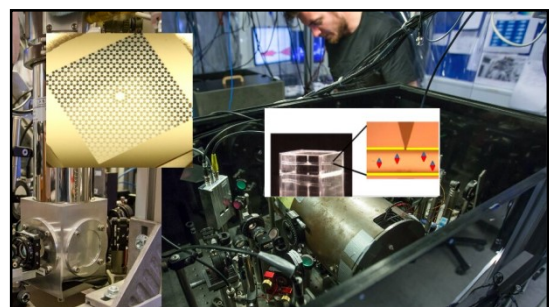
*By Ingrid Fadelli*

Quantum entanglement is the basic phenomenon underlying the functioning of a variety of quantum systems, including quantum communication, quantum sensing and quantum computing tools. This phenomenon results from an interaction (i.e., entanglement) between particles. Attaining entanglement between distant and very different objects, however, has so far proved highly challenging.

Researchers at the University of Copenhagen have recently generated entanglement between a mechanical oscillator and a collective atomic spin oscillator. Their work, outlined in a paper published in *Nature Physics*, introduces a strategy for generating entanglement between these two distinct systems.

"About a decade ago, we proposed a way to generate entanglement between a mechanical oscillator and a spin oscillator via photons, using the principle that was later called 'quantum mechanics free subspaces' or 'trajectories without quantum uncertainties,'" said Eugene S. Polzik, who led the group that carried out the study. "In our new paper, we report experimental implementation of these proposals."

To generate entanglement between a mechanical and a spin system, Polzik and his colleagues leveraged a key feature of spin oscillators, namely that they can have an effective negative mass. When it is excited, a spin oscillator's energy is reduced, which allows it to become entangled with a more conventional mechanical oscillator that has a positive mass. The researchers experimentally generated this entanglement by performing a joint measurement on both oscillators.



**Image illustrating the experiment carried out by the researchers. Credit: Thomas et al.**

"Entanglement between the mechanical and spin systems is generated by sending light through both systems, a positive mass mechanical oscillator and a spin oscillator with an effective negative mass," Polzik said. "Performing a measurement on the transmitted light projects the two systems into an entangled state. Subsequent repeated measurement verifies the entanglement by showing that the quantum fluctuations of the two systems are strongly correlated."

The experiment carried out by Polzik and his colleagues shows that mechanical motion can, at least in principle, be measured with arbitrary accuracy by identifying and applying a suitable reference frame. These measurements overcome the so-called 'standard quantum limit of measurement' that derives from the Heisenberg uncertainty principle, which is applicable to measurements in a standard, classical reference frame.

"The essence of the uncertainty principle is the balance between the imprecision of measurement and the disturbance caused by the measurement, the quantum back action," Polzik said. "With a measurement in the negative mass reference frame the backaction disturbances imposed on the object and on the reference frame interfere destructively and cancel out, thus leading to potentially unlimited measurement accuracy."

This team of researchers was the first to experimentally demonstrate entanglement between a mechanical and a spin system. In the future, their work could contribute to the development of new quantum technologies and protocols that are based on entanglement between different types of oscillators. In their next studies, Polzik and his colleagues plan to evaluate the effectiveness of their approach for performing quantum teleportation and to develop other quantum communication tools.

"With the recent observation of quantum back action by the gravitational wave detectors' teams LIGO and VIRGO the ways to overcome the quantum back action limits become especially relevant for those extremely challenging instruments," Polzik said. "We are constructing an experiment where we intend to demonstrate potential applicability of our approach to the improved sensitivity of gravitational wave detectors."

**More information:** Entanglement between distant macroscopic mechanical and spin systems. *Nature Physics* (2020). [DOI: 10.1038/s41567-020-1031-5](https://doi.org/10.1038/s41567-020-1031-5).

**Journal information:** [Nature Physics](https://www.nature.com/news)  
<https://phys.org/news/2020-10-experimental-entanglement-mechanical.html>



# Researchers investigate material properties for longer-lasting, more efficient solar cells

By Bill Wellock

The designers of solar cells know their creations must contend with a wide range of temperatures and all sorts of weather conditions—conditions that can impact their efficiency and useful lifetime.

Florida State University Assistant Professor of Chemistry and Biochemistry Lea Nienhaus and former FSU postdoctoral researcher Sarah Wieghold are helping to understand the fundamental processes in a material known as perovskites, work that could lead to more efficient solar cells that also do a better job of resisting degradation. They found that small tweaks to the chemical makeup of the materials as well as the magnitude of the electrical field it is exposed to can greatly affect the overall material stability.

Their latest work is published in a pair of studies in *Journal of Materials Chemistry C* and *Journal of Applied Physics*.

Their research is focused on improving the potential of perovskites, a material with a crystal structure based on positively charged lead ions known as cations and negatively charged halide anions. In a cubic perovskite crystal structure, the octahedra formed by the lead and halide ions are surrounded by additional positively charged cations.

The first perovskite solar cells, which were developed in 2006, had a solar energy power conversion efficiency of about 3 percent, but cells developed in 2020 have a power conversion efficiency of more than 25 percent. That rapid increase in efficiency makes them a promising material for further research, but they have drawbacks for commercial viability, such as a tendency to degrade quickly.

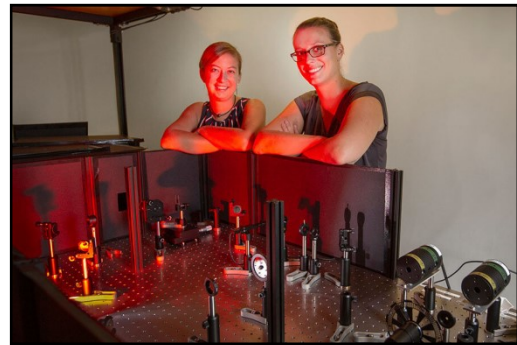
"How can we make perovskites more stable under real-world conditions in which they'll be used?" Nienhaus said. "What is causing the degradation? That's what we're trying to understand. Perovskites that don't degrade quickly could be a valuable tool for obtaining more energy from solar cells."

Perovskites are a so-called "soft material," despite the ionic bonds of the crystal lattice that make up their structure. The halides or cations in the material can move through that lattice, which may increase their rate of degradation, resulting in a lack of long-term stability.

In the *Journal of Materials Chemistry C* paper, the researchers investigated the combined influence of light and elevated temperature on the performance of mixed-cation mixed-halide perovskites.

They found that adding a small amount of the element cesium to the perovskite film increases the stability of the material under light and elevated temperatures. Adding rubidium, on the other hand, led to worse performance.

"We found that depending on the choice of the cation, two pathways of degradation can be observed in these materials, which we then correlated to a decrease in performance," said Wieghold, now an assistant scientist at the Center for Nanoscale Materials and the Advanced



Former Florida State University postdoctoral researcher Sarah Wieghold, left, and FSU Assistant Professor of Chemistry and Biochemistry Lea Nienhaus. Their research is helping to understand the fundamental processes in a material known as perovskites, work that could lead to more efficient solar cells that also do a better job of resisting degradation. Credit: FSU

Photon Source at Argonne National Laboratory. "We also showed that the addition of cesium increased the film stability under our testing conditions, which are very promising results."

They also found that a decrease in film performance for the less stable perovskite mixtures was correlated with the formation of the compound lead bromide/iodide and an increase in electron-phonon interactions. The formation of lead bromide/iodide is due to the unwanted degradation mechanism, which needs to be avoided to achieve long-term stability and performance of these perovskite solar cells.

In the *Journal of Applied Physics* paper, they explored the link between voltage and the performance of perovskite materials. This showed that the ion movement in the material changes the underlying electrical response, which will be a critical factor in the photovoltaic performance.

"Perovskites present a great opportunity for the future of solar cells, and it's exciting to help move this science forward," Nienhaus said.

**More information:** Sarah Wieghold et al, Understanding the effect of light and temperature on the optical properties and stability of mixed-ion halide perovskites, *Journal of Materials Chemistry C* (2020). DOI: [10.1039/D0TC02103B](https://doi.org/10.1039/D0TC02103B)

<https://phys.org/news/2020-10-material-properties-longer-lasting-efficient-solar.html>



Wed, 28 Oct 2020

## Making it possible to create larger 3-D-printed objects with ceramics

By Henk Van Appeven

Ceramics are some of the oldest materials made by humans. At the same time, they are some one of the most promising materials for the key technologies of the twenty-first century. However, ceramics are challenging to shape and process, especially for applications where 3-D printing, also known as additive manufacturing (AM), would be an interesting manufacturing method.

Eindhoven University of Technology (TU/e) Ph.D. candidate Steyn Westbeek developed a model to help make AM of larger ceramic objects possible. This research was part of a larger research project—together with applied scientific research center TNO and the TU/e High Tech Systems Center—with other Ph.D. candidates, studying the whole print process for ceramics, including layer deposition and improving 3-D printer concepts and control.



Steyn Westbeek. Credit: Eindhoven University of Technology

### Unique properties both a benefit and a challenge

Ceramics are typically excellent electrical and heat insulators that are hard, strong, biocompatible and robust when faced with many chemicals and temperatures. These unique properties mean ceramics could help improve quality of living, save energy, reduce wear and increase the lifetime of components in many different applications. However, these qualities also make it likely that deformations and cracks occur at some stage during the 3-D printing process—usually, because of stresses within the material.

Although increasingly mainstream for other materials, AM is not well understood for ceramics. Until now, it has mostly been used to produce low volumes of very detailed objects smaller than a few cm. Bigger objects run a high risk of cracking.

Westbeek created a model of the physical processes inside the 3-D printer, to help improve understanding of 3-D printing of ceramics and make it possible to print larger objects. AM of ceramics is a two-step process: first, very thin layers of a mixture of ceramic powder and a binder

are laid down, hardened by UV light between each layer. This creates the final shape of the object. Second, the object is heated in an oven to remove the binder—much like baking a clay sculpture.

### **Predicting what goes wrong during the hardening phase**

Westbeek focused mostly on the UV hardening phase, where the binder/powder mixture becomes solid. The hardening step can be a source of stresses in the material. The model includes the printer settings, such as the characteristics of the UV light source and the properties of the binder, and processes such as light bouncing off the ceramic powder and temperature increases inside the object during hardening.

With this knowledge, it is possible to change the 3-D printing process to make sure it works best for the shape you want to print. This reduces many different issues, such as walls that are too thick, object overheating, too little or uneven hardening and, finally, the development of stresses that can lead to cracks and of unwanted deformation. This new understanding is a valuable step towards the printing of complex shaped and large-area ceramics.

**More information:** Multi-scale modeling of the additive manufacturing of ceramics by vat photopolymerization. [research.tue.nl/nl/publication ... uring-of-ceramics-by](https://research.tue.nl/nl/publication...uring-of-ceramics-by)  
<https://phys.org/news/2020-10-larger-d-printed-ceramics.html>



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## **60-year-old limit to lasers overturned by quantum researchers**

A team of Australian quantum theorists has shown how to break a bound that had been believed, for 60 years, to fundamentally limit the coherence of lasers.

The coherence of a laser beam can be thought of as the number of photons (particles of light) emitted consecutively into the beam with the same phase (all waving together). It determines how well it can perform a wide variety of precision tasks, such as controlling all the components of a quantum computer.

Now, in a paper published in *Nature Physics*, the researchers from Griffith University and Macquarie University have shown that new quantum technologies open the possibility of making this coherence vastly larger than was thought possible.



Credit: Pixabay/CC0 Public Domain

"The conventional wisdom dates back to a famous 1958 paper by American physicists Arthur Schawlow and Charles Townes," said Professor Wiseman, project leader and Director of Griffith's Center for Quantum Dynamics.

Each of them went on to win a Nobel prize for their laser work.

"They showed theoretically that the coherence of the beam cannot be greater than the square of the number of photons stored in the laser," he said.

"But they made assumptions about how energy is added to the laser and how it is released to form the beam.

"The assumptions made sense at the time, and still apply to most lasers today, but they are not required by quantum mechanics."

"In our paper, we have shown that the true limit imposed by quantum mechanics is that the coherence cannot be greater than the fourth power of the number of photons stored in the laser," said Associate Professor Dominic Berry, from Macquarie University.

"When the stored number of photons is large, as is typically the case, our new upper bound is much bigger than the old one."

But can this new bound on coherence be achieved? "Yes," says Dr. Nariman Saadatmand, a researcher in Professor Wiseman's group.

"By numerical simulation we have found a quantum mechanical model for a laser which achieves the theoretical upper bound for coherence, in a beam that is otherwise indistinguishable from that of a conventional laser."

So when will we see these new super-lasers? "Probably not for a while," says Mr Travis Baker, the Ph.D. student on the project at Griffith University. "But we do prove that it would be possible to construct our truly quantum-limited laser using superconducting technology. This is the same technology used in the current best quantum computers, and our proposed device may have applications in that field."

"Our work raises many interesting questions such as whether it could allow more energy-efficient lasers," Professor Wiseman said. "That would also be a great benefit, so we hope to be able to investigate that in the future."

**More information:** Travis J. Baker et al. The Heisenberg limit for laser coherence, *Nature Physics* (2020). [DOI: 10.1038/s41567-020-01049-3](https://doi.org/10.1038/s41567-020-01049-3)

**Journal information:** [Nature Physics](https://www.nature.com/subjects/physics)  
<https://phys.org/news/2020-10-year-old-limit-lasers-overtuned-quantum.html>



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## Researchers develop new atomic layer deposition process

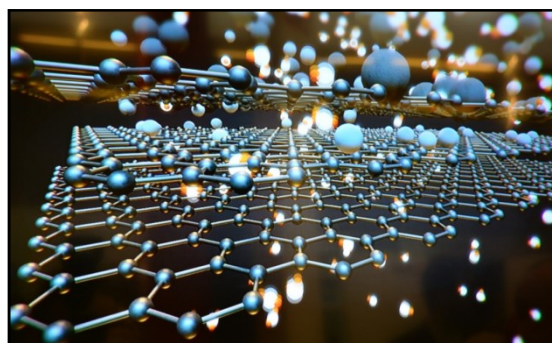
By Jim Steele

A new way to deposit thin layers of atoms as a coating onto a substrate material at near room temperatures has been invented at The University of Alabama in Huntsville (UAH), a part of the University of Alabama System.

UAH postdoctoral research associate Dr. Moonhyung Jang got the idea to use an ultrasonic atomization technology to evaporate chemicals used in atomic layer deposition (ALD) while shopping for a home humidifier.

Dr. Jang works in the laboratory of Dr. Yu Lei, an associate professor in the Department of Chemical Engineering. The pair have published a paper on their invention that has been selected as an editor's pick in the *Journal of Vacuum Science & Technology A*.

"ALD is a three-dimensional thin film deposition technique that plays an important role in microelectronics manufacturing, in producing items such as central processing units, memory and hard drives," says Dr. Lei.



Credit: CC0 Public Domain

Each ALD cycle deposits a layer a few atoms deep. An ALD process repeats the deposition cycle hundreds or thousands of times. The uniformity of the thin films relies on a surface self-limiting reaction between the chemical precursor vapor and the substrates.



"ALD offers exceptional control of nanometer features while depositing materials uniformly on large silicon wafers for high volume manufacturing," Dr. Lei says. "It is a key technique to produce powerful and small smart devices."

While browsing online for a safe and easy-to-use home humidifier, Dr. Jang observed that humidifiers on the market use either direct heating at high temperature or ultrasonic atomizer vibration at room temperature to generate the water mist.

"Moon suddenly realized that the latter could be a safe and simple way to generate vapors for reactive chemicals that are thermally unstable," says Dr. Lei.

"The next day, Moon came to discuss the idea and we designed the experiments to prove the concept in our research lab. The whole processes took almost a year. But the great idea came to Moon like a flash."

ALD processes typically rely on heated gas-phase molecules that are evaporated from their solid or liquid form, similar to room humidifiers that use heat to vaporize water. Yet in that ALD process, some chemical precursors are not stable and can decompose before reaching a sufficient vapor pressure for ALD.

"In the past, many reactive chemicals were considered not suitable for ALD because of their low vapor pressure and because they are thermally unstable," says Dr. Lei. "Our research found that the ultrasonic atomizer technique enabled evaporating the reactive chemicals at as low as room temperature."

The UAH scientists' ultrasound invention makes it possible to use a wide range of reactive chemicals that are thermally unstable and not suitable for direct heating.

"Ultrasonic atomization, as developed by our research group, supplies low vapor pressure precursors because the evaporation of precursors was made through ultrasonic vibrating of the module," Dr. Lei says.

"Like the household humidifier, ultrasonic atomization generates a mist consisting of saturated vapor and micro-sized droplets," he says. "The micro-sized droplets continuously evaporate when the mist is delivered to the substrates by a carrier gas."

The process uses a piezo-electric ultrasonic transducer placed in a liquid chemical precursor. Once started, the transducer starts to vibrate a few hundred thousand times per second and generates a mist of the chemical precursor. The small liquid droplets in the mist are quickly evaporated in the gas manifold under vacuum and mild heat treatment, leaving behind an even coat of the deposition material.

"Using the room-temperature ultrasonic atomization reported by our manuscript, new ALD processes could be developed using low volatility and unstable precursors," Dr. Lei says. "It will open a new window to many ALD processes."

In their paper, the UAH researchers demonstrate proof of concept by comparing titanium oxide ALD using thermally evaporated and room-temperature ultrasonic atomized chemical precursors, respectively.

"The TiO<sub>2</sub> thin film quality is comparable," says Dr. Lei.

**More information:** Henrik H. Sønsteby et al. tert-butoxides as precursors for atomic layer deposition of alkali metal containing thin films, *Journal of Vacuum Science & Technology A* (2020). DOI: [10.1116/6.0000589](https://doi.org/10.1116/6.0000589)

<https://phys.org/news/2020-10-atomic-layer-deposition.html>



## After studies, it's clear that air pollution contributes to Covid mortality: ICMR

By Aparna Banerjee

- According to a study, scientists have estimated that about 15% of deaths worldwide from COVID-19 could be attributed to long-term exposure to air pollution
- Furthering on the development of the Covid-19 vaccines in India and its distribution, Dr Bhargava informed that three vaccine candidates are in different stages of clinical testing

Amid coronavirus pandemic and the onset of winters in the country, the Indian Council of Medical Research (ICMR) on Tuesday said that studies have proven that long-term exposure to air pollution has been linked to an increased risk of dying from Covid-19.

"There have been studies from Europe and US, where they have looked at polluted areas and have compared mortality during lockdown and correlation with pollution. It is found that pollution is contributing to mortality in COVID, that's well established by studies," said Dr Balram Bhargava, DG ICMR, in a health ministry briefing today.

According to a study, published in Cardiovascular Research on Tuesday, scientists estimated that about 15% of deaths worldwide from COVID-19 could be attributed to long-term exposure to air pollution. In Europe the proportion was about 19%, in North America it was 17%, and in East Asia about 27%.

In their CVR paper, the researchers write that these proportions are an estimate of "the fraction of COVID-19 deaths that could be avoided if the population were exposed to lower counterfactual air pollution levels without fossil fuel-related and other anthropogenic [caused by humans] emissions".

Moreover, speaking on the Covid-19 spread in the country among youngsters, Dr Bhargava added that overall the figure in India is that below the age of 17 years, only 8% are COVID-19 positive, and below the age of 5 years, that figure would be much less.

Furthering on the development of the Covid-19 vaccines in India and its distribution as soon as it's available, Dr Bhargava informed that three vaccine candidates in India are in different stages of clinical testing. "Covaxin has got approval for phase III trials, Cadila also progressing with phase-II trials & Serum is completing phase 2b trial and has an ongoing trial in Brazil, South Africa and the US," he added.

Echoing the concern of availability and distribution in the country, V K Paul, Niti Aayog member, said, "We've requested state governments to wait for overall picture to become clear and to take a national approach towards engaging companies & deciding the criteria for vaccine. In order to deliver the vaccine to priority groups, there's no problems in terms of resources."

Meanwhile, air quality deteriorated in the national capital with the rise of pollutants in the atmosphere and overall Delhi's Air Quality Index (AQI) is in the "very poor" category, said the Delhi Pollution Control Committee data on Tuesday.



DG, ICMR Dr. Balram Bhargava addressing a press conference on the actions taken, preparedness, and updates on COVID-19 (ANI)

The Air Quality Index (AQI) was recorded at 346 in Rohini, 329 in RK Puram, 377 in Anand Vihar, and 363 in Mundka, all four in the 'very poor' category, as per Central Pollution Control Board (CPCB) data.

In an attempt to curb the increasing air pollution in the national capital, the Delhi government recently launched the 'Red Light On, Gaadi Off' campaign as part of its 'Yuddh Pradushan Ke Viruddh' (War Against Pollution) initiative.

Along with this, Delhi Environment Minister Gopal Rai had also announced the launch of a campaign starting on Monday to include the citizens of the capital in raising awareness on air pollution.

<https://www.livemint.com/news/india/after-studies-it-s-clear-that-air-pollution-contributes-to-covid-mortality-icmr-11603799525870.html>

