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CONTENTS

S. No.	TITLE	Page No.
DRDO News		1-7
DRDO Technology News		1-7
1.	Missile scientists encountered multiple challenges developing complex technologies	1
2.	India's DRDO completes second testing of QRSAM system	3
3.	Japan's decision to release Fukushima radioactive water into sea will cause disease along Asian coastal belt: experts	4
4.	Railways to provide train coaches with 800 beds to Delhi for Covid-19 treatment: MHA	6
5.	दिल्ली में कोरोना को लेकर एक्शन में गृह मंत्रालय, उठाया ये बड़ा कदम	7
Defence News		8-16
Defence Strategic National/International		8-16
6.	Army completes setting up of modern habitat for troops in Ladakh	8
7.	कड़कड़ाती सर्दी में भी चीन पर जारी रहेगी निगेहबानी, सेना ने पूर्वी लद्दाख में जवानों के लिए बनाए अत्याधुनिक आवास	9
8.	China is fortifying defences across Ladakh border, not prepping to disengage	10
9.	IAF for short-term leasing of trainer aircraft, light copters	12
10.	Indian Navy gets 9th P-8I anti-submarine warfare aircraft ordered from US	13
11.	Indian AI company wins at UK-US military space pitch	14
12.	China's endgame in Ladakh	15
Science & Technology News		17-26
13.	First crewless Gaganyaan flight only by end of 2021	17
14.	Faster detection of photocatalyst-generated oxygen has big implications for clean energy	18
15.	A new understanding of ionic interactions with graphene and water	20
16.	Researchers establish proof of principle in superconductor study	22
17.	The ultimate conditions to get the most out of high-nickel batteries	23
COVID-19 Research News		25-26
18.	Early details of brain damage in COVID-19 patients	25



Thu, 19 Nov 2020

Missile scientists encountered multiple challenges developing complex technologies | HSTDV series Part-1

Bengaluru: The Defence Research and Development Organisation (DRDO), in September this year successfully flight-tested the Hypersonic Technology Demonstrator Vehicle (HSTDV) using the indigenously developed scramjet propulsion system.

Termed as a giant leap in indigenous defence technologies, the initial success of this hypersonic airbreathing scramjet technology has given missile scientists the confidence to undertake R&D into much more complex areas as they progress into the next phase.

Onmanorama interacted with the HSTDV team, capturing the history of the programme and the challenges involved in realizing some of the complex technologies set to serve as the building block for next generation hypersonic vehicles.

Through this three-part series, we bring to you a glimpse of the early years of India's HSTDV dream, the current state, and the road ahead.

A decade of work

It was in early 2000 that DRDO initiated work on HSTDV in order to be on par with developed nations in the field of hypersonics. During this period the United States, Russia and Australia were among the developed nations deeply involved in hypersonic missions.

The primary aim was to develop an autonomous hypersonic cruise vehicle, which can cover a long distance in a short time.

Hypersonic cruise vehicles are very different from ballistic missiles in the sense, the trajectory is difficult to predict.

Accordingly, feasibility studies were carried out in 2004 at the Defence Research and Development Laboratory (DRDL), Hyderabad. This feasibility study formed the base for developing the hypersonic vehicle.

Dr S Panneerselvam, a pioneer in the field of aerodynamics, was the first Project Director of the HSTDV project. He and a team of five scientists worked to conceptualize the shape and size of the HSTDV Cruise Vehicle (CV) using computational tools. The team was multidisciplinary, with expertise in streams of engineering involving aerodynamics, structures, controls, and scramjet propulsion.

Many new technologies were developed during the development cycle. Subsequently, a cruise vehicle was indigenously realized in DRDO.



There were several scientists who played the role of mentors during the HSTDV design work. Late AK Kaushik (retired DRDL scientist), Prof HS Mukunda (ex-Prof, IISc), late Prof PJ Paul (ex-Prof, IISc), Prof MA Ramaswamy (ex-Prof, IISc), Dr YR Mahajan (ex-ARCI), Dr TS Prahlad (former Director, NAL), Dr Abdul Majeed (Ex-VSSC), Dr Kota Harinaryana (former Programme Director, LCA), Prof GR Shevare (ex-Prof, IIT, Bombay), NV Kadam (former Associate Director, DRDL), SK Ray (former Director, RCI) and Dr Rajaram Nagappa (ex-Prof, MIT) were the pillars who guided a dedicated team of DRDO scientists towards the realization of the design.

Challenges Galore

Initially, the HSTDV CV was conceptualized. The CV works in a specific window of hypersonic regime (altitude: 29-34 kms and at 5.8-6.5 Mach).

A launch vehicle (LV) was required to carry the CV to the desired conditions. It was planned to design the CV with available materials (titanium, nickel-based alloys and aluminum).

“Those days DRDO’s well-proven Agni-I missile was the best suited booster for HSTDV CV and it was chosen for the LV. During the ascent phase of the LV, due to high kinetic heating within the atmosphere, the temperature on the exposed CV was exceeding the capability of materials. There was a need for a protective system for the HSTDV CV to deal with the kinetic heating during the LV ascent phase. Seven-metre -long and one-metre diameter size split protective fairings were designed to keep the CV within the allowable temperature,” said a scientist, who is in the team.

The LV was going through very high dynamic pressure of around 5 bar, which is a very huge number for a launch vehicle.

The scientists had to conduct several heating studies and experiments to clear the LV. The control capability of the LV was another bottleneck. Extensive modifications of the launch vehicle control surfaces and wind tunnel and aero-thermal testing were carried out to qualify the LV.

Within the one-meter diameter restrictions of the Agni-I launch vehicle, the cruise vehicle’s wing had to be folded like a small baby in the womb. This required an unfolding mechanism at high speed and it was implemented.

“The protective fairings have to be separated when the injection conditions for cruise vehicle have been achieved. This was massive bottleneck as it needed a large number of pyro-mechanisms to be operated within a few milliseconds simultaneously so that the panels open at hypersonic speed,” recalled the scientist.

Finally, several iterations and brain storming sessions with experts in the country provided major design inputs that came to the rescue of the team “Very limited testing is possible for fairing separation. The entire sequence of separation was studied through CFD (Computational Fluid Dynamics) and it was tested successfully in the Terminal Ballistics Research Laboratory (TBRL), Chandigarh. So far the most developed nations have not attempted such separation mechanisms at relatively high dynamic pressures,” said another team member.

New Technologies

In the CV, the design process was newly evolved and it was the first of its kind in DRDL, Hyderabad.

Eventually, a lot of technological base was developed in the areas of hypersonic aerodynamics, aerothermo dynamics, intake aerodynamics and scramjet propulsion.

“The design was a purely indigenous effort. With the CV being non-axisymmetric and since we were addressing it for the first time, there were thermal buckling issues, which were sorted out tweaking the design of hot structures,” recalled the scientist.

The materials for fuel injection posed a fresh set of challenges due to the high combustion temperatures.

The scientists had to constantly make multiple iterations, changing the material and construction.

The HSTDV team says that most of the technologies for the mission were developed afresh, as its design aspects were completely different from the various missiles developed by DRDO.

“In other missiles, there is a certain decoupling between airframe and engine. But the CV needs an aeropropulsion-structure-integrated design. The engine–airframe attachment was another major technical challenge we had to address. We attempted several schemes before nalizing the right one,” added the scientist.

(The writer is an independent aerospace and defence journalist, who blogs at Tarmak007 and tweets @writetake.)

<https://www.onmanorama.com/news/nation/2020/11/18/hstdv-hypersonic-missile-challenges-technology.html>

Army Technology

Thu, 19 Nov 2020

India’s DRDO completes second testing of QRSAM system

The Indian Ministry of Defence (MoD) has announced the completion of the second testing of Quick Reaction Surface-to-Air Missile (QRSAM)

The Indian Ministry of Defence (MoD) has announced the completion of the second testing of Quick Reaction Surface-to-Air Missile (QRSAM).

The test is claimed to prove the warhead’s performance parameters.

The system was fired against a Banshee pilotless target aircraft. It is claimed to have tracked and neutralised the airborne target.

The test was carried out by the Defence Research and Development Organisation (DRDO) on 17 November.

DRDO conducted the second test at the Integrated Test Range at Chandipur, which is located off Odisha coast, India.

The target was acquired by the radars from a long range, following which, it was tracked until the mission computer launched the missile automatically.

The radar data link provided continuous guidance.

QRSAM entered the terminal active homing guidance and then reached the target close enough to have proximity operation of warhead activation.

The flight test was carried out in the deployment configuration of the QRSAM weapon system elements such as the launcher, fully automated command and control system, surveillance system and multi-function radars.

It can detect and track targets on the move and engages with the target with short halts.

Radar, telemetry and electro-optical sensors and other range instruments were deployed during the flight test.

The test saw participation from ARDE and R&DE(E) from Pune, LRDE Bengaluru, and IRDE Dehradun as well as Missile Complex Laboratories from Hyderabad and Balasore.

On 13 November, Indian MoD announced the completion of the first testing of Quick Reaction Surface-to-Air Missile (QRSAM).

<https://www.army-technology.com/news/indias-drdo-second-testing-qrsam-system/>



The second test of the Quick Reaction Surface-to-Air Missile (QRSAM) took place on 17 November 2020. Credit: Government of India / Press India Bureau.

Japan's decision to release Fukushima radioactive water into sea will cause disease along Asian coastal belt: experts

By Rupesh Dutta

New Delhi: Japan's decision to release radioactive contaminated water from its wrecked nuclear plant in Fukushima into the sea by 2022 has led to alarm bells ringing in India with experts warning it would set a wrong precedent and impact aquatic and human life along coastal belts of several parts of the world.

The contaminants of the massive quantities of nuclear water will include radioactive isotopes such as cesium, tritium, cobalt and carbon-12 and may take from 12 to 30 years to decay. It will destroy everything it comes in contact with almost immediately and cripple the economy related to the fishing industry and lead to a spectrum of diseases, including cancer.

"This will be the first incident of high volumes of radioactive water being released in the sea and can set a wrong precedent for others to follow. Concerns related to the environment and health are crucial for the existence of the human race. Therefore, alternative arrangements may be debated globally," AK Singh, Director General of Life Science at the Defence Research Development Organisation (DRDO), told PTI.

On March 11, 2011, a 9.0 magnitude earthquake struck off the north-eastern coast of Japan, triggering a 15-metre tsunami that damaged the 5,306 MW Fukushima nuclear plant. It is the second biggest nuclear disaster in the history of nuclear power generation after Chernobyl in 1986.

After the accident, 1.2 million tonnes of radioactive contaminated water released from the reactors in over 1,000 tanks were kept in a cordoned off large area near the Fukushima plant.

However, authorities are running out of space as the plant is to be decommissioned and the Japanese government has decided to release the radioactive contaminated water in the sea starting 2022.

The decision to release the radioactive water was taken on October 16, 2020 after years of debate.

Singh, among the Indian government's top nuclear health scientists, said the release of contaminated water into the ocean will directly impact human and aquatic life.

"The possibility of ingestion of tritium in humans will increase and since this isotope will distribute in all organs in humans and long. Radioactivity monitoring in fish and other aquatic life in near vicinity (coastal areas) and drinking water will be necessary. Deposition of the radioactive elements on the rocks has also to be seen," he said.

While Japanese authorities have said the water would be diluted before being released and it would only contain only tritium, other health experts who have been monitoring the issue said the risk involved should never be undermined.

Yudhyavir Singh, assistant professor of anaesthesia and critical care at the All India Institute of Medical Sciences, said the risks will depend entirely on the amount of the contaminants present in the nuclear wastewater and their nature.

"Mostly contaminants are radioactive isotopes which include cesium, cobalt, carbon-14 and tritium. The half-life of cesium is 30 years... it will take 30 years of half of the material to decay. Also the half-life of tritium is 12 years," he told PTI.

"All the radioactive isotopes are carcinogenic and can induce cancer on prolonged exposure. In Chernobyl, it has been seen in the rise of thyroid cancer post nuclear leakage after 20 years," he said.

Once the water is released into the ocean, it would be advisable to move and stay away from the coastal area in the region while completely avoiding seafood, added Yudhavir Singh, who has several publications on critical care and is a renowned researcher too.

“In the past, it has been seen that radioactive material discarded in France travelled to the North Atlantic and Arctic Oceans and found in the bodies of seals and Tortoises,” he said, warning that South East Asian nations will be at higher risk.

Environmentalists and several organisations, including Safecast and Greenpeace, have urged the Tokyo Electric Power Company (TEPCO), the operator of the Fukushima plant, to build more storage tanks and keep the water stored.

Greenpeace claimed the water could change human DNA if consumed.

“Tritium is a beta emitter with low energy so causes damage to the DNA leading to genetic damage and affecting reproductions. It will depend upon the radioisotopes contaminants in the water. Cesium has a half-life of 30 years and will be the last to decompose,” Yudhyavir Singh said.

The quantity of cesium in the nuclear waste water may take 180-300 years to decompose, he said.

Citing studies from the World Health Organisation, MC Misra, former Director of AIIMS, Delhi, said an increase for specific cancers for certain subsets of the population inside the Fukushima Prefecture is very likely.

“A 2013 report predicts that for populations living in the most affected areas there is a 70 per cent higher risk of developing thyroid cancer for girls exposed as infants, a 7 per cent higher of leukemia in males exposed as infants, a 6 per cent higher risk of breast cancer in women and 4 per cent higher risk, overall, of developing solid cancers for females,” Misra told PTI.

Misra, who has dealt with all types of medical cases, including that of radiation, said Japan could have easily prevented the entire accident.

“The Japanese focused on the prevention principle without paying due attention to the mitigation principle as if it was sure that an accident was impossible. The power unit of the Fukushima plant was built on the basis of a design developed in 1960 and, therefore, the station was not ready for a crisis situation of the 21st century,” Misra said, citing the complexity of such situations. PTI RUP MIN MIN MIN

(Disclaimer: This story has not been edited by Outlook staff and is auto-generated from news agency feeds. Source: PTI)

<https://www.outlookindia.com/newscroll/japans-decision-to-release-fukushima-radioactive-water-into-sea-will-cause-disease-along-asian-coastal-belt-experts/1977829>

Railways to provide train coaches with 800 beds to Delhi for Covid-19 treatment: MHA

DRDO is going to add 250 additional ICU beds to the existing 250 ICU beds in addition to creating 35 BIPAP beds in the next 3 to 4 days at its COVID-19 hospital near the Delhi airport

New Delhi: As many as 45 doctors and 160 paramedics of the paramilitary forces have arrived in Delhi for deployment on COVID-19 duties while the Railways will make available coaches with 800 beds at a station here to be used as COVID care-cum-isolation facilities, the MHA said on Wednesday.

The Union Ministry of Home Affairs (MHA) also said that the Defence Research and Development Organisation (DRDO) is going to add 250 additional ICU beds to the existing 250 ICU beds in addition to creating 35 BIPAP beds in the next 3 to 4 days at its COVID-19 hospital near the Delhi airport.

The actions come in the wake of 12 decisions taken at a high-level meeting chaired by Union Home Minister Amit Shah on Sunday.

Delhi has witnessed a spurt in coronavirus cases since October 28 when the daily rise breached the 5,000-mark for the first time and it crossed the 8,000-mark on November 11.

Forty-five doctors and 160 para-medics from paramilitary forces have arrived in Delhi for deployment at DRDO hospital near Delhi airport and at a COVID care centre at Chhatarpur, a home ministry spokesperson said.

Remaining doctors and medics will reach Delhi in the next few days, the official said.

The home ministry has constituted 10 multi-disciplinary teams to visit more than 100 private hospitals in Delhi for assessing bed utilisation and testing capacity and to identify extra ICU beds. Visits by the teams is underway, the official said.

The Indian Railways is making available coaches with 800 beds at Shakur Basti railway station while doctors and para-medics from paramilitary forces will man the coaches which will act as COVID care-cum-isolation facilities.

The Indian Council of Medical Research (ICMR) and the Delhi government are working together to enhance RT-PCR testing capacity to 60,000 tests by end of November, the official said.

Testing capacity has already been enhanced by 10,000 tests per day on November 17, the spokesperson said.

The planning for house to house survey in Delhi is in the advanced stage. The survey is expected to begin by the end of the week and completed by November 25, the official said.

According to the spokesperson, Bharat Electronics Limited (BEL) has dispatched 250 ventilators from Bengaluru and they are expected to reach Delhi by the end of the week.

The Union health ministry has delivered 35 BIPAP machines to DRDO COVID facility near the Delhi airport, the official said.

To bring testing closer to Delhi residents, the ICMR will help Delhi government in deploying 10 mobile testing laboratories with a total capacity of 20,000 tests in a phased manner beginning next week, the spokesperson said.

<https://www.india.com/news/india/railways-to-provide-train-coaches-with-800-beds-to-delhi-for-covid-19-treatment-mha-4214391/>



File photo: PTI

दिल्ली में कोरोना को लेकर एक्शन में गृह मंत्रालय, उठाया ये बड़ा कदम

गृह मंत्रालय के मुताबिक, पारा मिलिट्री के 45 डॉक्टर और 160 पारा-मेडिकल स्टाफ दिल्ली (Delhi) में कोविड (COVID) इयूटी के लिए पहुंच चुके हैं। इससे पहले गृहमंत्री अमित शाह (Amit Shah) ने 15 नवंबर को दिल्ली में कोरोना वायरस (Coronavirus) के बढ़ते मामलों की समीक्षा बैठक थी

By मनीष शुक्ला

नई दिल्ली: देश की राष्ट्रीय राजधानी दिल्ली (Delhi) में कोरोना वायरस (Coronavirus) को लेकर गृह मंत्रालय एक्शन में आ गया है। गृह मंत्रालय ने 10 टीमों का गठन किया है। ये 10 टीमें 100 प्राइवेट अस्पतालों का दौरा करेंगी। ये 10 टीमें अस्पतालों में बेड की क्षमता और ICU बेड की जानकारी इकट्ठा करके वहां के हालात के बारे में गृह मंत्री को जानकारी देंगी।

आपको बता दें कि गृह मंत्रालय के मुताबिक, पारा मिलिट्री के 45 डॉक्टर और 160 पारा-मेडिकल स्टाफ [दिल्ली \(Delhi\)](#) में कोविड (COVID) इयूटी के लिए पहुंच चुके हैं। इससे पहले गृहमंत्री [अमित शाह \(Amit Shah\)](#) ने 15 नवंबर को दिल्ली में [कोरोना वायरस \(Coronavirus\)](#) के बढ़ते मामलों की समीक्षा बैठक थी।

गौरतलब है कि रक्षा अनुसंधान एवं विकास संगठन (DRDO) दिल्ली एयरपोर्ट के पास कोविड अस्पताल बना रहा है। DRDO 250 ICU बेड का अस्पताल तैयार कर रहा है।

डीआरडीओ दिल्ली एयरपोर्ट के पास अपने कोविड अस्पताल में अगले 3 से 4 दिनों में 250 आईसीयू बेड और 35 BIPAP बेड बनाने के काम में जुट गया है। हालांकि इस कोविड अस्पताल में पहले से 250 आईसीयू बेड मौजूद हैं।

<https://zeenews.india.com/hindi/india/drdo-to-add-250-icu-beds-in-covid-hospital-near-delhi-airport-following-amit-shah-meeting/788269>



Army completes setting up of modern habitat for troops in Ladakh

Temperatures in some places held by the Indian Army can dip to minus 40 degrees Celsius, with the super high-altitude areas also likely to receive several feet of snow during the peak of winters
By Rahul Singh

New Delhi: With temperature set to dip substantially in the Ladakh sector in the winter months and no solution to the border row with China in sight, the Indian Army has completed the setting up of modern habitats for thousands of soldiers deployed in forward areas to deal with any misadventure by the People's Liberation Army, officials familiar with developments said on Wednesday.

Temperatures in some places held by the Indian Army can dip to minus 40 degrees Celsius, with the super high-altitude areas also likely to receive several feet of snow (30 to 40 feet) during the peak of winters.

“Apart from smart camps with integrated facilities which have been built over the years, additional state-of-the-art habitat with arrangements for electricity, water, heating



Porta cabins for troops deployed in Ladakh.(Photo: Sourced by HT)

facilities, health and hygiene has been created to accommodate frontline troops. The troops are not lacking anything and prepared to take on any challenge,” said one of the officials cited above.

Fresh images emerging from Ladakh on Wednesday provided glimpses of the infrastructure the army has created to support its forward deployed troops at a time talks to resolve the border situation remain deadlocked and both armies are prepared for a long haul in the Ladakh theatre.

“Troops in the front line have been accommodated in heated tents as per tactical considerations of their deployment... Adequate civil infrastructure has also been identified to cater for any emergency,” said a second official.

India has made vigorous attempts to provide logistics support to its forward deployed soldiers, including the supply of specialised winter clothing from the United States. India has imported more than 15,000 sets of extended cold weather clothing system (ECWCS) from the US, with the emergency supply made by activating the Logistics Exchange Memorandum of Association (LEMOA). India signed the LEMOA, the first of the three foundational agreements proposed by Washington to deepen bilateral military cooperation, with the US in August 2016.

The Indian Army and the PLA have held eight rounds of talks to reduce friction along the contested Line of Actual Control (LAC) without any breakthrough. At the last round of talks on November 6, the two sides said they would ensure that their front line soldiers “exercise restraint and avoid misunderstanding and miscalculation” along the LAC. They also agreed to hold the ninth

round of talks between corps commander-ranked officers soon but no date has been fixed for that dialogue yet.

India is pushing for comprehensive disengagement at all flashpoints and restoration of status quo ante of early April during the talks. Chief of Defence Staff General Bipin Rawat said on November 6 that India will not accept shifting of the LAC in eastern Ladakh even as he did not rule out the possibility of the situation escalating into a larger conflict in the sensitive theatre.

<https://www.hindustantimes.com/india-news/army-completes-setting-up-of-modern-habitat-for-troops-in-ladakh/story-VOVvUdb4ntl6xTrsSY1RjN.html>



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कड़कड़ाती सर्दियों में भी चीन पर जारी रहेगी निगेहबानी, सेना ने पूर्वी लद्दाख में जवानों के लिए बनाए अत्याधुनिक आवास

पूर्वी लद्दाख में चीन से जारी तनाव के बीच भारतीय सेना ने हजारों जवानों के लिए अत्याधुनिक आवास तैयार किए हैं। कड़ाके की सर्दियों में चीन पर नजर रखने वाले जवानों के लिए इन आवासों में ठंड से बचाव के साथ हर तरह की बुनियादी सुविधाएं मौजूद हैं।

नई दिल्ली: पूर्वी लद्दाख में सीमा पर चीन के साथ जारी तनाव का फिलहाल कोई समाधान निकलता नजर नहीं आ रहा, ऐसे में भारतीय सेना ने हजारों जवानों के लिए अत्याधुनिक आवास तैयार किए हैं। इन आवासों में ठंड से बचाव के साथ ही हर तरह की बुनियादी सुविधाएं हैं। बुधवार को सरकार से जुड़े सूत्रों ने यह जानकारी दी।

50 हजार जवान हैं तैनात

सूत्रों ने बताया कि इन आधुनिक आवासों में सैनिकों को ठंड से बचाने के लिए भी पर्याप्त व्यवस्था है, क्योंकि सर्दियों के मौसम में पूर्वी लद्दाख के कुछ स्थानों पर तापमान 40 डिग्री सेल्सियस नीचे तक लुढ़क जाता है। इसके अलावा ऊंचाई वाले इलाकों में 40 फीट तक बर्फबारी भी होती है। पूर्वी लद्दाख में इस समय करीब 50 हजार जवान तैनात हैं।

आपात जरूरत के लिए नागरिकों की मदद

सूत्रों ने बताया कि स्मार्ट शिविरों के अलावा बिजली, पानी, हीटिंग, स्वास्थ्य और स्वच्छता के लिए अत्याधुनिक आवास बनाए गए हैं। अग्रिम चौकियों पर तैनात सैनिकों को उनके सामरिक महत्व को देखते हुए गर्म टेंट में समायोजित किया गया है। इसके अलावा किसी भी आपात जरूरत को पूरा करने के लिए पर्याप्त नागरिक बुनियादी ढांचे की भी पहचान की गई है।

अब तक बेनतीजा रही बातचीत

सीमा पर जारी तनाव को दूर करने के लिए दोनों देशों के बीच कोर कमांडर स्तर की आठ दौर की बातचीत हो चुकी है, लेकिन अभी तक कोई सफलता नहीं मिली है। आखिरी दौर की बातचीत छह नवंबर को हुई थी, जिसमें दोनों ही पक्षों के बीच टकराव वाले बिंदुओं से सैनिकों को हटाने को लेकर व्यापक बातचीत हुई थी।



पूर्वी लद्दाख में चीन से जारी तनाव के बीच भारतीय सेना ने हजारों जवानों के लिए अत्याधुनिक आवास तैयार किए हैं। कड़ाके की सर्दियों में चीन पर नजर रखने वाले जवानों के लिए इन आवासों में ठंड से बचाव के साथ हर तरह की बुनियादी सुविधाएं मौजूद हैं।

वादों से मुकर जाता है चीन

भारत ने हर वार्ता में यह स्पष्ट किया है कि तनाव कम करने की जिम्मेदारी चीन पर है। टकराव के सभी बिंदुओं से उसे पहले अपने सैनिकों को पीछे हटाना होगा। दरअसल, चीन बातचीत में पीछे हटने की बात तो कहता है लेकिन जब जमीन पर अमल की बात आती है तो सभी वादों को दरकिनार कर देता है।

<https://www.jagran.com/news/national-indian-army-facilities-for-soldiers-in-eastern-ladakh-21074404.html>



Thu, 19 Nov 2020

China is fortifying defences across Ladakh border, not prepping to disengage

China's PLA, contrary to media reports, is not moving back from Finger 4 on the north bank of Pangong Tso and is carrying out an exercise to widen and black tar a road between Finger 6 and Finger 8 to enable faster deployment of troops

By Shishir Gupta

New Delhi: Reinforcements of People's Liberation Army (PLA) posts, relocation of troops, and rapid strengthening of road infrastructure across the friction points in occupied Aksai Chin over the past 30 days – all clearly indicate that China is preparing for a long haul along the 3,488km Line of Actual Control (LAC), keeping up the pressure on India even as the two countries talk disengagement and de-escalation.

The ninth round of the India-China military dialogue on disengagement and de-escalation is expected to take place soon.

According to senior military commanders, PLA is constructing more than 10 dugouts each at Samar Lungpa, 30km east of Karakoram Pass; and at Mount Sajum, south of Rechin La. It is also increasing troop deployment at Qizil Jilga, 70km east of Daulet Beg Oldi (DBO).

India and China have major differences on their respective perceptions of the LAC at these points, as noted during the failed exchange of maps on June 17, 2002. This difference is as significant as 176 sq-km at Samar Lungpa, and 129 sq-km at Mount Sajum. Qizil Jilga is a major PLA outpost. Although a section of South Block believes that PLA wants to disengage and de-escalate soon, available intelligence, such as this, point to the contrary, and means that the Indian Army may well have to spend the entire winter in subpolar Ladakh.

For instance, the movement of over 60 heavy-equipment transport vehicles has been noticed on the road from Shendong to Spanggur Gap, just south of Chushul, and surveillance equipment is being installed by the Chinese all along the LAC in Ladakh. Chinese tank transporters have also been noticed at Gobak, 60km east of LAC indicating that PLA has not let their guard down. Finally, there has been redeployment of troops in Aksai Chin at Rudog, Mapotheng, Sumxi, and west of Chang La, north-east of Demchok.

Roads and infrastructure

According to Indian national security planners, the Chinese army is undertaking strategic road construction for faster deployment on LAC with focus on the Depsang Bulge area and the DBO sector. It is understood that PLA is constructing a road north of Karakoram Pass to Chip Chap Valley for faster deployment across the DBO post. Road construction is also ongoing near Chuti Chang La, across the Depsang Bulge, a mere 8km from LAC. Depsang Bulge has been a friction point between the two armies since early 2013 transgressions by PLA. While there have been news reports about PLA deciding to move back to Finger 8 on the north bank of Pangong Tso from its present position of Finger 4, it is, in reality, undertaking an exercise to widen and black tar a road

from Finger 6 to Finger 8. Again the motive is faster deployment of PLA in case of a flare-up on the north banks of the frozen salt water lake.

With PLA fully deployed across LAC, China has stationed container housing modules across all the friction points including Jeevan Nullah in Depsang Plains and Dehra La across the Bulge area. At least 285 container units have come up south west of Samzungling, in the depth area of the Galwan Valley, which saw a flare-up on June 15.

Shiqanhe Town across Chumar has been turned into a major army supply depot with heavy construction materials stationed there to maintain continuous supply of heavy equipment.



<https://www.hindustantimes.com/india-news/china-is-fortifying-defences-across-ladakh-border-not-prepping-to-disengage/story-yNM2E5GOX3RzhqiIOBSPwJ.html>

IAF for short-term leasing of trainer aircraft, light copters

IAF is already exploring options of leasing mid-air refuelling aircraft, which it is in urgent need of

By Dinakar Peri

New Delhi: The Indian Air Force (IAF) is looking at leasing training aircraft and Light Utility Helicopters (LUH) for short duration till the indigenous platforms under development are inducted into service, said IAF Deputy Chief Air Marshal Sandeep Singh on Wednesday. The recently released Defence Acquisition Procedure (DAP) 2020 allows leasing of military platforms.

“The IAF is in the process of sending out Request for Information (RFI) for leasing trainer aircraft for relatively short period,” Air Marshal Singh said at a webinar organised by the Federation of Indian Chambers of Commerce and Industry.

The IAF is already exploring options of leasing mid-air refuelling aircraft, which it is in urgent need of.

With Kiran trainers being obsolete and indigenous HTT-40 being developed by Hindustan Aeronautics Limited (HAL) in advanced trials, the IAF is looking to plug the gaps for a short term through leasing. About 20-30 aircraft could be leased for 4-5 years. The indigenous LUH, being developed by HAL, has completed development trials and its limited series development is expected to begin soon.



IAF Deputy Chief Air Marshal Sandeep Singh. Photo: Special arrangement

Navy's needs

Speaking at the webinar, Vice Chief of Navy Vice Admiral Ashok Kumar said the Navy was looking to lease operational support assets and auxiliaries to enhance operational capabilities and avoid huge investments in manning and maintaining them. “The Indian Navy is planning to lease certain assets in the medium term to mitigate critical operational capability gap”.

On leasing of mid-air refuellers, Air Marshal Singh said that even before the DAP-2020 was issued, they had sent out preliminary RFIs for wet and dry lease of such aircraft. “We have good inputs for both options and we are in the process of analysing the options for making the Statement of Case (SoC),” he noted.

The IAF presently has six Russian IL-78 tankers and has been looking to procure six new aircraft but the deal has been repeatedly delayed.

Air Marshal Singh said that broadly wet lease of platforms could be used for peacetime use and dry leasing for operational requirements. The Services were also exploring options of leasing Unmanned Aerial Vehicles (UAV) and surveillance aircraft.

<https://www.thehindu.com/news/national/iaf-for-short-term-leasing-of-trainer-aircraft-light-copters/article33126336.ece>

Indian Navy gets 9th P-8I anti-submarine warfare aircraft ordered from US

India, which had first signed a contract for eight such aircraft in 2009, is also negotiating a deal for six more P-8I with the US under the government-to-government route

By Raghav Bikhchandani

New Delhi: Amid the standoff with China in eastern Ladakh, the Indian Navy Wednesday got its ninth P-8I long range maritime reconnaissance and anti-submarine warfare aircraft, part of the nearly \$1 billion deal with the US for four additional planes signed in 2016.

India, which had first signed a contract for eight such aircraft in 2009, is also negotiating a deal for six more P-8Is with the US under the government-to-government route.

Incidentally, the aircraft, the latest of which landed at INS Hansa in Goa early Wednesday morning, is also being used by India in Ladakh for surveillance besides the Indian Ocean Region. It was deployed during the 2017 Doklam standoff as well.

The Indian Navy has been put on complete operational alert and almost its entire Western and Eastern Fleet are out in the Indian Ocean Region as part of India's response to Chinese aggression.

While the ninth aircraft was scheduled to be handed over to the Indian Navy in July this year, the Covid pandemic delayed plans. The remaining three are scheduled to be handed over to India in 2021.

The Indian fleet of P-8I aircraft, a variant of the P-8A Poseidon aircraft that Boeing developed as a replacement for the US Navy's ageing P-3 fleet, has surpassed 25,000 flight hours since it was inducted in 2013.

India had become the first international customer for the P-8 aircraft with the conclusion of the nearly \$2.1 billion contract on 1 January 2009 for a total of eight aircraft.

India is also the second biggest operator of the aircraft in the world.

The P-8I

The P-8I is equipped for long range anti-submarine warfare, anti-surface warfare, intelligence, surveillance and reconnaissance in support of broad area, maritime and littoral operations.

Incidentally, its communication and sensor suite include indigenous equipment developed by defence PSUs and private manufacturers.

India awarded Boeing a three-year contract to continue supporting the Indian Navy's P-8I fleet, not only through "field and logistics service representatives" but also "engineering", "planning" and "robust material support."

In a statement, Boeing said it is currently completing construction of the Training Support and Data Handling Centre at INS Rajali, Arakkonam, Tamil Nadu, and a secondary centre at the Naval Institute of Aeronautical Technology, Kochi, as part of a training and support package contract signed in 2019.

The indigenous, ground-based training is meant to allow the Indian Navy crew to increase mission proficiency in a shorter time while reducing the on-aircraft training time resulting in increased aircraft availability for mission tasking.

<https://theprint.in/defence/indian-navy-gets-9th-p-8i-anti-submarine-warfare-aircraft-ordered-from-us/546972/>



The P-8I is equipped for long range anti-submarine warfare, anti-surface warfare, intelligence, surveillance and reconnaissance | Photo: Boeing

Indian AI company wins at UK-US military space pitch

The winners of same-day contracts worth up to £53,000 (\$66,000) were announced on Tuesday after pitches were made directly to UK, US and Nato military leaders. The Indian company is 114 AI Innovation LLP, whose pitch titled “Spacewise” was selected for funding

By Prasun Sonwalkar

London: A New Delhi-based artificial intelligence (AI) company is among 10 global winners in a UK-US initiative that aims to find, fund and fast-track innovation and technology that gives advantage to military personnel and operations in the space domain.

The winners of same-day contracts worth up to £53,000 (\$66,000) were announced on Tuesday after pitches were made directly to UK, US and Nato military leaders. The Indian company is 114 AI Innovation LLP, whose pitch titled “Spacewise” was selected for funding.

Its brief was, “Exploitation tool-set to visualise, access and analyse multiple input streams of data for advanced space command and control using cognitive AI. This tool-set enables space operations with allies and commercial partners by allowing visualisation and analysis of multiple different sources of data in real time.”



Indian company 114 AI Innovation LLP was selected for funding. (AFP/ FILE)

Besides the Indian company, the other nine winners included five from the US, three from UK and one from Australia.

The defence ministry said it is the first time two nations anywhere in the world have come together to award defence contracts based around a pitch-style event, and also the first time two nations have awarded joint defence innovation contracts to overseas-based enterprises.

Air Vice-Marshal Harvey Smyth, UK director (Space), said, “Congratulations to the winners and all those that took part in the first International Space Pitch Day - it has captured the imagination of innovators and militaries not just across the UK and US, but all over the world.

“It has achieved several world firsts and we look forward to building on its success as we seek to fast-track innovation and cutting-edge technology to the front-line quicker than ever before with fresh ways of working with industry to make sure we stay ahead of our shared adversaries and the threats they pose.”

The competition was open to innovators and entrepreneurs from all over the world delivered through the UK jointly funded by the UK’s Defence Science and Technology Laboratory, Royal Air Force and the US Air Force.

<https://www.hindustantimes.com/world-news/indian-ai-company-wins-in-uk-us-military-space-pitch/story-XJxNWqDFPY6y3bzFTPX9IL.html>

China's endgame in Ladakh

History tells us that China is pushing India into a military alliance with the US, in order to consolidate a bipolar world order

By Sreejith Sasidharan

There is a dangerous parallel in history to the current India-China conflict in Ladakh. The violence in the Galwan river valley in June 2020, and the ongoing military confrontation in the Himalayas over the past six months, bears striking resemblance to a watershed moment in world history known as the Seven Years War. It is, therefore, important to examine the larger implications of this Sino-Indian rivalry on the polarity and distribution of power in the international system.

Experts have argued that China's aggression in the Himalayas is an attempt to dissuade India from getting into an alliance with the United States. However, upon closer examination, the exact opposite is revealed. China's attempt seems to be to drive New Delhi into Washington's arms, use it as a precursor to consolidate a Sino-Russian alliance, and divide the world in two camps — a bipolar structure with the United States and China as the leaders competing for global hegemony. China's strategy to strike a fatal blow to a multipolar world, is straight out of the playbook of the Seven Years War, between Britain and France.



Army convoy moves on the Srinagar- Ladakh highway at Gagangeer. (AP, File)

During the mid-18th century, the boundary between French and British colonial possessions in the present-day United States were not demarcated on a mutually agreed map, much like the Line of Actual Control (LAC) between China and India in the Himalayas. In 1753, Britain opposed infrastructure developments – a series of forts in the Ohio river valley — to check the assertive anti-status quo policy by the French.

Peaceful attempts by the British failed to restore status quo ante and led to a skirmish in which 10 French soldiers, including the commanding officer were killed. The French revenge on the British forces came shortly thereafter. Eventually, the first President of the United States, George Washington, who led the British army as a Lieutenant Colonel in that skirmish, surrendered to the French forces at the Ohio river valley. Diplomatic attempts to resolve the crisis could hardly reach a meaningful compromise, once blood had been shed.

The Ladakh conflict has followed a similar script so far. New Delhi's peaceful efforts to halt Beijing from erecting structures on the disputed areas of the LAC were unsuccessful in the summer of 2020. Following this, India objected to the presence of Chinese structures on June 15, leading to a violent clash and the death of 20 Indian soldiers on the Galwan river valley, in addition to an unknown number of Chinese casualties. This was the first instance of blood being shed on the India-China border in over four decades. In retaliation, the use of special frontier force comprising Tibetan exiles by India, to capture strategic heights, along the LAC at Pangong Tso, is a leaf out of Britain's strategy of working with local American Indians against aggressive French designs.

Two rounds of diplomacy at very high levels, between the defence and foreign ministers of India and China had limited success in reducing tensions, just as diplomatic efforts between Britain and France were not very successful. Although Beijing may have a stronger army than New Delhi, Indian Navy has operational advantages, and a history of being a maritime power, unlike the Chinese navy. These realities are reminiscent of the British-French military balance of power in the

mid-18th century – while France had a superior army, British navy had access to key maritime chokepoints.

The Ohio river valley conflict eventually snowballed into the Seven Years War between Britain and France, leading to a rush for colonisation and global hegemony. The most significant development during this conflict was the British-Prussian alliance formation, followed by the Franco-Austrian alliance. Interestingly, this development came to be known as the “diplomatic revolution”, because it involved Britain and France, interchanging their erstwhile allies. It is along these lines, that if China’s aggression in the Himalayas provokes India to enter into an alliance with the United States, China can then use it an excuse for full-fledged military alliance with Russia, thereby splitting the Indo-Russian strategic partnership.

What lessons can India and China draw from the Anglo-French Seven Years War? Although Britain ended up being the victor, the Seven Years War took a huge toll on its economic and military resources. For France, the military campaigns only resulted in minor tactical victories. The jostling for power ended multipolarity and established a bipolar order of British-Prussian alliance against Franco-Austrian alliance. Therefore, pushing the current Ladakh crisis to its logical conclusion may end with an Indo-US military alliance followed by a Sino-Russian alliance.

Beijing is acutely aware that a war with China may well be the final nail in the coffin for India’s conception of strategic autonomy. Therefore, pushing India to the brink of war, is a well-thought-out strategy by China. Irrespective of the outcome, a war in itself may drive India towards a military alliance with the United States, allowing China to turn Russia against India, effectively breaking the Indo-Russian strategic partnership. Consequently, the Indo-US alliance and a Sino-Russian alliance, will end New Delhi’s vision of multipolarity and establish a transient bipolar world order. This is China’s endgame in the current Himalayan conflict with India.

(Sasidharan is a researcher at the Institute of International Relations, University of Warsaw)

<https://indianexpress.com/article/opinion/chinas-endgame-in-ladakh-7056037/>

First crewless Gaganyaan flight only by end of 2021

By Chethan Kumar

Bengaluru: The first crewless flight as part of the preparations for the ambitious Gaganyaan project originally planned for this year and then pushed to the first half of 2021 due to Covid-19, will now only happen at the end of next year. ISRO will eventually also launch a second crewless flight, now scheduled for 2022 before launching humans into space.

ISRO Chairman K Sivan told TOI that the process of human rating is progressing well and is expected to be complete in the second half of next year. TOI was the first to report the postponement of the crewless/unmanned flight and also the fact that the human mission too is likely to miss its original deadline.

As part of the unmanned flight, ISRO plans to send a humanoid (developed indigenously). In June, when it became clear that the first crewless flight won't happen this year, Sivan had said: "Whether we will launch two unmanned missions next year will depend on the emerging situations, we will have to decide based on what happens in the coming months. If Covid effects continue further, we may have to revisit some of our plans." It is now apparent that Isro will only be able to launch one crewless flight next year.



Human Rating & Pvt Players

Further, just last week Isro flagged off the first human rated S200 motor case for Gaganyaan's first crewless mission. "The high thrust solid propellant strap-on boosters — S200 — play an important role in the human rated GSLV MkIII. In order to human rate the booster, many new design features have been introduced in the hardware," Isro said.

ISRO'S heavy lift launcher, GSLV MkIII — identified for the Gaganyaan Mission — is in the process of being human-rated. The human rating of the S200 motor case is another successful industry collaboration.

"...The first critical booster segment of the motor case with a diameter of 3.2 meter, 8.5 meter in length and weighing 5.5 tonne has been indigenously developed and delivered by L&T," Sivan said.

Describing it as a major achievement, Sivan said that the next step would be to achieve human rating of all the hardware required for the mission. S Somnath, director, Vikram Sarabhai Space Centre (VSSC) had earlier told TOI: "...The reliability targeted for human-rated launch vehicles is 0.99, which means statistically only 1 out of 100 can be unreliable. And, for the crew escape system, which is very crucial, we are targeting greater than 0.998, which means we want almost 100% reliability."

<https://timesofindia.indiatimes.com/india/first-crewless-gaganyaan-flight-only-by-end-of-2021/articleshow/79290282.cms>

Faster detection of photocatalyst-generated oxygen has big implications for clean energy

Currently, the majority of energy consumed by the world's population is derived from oil and other non-renewable resources which are in danger of running out in the near future. Consequently the development of artificial photosynthesis methods using photocatalysts to produce chemical energy (hydrogen fuel) from sunlight and water has received much attention and various research projects are being conducted in this area.

During artificial photosynthesis, oxygen (O₂) is produced by the photocatalyst via the water splitting reaction. Working with researchers from Kanazawa University, Shinshu University and The University of Tokyo, Professor Onishi Hiroshi et al. of Kobe University's Graduate School of Science developed a measurement evaluation method which is able to detect O₂ 1000 times faster than conventional methods. It is hoped that the method developed through this research can be utilized to improve our understanding of the reaction mechanisms behind artificial photosynthesis and contribute towards developing photocatalysts that could be implemented in the real world.

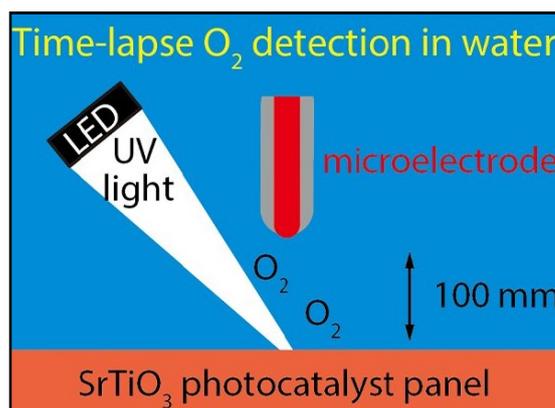


Figure 1: Detecting the oxygen (O₂) generated from artificial photosynthesis using a microelectrode. Credit: Kobe University

The importance of making these research results public as soon as possible has been recognized; the paper published in the American Chemistry Society's journal *ACS Catalysis* was given an advanced online release on October 29, 2020.

Research Background

Artificial photosynthesis, which can be utilized to produce chemical energy (hydrogen fuel) from sunlight and water has received much attention for its potential to provide an energy source that does not emit CO₂. Photocatalysts are the key component of artificial photosynthesis. The first photocatalyst material was discovered and developed by Japanese researchers in the 1970s, and scientists around the world have continuously strived to improve their efficiency over the last 50 years.

The current research study used a strontium titanate (SrTiO₃) photocatalyst, which was originally developed by Special Contract Professor Domen Kazunari et al. of Shinshu University (a contributing researcher to this study). As a result of various improvements made by Shinshu's Associate Professor HISATOMI Takashi et al. (also a contributing researcher), this photocatalytic material achieved the highest reaction yield (i.e. the efficiency of hydrogen conversion from water via illumination by ultraviolet light) in the world. The final remaining issue is improving the efficiency of hydrogen generation from water and sunlight, instead of artificial ultraviolet light. Overcoming this issue would mean the birth of CO₂-free hydrogen fuel producing technology that can be utilized by society.

However, one factor that hinders efforts to improve conversion efficiency is the low rate of oxygen produced from the water when hydrogen is also being produced. In order to generate hydrogen (H₂) from water (H₂O) via artificial photosynthesis, the following chemical reaction has to take place: $2\text{H}_2\text{O} \rightarrow 2\text{H}_2 + \text{O}_2$. Even though the goal is to produce hydrogen (that can be utilized as a fuel by society) and not oxygen, the principles of chemistry require oxygen to be produced from the water at the same time in order for hydrogen to be produced.

Furthermore, the process of generating oxygen is more complicated than the process of generating hydrogen, which consequently makes it difficult to improve the efficiency of the reaction (the oxygen atoms taken from two H₂O particles must adhere to one another). This is a bottleneck that limits the efficient conversion of hydrogen from water using sunlight.

A solution would be to improve the efficiency of oxygen conversion from water, however this is no simple matter. It is not well understood how oxygen is generated from water (i.e. the mechanism behind the reaction), therefore trying to improve this reaction is akin to working in the dark. In order to shed light on the situation, this research aimed to develop a high speed detection method to observe the oxygen generated by artificial photosynthesis to reveal the mechanism behind the water to oxygen reaction.

Research Methodology

This research study utilized a method of underwater chemical analysis using microelectrode developed by Kanazawa University's Professor TAKAHASHI Yasufumi et al. (contributing researcher) as the underlying technology. The oxygen generated from the artificial photosynthesis photocatalyst was detected as it merged back into the water. As shown in Figure 1, the strontium titanite photocatalyst panel was submerged in water. The microelectrode, which consisted of a 20 micrometer platinum wire (about ¼ of a human hair) with its sides coated in glass, was lowered into the water 100 micrometers away from the surface of the photocatalyst panel.

When the photocatalyst panel was illuminated by ultraviolet light (with a wavelength of 280nm) from a light-emitting diode, oxygen (O₂) and hydrogen (H₂) were dissociated from the water where it made contact with the panel. These oxygen and hydrogen molecules were subsequently released into the water. The released oxygen was scattered throughout the water and reached the microelectrode. The oxygen that reached the microelectrode received four electrons (e⁻) from the electrode resulting in the following transformation: $O_2 + 2H_2O + 4e^- \rightarrow 4OH^-$.

The number of electrons received from the electrode by the oxygen can be determined by measuring the electric current that passes through the electrode. Measuring the electric current that passed through the electrode every 0.1 seconds enabled the researchers to calculate the amount of oxygen that reached the electrode every 0.1 seconds. Gas-chromatographic detection, the analytic apparatus used for oxygen detection up until now, can only measure the amount of oxygen every three minutes. This study succeeded in developing a detection method that is 1000 times faster.

Calculating the time required for the oxygen to travel the 100 micrometer distance through the water from the photocatalyst panel to the electrode is not difficult. This can be achieved by conducting numerical simulations on a desktop computer, based on Fick's laws of diffusion. Comparing the measurement results obtained from the microelectrode with those of the simulation revealed that there was a one- to two-second delay between the photocatalyst panel being illuminated by UV light and the oxygen being released into the water. This delay is a new phenomenon that couldn't be observed via gas-chromatographic detection.

It is believed that this delay is a necessary preparatory stage for the illuminated photocatalyst to commence water-splitting. Future research will seek to verify this hypothesis, in addition to investigating what the photocatalyst is doing during the preparatory stage. Nevertheless, it is expected that the oxygen detection method developed in this study, which is 1000 times faster than previous detection methods, will lead to new developments in artificial photosynthesis.

Professor Onishi Hiroshi, Graduate School of Science, Kobe University, says, "I am a physical chemistry specialist, and the idea to detect the oxygen generated via artificial photosynthesis using a microelectrode came to me in 2015. At Kobe University, we set up the measuring apparatus developed by Professor Takahashi et al., who are experts in chemical analysis using microelectrodes, and began to apply it to photocatalysts.

"By improving the apparatus and accumulating know-how regarding its operation, we verified that this method is able to measure the oxygen generated from the photocatalyst panel provided by Professor Domen and Associate Professor Hisatomi et al., who are authorities on photocatalyst research.

"In addition, three graduate students at Kobe University's Graduate School of Science were at the forefront of this research for the five-year period spanning from the development of the computer program for the numerical simulation up until the discovery of the 'oxygen release delay'.

"The three teams brought the distinct features of their respective fields of physical chemistry, analytical chemistry and catalyst chemistry to the development of this research. Through this collaboration, we succeeded in contributing a new perspective to the science of artificial photosynthesis."

More information: Takumu Kosaka et al. Transient Kinetics of O₂ Evolution in Photocatalytic Water-Splitting Reaction, *ACS Catalysis* (2020). DOI: [10.1021/acscatal.0c04115](https://doi.org/10.1021/acscatal.0c04115)

Journal information: *ACS Catalysis*

<https://phys.org/news/2020-11-faster-photocatalyst-generated-oxygen-big-implications.html>



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A new understanding of ionic interactions with graphene and water

By Alex Gerage

A research team led by Northwestern University engineers and Argonne National Laboratory researchers have uncovered new findings into the role of ionic interaction within graphene and water. The insights could inform the design of new energy-efficient electrodes for batteries or provide the backbone ionic materials for neuromorphic computing applications.

Known for possessing extraordinary properties, from mechanical strength to electronic conductivity to wetting transparency, graphene plays an important role in many environmental and energy applications, such as water desalination, electrochemical energy storage, and energy harvesting. Water-mediated electrostatic interactions drive the chemical processes behind these technologies, making the ability to quantify the interactions between graphene, ions, and charged molecules vitally important in order to design more efficient and effective iterations.

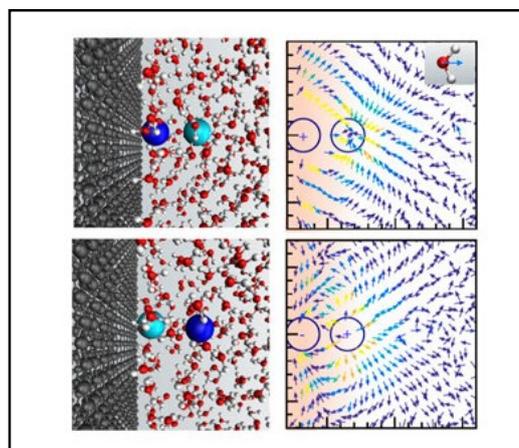


Illustration showing the interaction between ions at graphene-water interface. Credit: Northwestern University

"Every time you have interactions with ions in matter, the medium is very important. Water plays a vital role in mediating interactions between ions, molecules, and interfaces, which lead to a variety of natural and technological processes," said Monica Olvera de La Cruz, Lawyer Taylor Professor of Materials Science and Engineering, who led the research. "Yet, there is much we don't understand about how water-mediated interactions are influenced by nanoconfinement at the nanoscale."

Using computer model simulations at Northwestern Engineering and X-ray reflectivity experiments at Argonne, the research team investigated the interaction between two oppositely charged ions in different positions in water confined between two graphene surfaces. They found that the strength of the interaction was not equivalent when the ions' positions were interchanged. This break of symmetry, which the researchers' dubbed non-reciprocal interactions, is a phenomenon not previously predicted by electrostatic theory.

The researchers also found that the interaction between oppositely charged ions became repulsive when one ion was inserted into the graphene layers, and the other was absorbed at the interface.

"From our work, one can conclude that the water structure alone near interfaces cannot determine the effective electrostatic interactions between ions," said Felipe Jimenez-Angeles, senior research associate in Northwestern Engineering's Center for Computation and Theory of Soft Materials and a lead author on the study. "The non-reciprocity we observed implies that ion-ion interactions at the interface do not obey the isotropic and translational symmetries of Coulomb's law and can be present in both polarizable and non-polarizable models. This non-symmetrical water polarization affects our understanding of ion-differentiation mechanisms such as ion selectivity and ion specificity."

"These results reveal another layer to the complexity of how ions interact with interfaces," said Paul Fenter, a senior scientist and group leader in the Chemical Sciences and Engineering Division at Argonne, who led the study's X-ray measurements using Argonne's Advanced Photon Source. "Significantly, these insights derive from simulations that are validated against experimental observations for the same system."

These results could influence the future design of membranes for selective ion adsorption used in environmental technologies, like water purification processes, batteries and capacitors for electric energy storage, and the characterization of biomolecules, like proteins and DNA.

Understanding ion interaction could also impact advances in neuromorphic computing—where computers function like human brains to perform complex tasks much more efficiently than current computers. Lithium ion can achieve plasticity, for example, by being inserted in or removing from graphene layers in neuromorphic devices.

"Graphene is an ideal material for devices that transmit signals via ionic transport in electrolytes for neuromorphic applications," said Olvera de la Cruz. "Our study demonstrated that the interactions between intercalated ions in the graphene and physically adsorbed ions in the electrolyte is repulsive, affecting the mechanics of such devices."

The study provides researchers with a fundamental understanding of the electrostatic interactions in aqueous media near interfaces that go beyond water's relationship with graphene, which is crucial for studying other processes in the physical and sciences.

"Graphene is a regular surface, but these findings can help explain electrostatic interactions in more complex molecules, like proteins," said Jimenez-Angeles. "We know that what's inside the protein and the electrostatic charges outside of it matters. This work gives us a new opportunity to explore and look at these important interactions."

A paper describing the work, titled "Non-Reciprocal Interactions Induced by Water in Confinement," was published November 17 in the journal *Physical Review Research*.

More information: Felipe Jiménez-Ángeles et al, Nonreciprocal interactions induced by water in confinement, *Physical Review Research* (2020). DOI: [10.1103/PhysRevResearch.2.043244](https://doi.org/10.1103/PhysRevResearch.2.043244)
<https://phys.org/news/2020-11-ionic-interactions-graphene.html>

Researchers establish proof of principle in superconductor study

Three physicists in the Department of Physics and Astronomy at the University of Tennessee, Knoxville, together with their colleagues from the Southern University of Science and Technology and Sun Yat-sen University in China, have successfully modified a semiconductor to create a superconductor.

Professor and Department Head Hanno Weitering, Associate Professor Steve Johnston, and Ph.D. candidate Tyler Smith were part of the team that made the breakthrough in fundamental research, which may lead to unforeseen advancements in technology.

Semiconductors are electrical insulators but conduct electrical currents under special circumstances. They are an essential component in many of the electronic circuits used in everyday items including mobile phones, digital cameras, televisions, and computers.

As technology has progressed, so has the development of semiconductors, allowing the fabrication of electronic devices that are smaller, faster, and more reliable.

Superconductors, first discovered in 1911, allow electrical charges to move without resistance, so current flows without any energy loss. Although scientists are still exploring practical applications, superconductors are currently used most widely in MRI machines.

Using a silicon semiconductor platform—which is the standard for nearly all electronic devices—Weitering and his colleagues used tin to create the superconductor.

"When you have a superconductor and you integrate it with a semiconductor, there are also new types of electronic devices that you can make," Weitering stated.

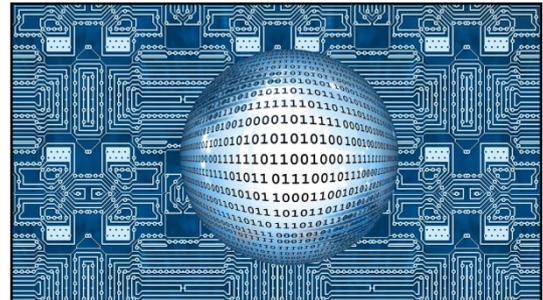
Superconductors are typically discovered by accident; the development of this novel superconductor is the first example ever of intentionally creating an atomically thin superconductor on a conventional semiconductor template, exploiting the knowledge base of high-temperature superconductivity in doped 'Mott insulating' copper oxide materials.

"The entire approach—doping a Mott insulator, the tin on silicon—was a deliberate strategy. Then came proving we're seeing the properties of a doped Mott insulator as opposed to anything else and ruling out other interpretations. The next logical step was demonstrating superconductivity, and lo and behold, it worked," Weitering said.

"Discovery of new knowledge is a core mission of UT," Weitering stated. "Although we don't have an immediate application for our superconductor, we have established a proof of principle, which may lead to future practical applications."

More information: Xuefeng Wu et al, Superconductivity in a Hole-Doped Mott-Insulating Triangular Adatom Layer on a Silicon Surface, *Physical Review Letters* (2020). [DOI: 10.1103/PhysRevLett.125.117001](https://doi.org/10.1103/PhysRevLett.125.117001)

Journal information: [Physical Review Letters](https://phys.org/news/2020-11-proof-principle-superconductor.html)
<https://phys.org/news/2020-11-proof-principle-superconductor.html>



Credit: CC0 Public Domain

The ultimate conditions to get the most out of high-nickel batteries

It is common knowledge in battery manufacturing that many cathode materials are moisture sensitive. However, as the popularity of high nickel-based battery components increases, researchers from WMG, University of Warwick have found that the drier the conditions that these cathodes are stored and processed in, then significant improvement in performance of the battery is gained.

High-Ni (Nickel) batteries are becoming increasingly popular worldwide, with more automotive companies investigating the use of high-Ni batteries for electric vehicles. However, high-Ni cathode materials are prone to reactivity and instability is exposed to humidity, therefore how

they are stored in order to offer the best performance is crucial.

In the paper, 'The effects of Ambient Storage Conditions on the Structural and Electrochemical Properties of NMC-811 Cathodes for Li-ion batteries,' published in the journal *Electrochimica Acta*, researchers from WMG, University of Warwick propose the best way to store high-nickel cathodes in order to mitigate premature degradation.

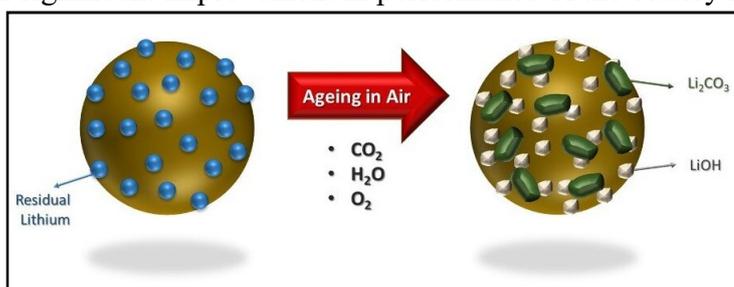
Researchers exposed NMC-811 (high-Ni cathode material) to different temperatures and humidities, then measured the material's performance and degradation in a battery over a 28 day period, analysing them using a combination of physical, chemical and electrochemical testing. This included high-resolution microscopy to identify the morphological and chemical changes that occurred at the micron and sub-micron scale during the batteries charging and discharging.

The storage conditions included vacuum oven-dried, as exposed (to humidity) and a control measure. Researchers looked for surface impurities, which include carbonates and H₂O, and found there were three processes that can be responsible for impurities, including:

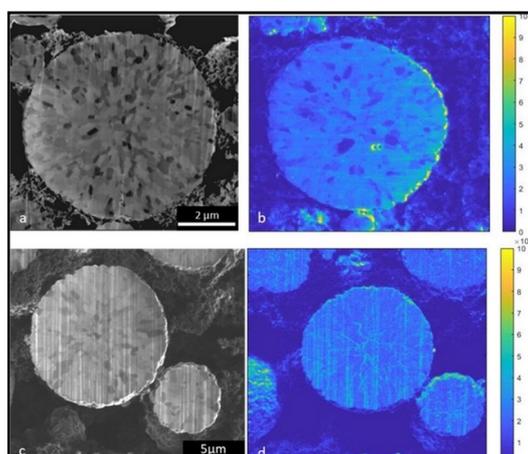
1. Residual impurities emanating from unreacted precursors during synthesis
2. Higher equilibrium coverage of surface carbonates/hydroxides (present to stabilise the surface of Ni-rich materials after the synthesis process)
3. Impurities formed during ambient storage time

They found that in all conditions, (oven dried and as-exposed) showed inferior first discharged specific capacity and cycling performance, compared to the control. However the as-exposed measure showed that after 28 days of ambient moisture exposure the H₂O and CO₂ react with the Li⁺ ions in the battery cell, resulting in the formation of lithium carbonate and hydroxide species.

The formation of carbonates and oxides on the surface of NMC-811 contribute to the loss of the electrochemical performance during ageing of the materials, due to the inferior ionic and electronic



The effects of ambient air storage on the surface of NMC-811 Credit: WMG, University of Warwick



Caption: (a-b) Post-mortem NMC811 particle, with no prior exposure to moist air, analysed by FIB-SIMS, targeting Lithium detection. (c-d) Post-mortem NMC811 particle, after 28 days exposure to moist air, analysed by FIB-SIMS, targeting Lithium detection. Credit: WMG, University of Warwick

conductivity, as well as the electrical isolation of the active particles. This means that they can no longer reversibly store lithium ions to convey "charge". SEM analysis confirmed the inter-granular porosity and micro-cracks on these aggregate particles, following the 28 days of ambient exposure.

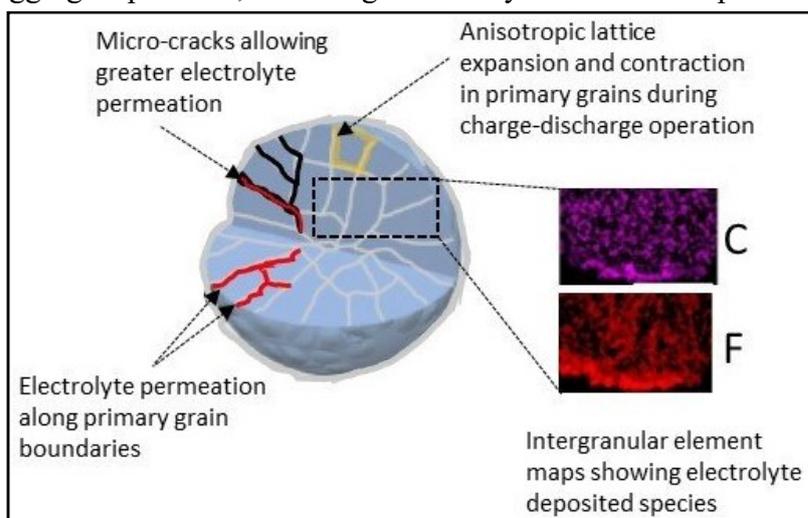
They can therefore conclude that the driest conditions, at dew points of around -45°C , are the best for storing AND processing the materials, in order to then produce the best battery performance. Humidity conditions and exposure at junctions along the manufacturing process will cause the materials and components to experience; this results in shorter battery lifespan.

Dr. Mel Loveridge from WMG at the University of Warwick says, "Whilst moisture is well known to be problematic here, we set about to determine the optimal storage conditions that are required to mitigate unwanted, premature degradation in battery performance. Such measures are critical to improve processing capability, and ultimately maintain performance levels. This is also of relevance to other Ni-rich systems e.g. NCA materials."

Professor Louis Piper from WMG at the University of Warwick says, "Considerable global research effort will continue to focus on these materials, including how to protect their surfaces to eliminate risks of parasitic reactions prior to incorporation into electrodes. In the UK, leading research by the Faraday Institution has a project consortium entirely devoted to unravelling the degradation mechanisms of such industry-relevant materials."

More information: Chiara Busà et al. The effects of ambient storage conditions on the structural and electrochemical properties of NMC-811 cathodes for Li-ion batteries, *Electrochimica Acta* (2020). DOI: [10.1016/j.electacta.2020.137358](https://doi.org/10.1016/j.electacta.2020.137358)

<https://phys.org/news/2020-11-ultimate-conditions-high-nickel-batteries.html>



Schematic illustration of particle breakdown during charge-discharge of a battery Credit: WMG, University of Warwick

Early details of brain damage in COVID-19 patients

Specialized scanning furthers understanding of the virus' potential effects on the brain

While it is primarily a respiratory disease, COVID-19 infection affects other organs, including the brain.

One of the first spectroscopic imaging-based studies of neurological injury in COVID-19 patients has been reported by researchers at Harvard-affiliated Massachusetts General Hospital (MGH) in the *American Journal of Neuroradiology*. Looking at six patients using a specialized magnetic resonance (MR) technique, they found that COVID-19 patients with neurological symptoms show some of the same metabolic disturbances in the brain as patients who have suffered oxygen deprivation (hypoxia) from other causes, but there are also notable differences.

It is thought that the disease's primary effect on the brain is through hypoxia, but few studies have documented the specific types of damage that distinguish COVID-19-related brain injury. Several thousand patients with COVID-19 have been seen at the MGH since the outbreak began early this year, and this study included findings from three of those patients.

The severity of neurological symptoms varies, ranging from one of the most well-known — a temporary loss of smell — to more severe symptoms such as dizziness, confusion, seizures, and stroke.

“We were interested in characterizing the biological underpinnings of some of these symptoms,” says Eva-Maria Ratai, an investigator in the Department of Radiology and senior author of the study. “Moving forward, we are also interested in understanding long-term lingering effects of COVID-19, including headaches, fatigue, and cognitive impairment. So-called ‘brain fog’ and other impairments that have been found to persist long after the acute phase,” adds Ratai, also an associate professor of radiology at Harvard Medical School.

“Moving forward, we are also interested in understanding long-term lingering effects of COVID-19, including headaches, fatigue, and cognitive impairment.”— Eva-Maria Ratai, senior author of the study.

The researchers used 3 Tesla Magnetic Resonance Spectroscopy (MRS), a specialized type of scanning that is sometimes called a virtual biopsy. MRS can identify neurochemical abnormalities even when structural imaging findings are normal. COVID-19 patients' brains showed N-acetyl-aspartate (NAA) reduction, choline elevation, and myo-inositol elevation, similar to what is seen with these metabolites in other patients with white matter abnormalities (leukoencephalopathy) after hypoxia without COVID. One of the patients with COVID-19 who showed the most severe white matter damage (necrosis and cavitation) had particularly pronounced lactate elevation on MRS, which is another sign of brain damage from oxygen deprivation.

Two of the three COVID-19 patients were intubated in the intensive care unit at the time of imaging, which was conducted as part of their care. One had COVID-19-associated necrotizing leukoencephalopathy. Another had experienced a recent cardiac arrest and showed subtle white matter changes on structural MR. The third had no clear encephalopathy or recent cardiac arrest. The non-COVID control cases included one patient with white matter damage due to hypoxia from

other causes (post-hypoxic leukoencephalopathy), one with sepsis-related white matter damage, and a normal, age-matched, healthy volunteer.

“A key question is whether it is just the decrease in oxygen to the brain that is causing these white matter changes or whether the virus is itself attacking the white matter,” says MGH neuroradiologist Otto Rapalino, who shares first authorship with Harvard-MGH postdoctoral research fellow Akila Weerasekera.

Compared to conventional structural MR imaging, “MRS can better characterize pathological processes, such as neuronal injury, inflammation, demyelination, and hypoxia,” adds Weerasekera. “Based on these findings, we believe it could be used as a disease and therapy monitoring tool.”

(The research was supported by the James S. McDonnell Foundation, National Institutes of Health and National Institute of Neurological Disorders and Stroke.)

<https://news.harvard.edu/gazette/story/2020/11/small-study-reveals-details-of-brain-damage-in-covid-19-patients/>

