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The Tribune

Sun, 22 May 2022

How DRDO is propelling self-reliance

Under the DRDO policy, 88 military equipment-making projects are in the pipeline, including some a few steps away from being formally inducted into the forces. At the end of April this year, the Advanced Towed Artillery Gun System (ATAGS) was firing away at the Pokhran firing ranges in Rajasthan amid temperatures touching 50°C. It was a ‘summer’ trial to judge the performance of the guns after the ‘winter’ trial in December last year. Designed by the Defence Research and Development Organisation (DRDO) and manufactured in two separate versions by Tata and Bharat Forge, the ATAGS is among the 88 projects that come under the Development-cum-Production Partner (DCPP) policy.

Under this, DRDO transfers documents, drawings and design to the industry, which is tasked to make a prototype and is further helped across trials and tests done by the armed forces. It’s a growing success story within the wider ambit of atmanirbharta (self-reliance) in military-equipment making. The DRDO remains a designer while the industry — public and private — is a partner for manufacturing, hence hastening the process.

The long and short of it

The ATAGS, having the ability to hit targets 48 km away, is the first Indian-designed and manufactured artillery gun. It is a few steps away from being formally inducted into the Army. Dhanush, an artillery gun made by the Ordnance Factory Board inducted in 2018, is based on a design of the Bofors gun inducted from Sweden in 1987. Light tanks are being made in partnership by L&T and the first one could be ready for trials soon. The Wheeled Armoured Amphibious Platform (WhAP) designed by DRDO for carrying troops is being made by Tata. The first such unit was handed in April to the Indian Army, which is looking for 500 such vehicles for use in the Himalayas. Among the missiles, the Very Short Range Air Defence (VSHORAD) has been tasked to Adani group, the long-range guided air-launched bombs are being made by Bharat Forge, the ‘guided’ Pinaka missile and grenades are being made by Economic Explosives Ltd, based in Nagpur. On the long list are Automatic Chemical Agent Detector & Alarm (ACADA) and Chemical Agent Monitor (CAM), which has undergone third party evaluation by an Organisation for the Prohibition of Chemical Weapons designated laboratory located in the Netherlands. Hand-held radars to look through walls, unmanned ground vehicles, counter-drone systems, extreme cold weather clothing are all being made under such tie-ups, while existing technology to make warship-grade steel is being shared with industrial partners. The DRDO-IIT Delhi collaboration has developed two versions of a bulletproof jacket

for troops which can withstand steel core bullets of AK-47 and bullets of self-loading rifles and sniper rifles like Dragunov.

PSUs continue on big tech

Technologies like fighter jet, its design and engine have been kept within the public sector. Hindustan Aeronautics Limited (HAL) is working on the design of the next generation Advanced Medium Combat Aircraft (AMCA) and also the naval fighter jet. The HAL would be the front-runner for a joint venture in making jet engines. Bharat Dynamics Limited is making missiles while ‘seekers’, which guide a missile to its pinpoint destination, are indigenous. The DRDO-made medium altitude drone ‘Rustom II’ is capable of flying at 28,000 feet and for 18 hours. “It has been tested for these parameters,” says DRDO chairman Dr G Satheesh Reddy. The drone so far is capable of surveillance and does not carry weapons.

Role of the academia

Funding is being done by the DRDO for research and collaboration with the academia and industries for defence application, and having outcomes relevant to the critical and futuristic technology requirements of the armed forces. After the successful design concept, development of a lab model, its testing and product development, start-ups and industry are taken on board as development partners. Ten DRDO Industry Academia — Centres of Excellence (DIA-COE) have been established for research on more than 50 identified thrust areas like hypersonics, directed energy technology, quantum technology, artificial intelligence, robotics, material sciences, biotechnology, computing and communication technology, cyber security, etc. These research cells are located in institutes like IIT Delhi, IIT Bombay, IIT Madras, IIT Hyderabad, IISc Bangalore, University of Hyderabad, Jadavpur University, Central University of Jammu, Mizoram University, Gujarat University and Bharathiar University. Research projects have been initiated at the Centre of Excellence, IIT Delhi, to develop indigenous technology for quantum-based secure communication over fibre-based transmission lines and free space communication. For the first time, a joint team of DRDO and IIT Delhi scientists successfully demonstrated secure ‘Quantum link’ over a distance of 100 km between Prayagraj and Vindhyachal.

Focus on R&D

Research and development has been allocated a sum of Rs 11,981 crore in the current defence budget. Of this, start-ups, academia and private industry will be allowed to claim 25 per cent to develop military platforms and equipment in collaboration with DRDO. About 68 per cent of the money for acquisition, made by the services, is to be used for indigenous items.

<https://www.tribuneindia.com/news/features/how-drdo-is-propelling-self-reliance-397013>

The Tribune

Sun, 22 May 2022

Focus on Advanced Tech: DRDO chief

THE Defence Research and Development Organisation (DRDO) is concentrating on advanced technologies like artificial intelligence, hypersonic weapons, cyber-warfare, electro-magnetic technologies, high-power lasers, long-range radars, quantum communication technologies, networking of systems and advanced materials, says DRDO chairman Dr G Satheesh Reddy.

The industry has matured. It has moved from designing as per drawings to now having the ability to design according to the specifications. The encouragement to industry is showing. We have roped them in to make big equipment, on integration of missiles, bombs and many other systems. Dr G Satheesh Reddy, DRDO Chief. The immediate targets, according to Dr Reddy, are increasing the range of air-to-air missiles beyond 150 km and that of surface-to-air missiles beyond 250 km. Airborne radars and long-range 1,000-plus km radars are the next on plan, with the Active Electronically Scanned Array (AESA) radar for fighter jets ending its final testing. For the Advanced Medium Combat Aircraft (AMCA), DRDO “may go in for the special purpose vehicle model”.

The Light Combat Aircraft (LCA) Mark2 is in the final design phase, while the AMCA design is in advanced stages. “We will definitely meet timelines on the AMCA and LCA Mark2,” he said. On ground fighting equipment, Dr Reddy said, “We are looking for partners for Future Infantry Combat Vehicle (FICV) and Future Ready Combat Vehicles (FRCV).” The scenario, he points out, is changing. “We are getting enquiries for export of Akash missiles, torpedoes and artillery gun, the ATAGS, to name a few.” Air Independent Propulsion System (AIP), that allows conventional submarines to remain under water for longer periods, has been demonstrated. “We are working to integrate the system. The basic model has been made.”

India, he said, has become self-sufficient in many technological areas like missiles, radars, sonars, electronic warfare systems, Airborne Warning And Control System (AWACS), artillery guns, armoured vehicles and fighter aircraft. “Industry participation is growing. We have at least 2,000 industries, which are capable of making systems and sub-systems of equipment. Close to 10,000 are now suppliers of components,” according to Dr Reddy, who is also the secretary, Department of Defence R&D.

<https://www.tribuneindia.com/news/features/focus-on-advanced-tech-drdo-chief-397014>



Sat, 21 May 2022

NASM-SR: How Indian Navy's new anti-ship missile can change warfare dynamics

NASM-SR launched

Defence Research and Development Organisation (DRDO) and the Indian Navy successfully recently conducted maiden flight-test of the indigenously-developed Naval anti-ship missile NASM-SR launched from a helicopter from Integrated Test Range (ITR) at Chandipur. It is the first indigenous air launched short-range anti-ship missile system for the Indian Navy. The missile test showcased sea skimming trajectory and reached the designated target with accuracy, validating the control, guidance and mission algorithms, the Navy said. Critically, the missile employed the indigenously developed launcher for the helicopter. The missile guidance system includes state-of-the-art navigation system and integrated avionics.

NASM-SR can be hosted on MH-60R helicopters

The Naval Anti-Ship Missile (Short Range) (NASM-SR) has a range of 55 km and is set to replace the Navy's sea eagle missiles. The NASM-SR will reportedly be hosted on MH-60R

helicopters. It can carry a 100 kg warhead and can travel at 0.8 Mach sub-sonic speed. The new missile is set to strengthen offensive capability of the Indian Navy. It can be fired from the shore at a ship in the sea. It can strategically target main areas of a large ship and make it dysfunctional.

Indo-Pacific at the centre of geopolitics

India's maritime strategy is in focus, with the Indo-Pacific being at the centre of geopolitics. The country's geographic location makes it a key player in the Indian Ocean, making the role of the Navy critical.

China's increased presence since 2008

The Indian subcontinent is buzzing with activity and the Indian Navy is closely watching as the events unfold. India has been cleanly observing China as it has increased presence in the Indian Ocean since 2008.

Global concern over China's growing assertiveness

From the United States to Japan and Australia there is a growing concern over China's growing assertion in the Indian Ocean. China's naval power has grown significantly as it has been building new ships, submarines and missiles. What's more concerning is China's investment in big-ticket maritime infrastructure, especially deepwater ports.

China's string of pearls strategy

China is following a string of pearls strategy, using investments as a tool it plans to encircle India by building naval ports. The Chinese already control the Hambantota port in Sri Lanka. Quadrilateral Security Dialogue India fears that the Chinese military could end up using such ports for military purposes, a fear that is shared by major nations around the world. India, Japan, Australia and the United States are working together in the Quadrilateral Security Dialogue to counter China's rise.

India steps up overseas deployment

India alone is taking steps to counter China's growing deployments by stepping up its own overseas deployments. India has secured agreements with other nations for military access to their bases.

<https://www.wionews.com/photos/nasm-sr-how-indian-navys-new-anti-ship-missile-can-change-warfare-dynamics-480992#quadrilateral-security-dialogue-266139>



Sat, 21 May 2022

Explained: Why the anti-ship missile tested by the Navy matters

The Navy recently tested an indigenous Naval Anti-Ship Missile (Short Range) or NASM-SR from a Sea King helicopter at the Integrated Test Range in Balasore, Odisha. A look at its

efficacy and the significant role it can play in modern naval warfare. What is the NASM-SR tested by the Navy? The NASM-SR has been developed by the Defence Research and Development Organisation (DRDO). The first time its development was revealed to the general public was in 2018 when then Defence Minister Nirmala Sitharaman made a reference to it in Parliament. Later, it was also part of the display at the 2020 Defence Exposition held in Lucknow. The NASM-SR has a range of 55 km and weighs 385 kg.

This missile will replace the Sea Eagle missiles which are currently in use with the Navy. With the Sea King helicopters too being phased out, it is expected that the NASM-SR will be used with the new MH-60R multi-role helicopters, which are being inducted into the Navy. The NASM-SR carries a warhead of 100 kg and has sub-sonic capabilities, which means that it flies below the speed of sound at 0.8 Mach. The sub-sonic flight speed makes it difficult for the naval vessels on target to detect it. It has a launch altitude of maximum of 3 km and can skim 5 metres above sea level when on final approach to the target. The NASM-SR can also be fired from the shore to target vessels in the sea. This kind of land-based missile launch capability was shown by the Ukrainian military recently when they used an anti-ship cruise missile to sink the Russian ship Moskva.

Is the small warhead size enough to sink ships?

The NASM-SR is very effective against smaller vessels like patrol boats and can also cause widespread damage on larger vessels. The smaller payload of the missile can still be effective if it targets certain key areas of a ship like the ones where fuel and ammunition is stored. It has been proven in modern naval conflict that a modest strike by a missile can still sink a ship because of the implosion caused by on-board fuel and ammunition. Also, the lighter size of the missile makes it easier to be carried by helicopters and in turn provides Naval Commanders with more options to choose from in the tactical battlefield on the seas.

<https://indianexpress.com/article/explained/navy-anti-ship-missile-significance-explained-7928016/>

Defence News

Defence Strategic: National/International

THE ECONOMIC TIMES

Sun, 22 May 2022

Focus on being self-reliant in defence technology: Rajnath Singh to stakeholders

Defence Minister Rajnath Singh on Sunday asked stakeholders in the sector to focus on being "self-reliant in defence technology while keeping pace with technology outside". During his visit

to Nagpur in Maharashtra, Singh also asked defence commanders to follow the correct maintenance and operational practices with the safety of personnel in mind, a release from a defence spokesperson said. Air Marshal Shashiker Chaudhary, AOC-in-C Maintenance command, and other dignitaries from civil and military establishments received Singh on his arrival at the airport in Nagpur. Singh interacted with some defence sector stakeholders at the airport, the release said. He was briefed about various activities undertaken by defence establishments, including the Army, the Air Force & defence PSUs, in this region, it said. While addressing the defence sector stakeholders, Singh advised them to focus on being "atmanirbhar (self-reliant) in defence technology while keeping pace with technology outside".

<https://economictimes.indiatimes.com/news/defence/focus-on-being-self-reliant-in-defence-technology-rajnath-singh-to-stakeholders/articleshow/91723530.cms?from=mdr>

THE TIMES OF INDIA

Sun, 22 May 2022

Defence Minister urges youths to indigenise new technologies

Defence Minister Rajnath Singh on Friday called upon the youth of the country to ideate, innovate and indigenise new technologies to achieve "Aatmanirbhar Bharat", as envisioned by Prime Minister Narendra Modi. Addressing the students of Dr DY Patil Vidyapeeth during the 13th convocation ceremony in Pimpri, Singh described the youth as the biggest strength, catalyst and source of change for any country. "The youth can face any challenge and convert it into an opportunity. They have the potential to discover new technologies, and set up new companies and research establishments," he said. He iterated the government's resolve of domestic procurement of defence equipment to achieve "Aatmanirbhar Bharat", saying that India should not depend on other countries for its needs. He said the government had faith in the youth and was striving to provide them with ample opportunities to ensure their progress and holistic development. Referring to Prime Minister Modi's appeal "Vocal for Local", he said it would create employment opportunities for the young and ignited minds of the country. The minister reminded students to value the contributions made by unknown people in their lives. "For example, an apron that you wear today may have come from a cotton farmer from Vidarbha, and your shoes may have been made in a factory in Kanpur. Likewise, many unknown people are contributing to your lives. They need your respect and love," he said.

<https://timesofindia.indiatimes.com/city/pune/defence-minister-urges-youths-to-indigenise-new-technologies/articleshow/91716668.cms>

Chinese bridge over Pangong Tso indicates growing PLA threat to East Ladakh

With China's no limits ally Russia getting bogged down in Ukraine war, India needs to examine options to circumvent any disruption in its military hardware supply chains from Moscow in future as it faces a growing threat from PLA across the LAC. The construction of a double-span bridge connecting north and south banks of Pangong Tso by Chinese Army in Khurnak Fort area, occupied by PLA in 1959, is part of the frantic military infrastructure upgradation carried out by Beijing across the 3488 km Line of Actual Control (LAC) with India. Although the fresh bridge construction is beyond India's black LAC claim line and within Chinese Green claim, the double span link will increase the PLA capacity to deploy on both banks of the saltwater lake with the road loop to military base at Rudog being reduced to a direct link. While the opposition Congress is trying to score political points against the Modi government over the fresh bridge construction, the PLA had over-run the entire north banks of Pangong Tso on October 22, 1962, after the three Indian Army posts at Srijap complex, west of the new bridge and east of finger eight, were attacked by the Red Army a day before as a military response to PM Jawahar Kaul Nehru's forward policy. This is part of the official history of the 1962 war. The frantic pace of construction across LAC shows the single-mindedness and relentless pursuit of Beijing to protect its territory as well as pose a direct long-term threat to India in the worst-case scenario. The Chinese pace of military upgradation is far superior to that of the Indian side, which time and again gets bogged down by red tape of military-civilian bureaucracy.

A classic example of the delays on the Indian side is the construction of a tunnel under Shinku La on the Ladakh-Himachal Pradesh border for alternative all weather route to Leh for rapid troop deployment even during peak winters. The decision on construction of the tunnel under Shinku La has been pending for the past four years due to tussle between the Border Roads Organization (BRO) and the Ministry of Road Transport and Highways (MORTH) on the length of the tunnel and should it be linked to national highway route. It is learnt that the issue has been sorted in favour of BRO and decision on the Shinku La tunnel is expected anytime. The potential threat that the PLA poses to Indian Army with its constant border nibbling tactics gets amplified with the possibility of defence hardware supply lines from Moscow to India getting disrupted with President Vladimir Putin focused on Ukraine war and Europe. With Atmanirbhar Bharat plan in defence manufacturing slated to take normal conception and gestation period, India needs to tie-up fast with countries like France and US to ensure that the hardware and ammunition supply is not disrupted due to Russia's Ukraine war. While the Modi government is talking to both the countries for getting involved in Atmanirbhar Bharat plan by setting up joint venture in India, the process will take time due to expected bureaucratic delays and fiefdom wars. Fact is that the Chinese threat is real, and the Modi government cannot be caught by surprise like Jawahar Lal Kaul government was in 1962 with the intelligence wrongly indicating that the PLA would not militarily respond to India's forward policy in Aksai Chin. It is in this context that the bilateral meeting between PM Modi and US President Joe Biden on the side-lines of the QUAD summit on May 24 assumes importance as Washington is willing to partner with New Delhi so

that the military hardware supply chain is not affected. France has also indicated the same when PM Modi met President Emmanuel Macron in Paris earlier this month. While the cold warriors in Indian military bureaucracy and national security planning still see US through the prism of 1971 war and its relationship with Pakistan and China in the past, the threat from Beijing is growing by the day with Russia its declared “no limits” ally. India must keep its options open and exercise them.

<https://www.hindustantimes.com/india-news/chinese-bridge-over-pangong-tso-indicates-growing-pla-threat-to-east-ladakh-101653192588703.html>

R. REPUBLICWORLD.COM

Sat, 21 May 2022

Explained: Know about HIMARS, PATRIOT air Defence System that US may deliver to Ukraine

A day after the US Senate overwhelmingly approved nearly \$40 billion in new aid for Ukraine, it is expected that the Biden administration will also deliver the HIMARS missile system and Patriot air defence system to the war-ravaged country. Though the significant amount will be spent on helping Ukrainian refugees in the US, seizing Russian oligarchs’ assets, reopening the US embassy in Kyiv and prosecuting Russian war crimes, there are reports that the US is planning to "gift" the most advanced weapons to deter the aggression of the Russian forces.

What is the HIMARS missile system?

According to Lockheed Martin Corporation, an American organisation that manufactures advanced weapons for the US army, HIMARS--High Mobility Artillery Rocket System-- is a full-spectrum, all-weather, 24/7, lethal and responsive, wheeled precision strike weapons system. It is designed to destroy enemy targets as far away as 300 kilometres. It employs a shoot-and-scoot capability which enhances crew and platform survivability in high threat environments. HIMARS carries a single six-pack of GMLRS rockets or one TACMS missile on the Army's Family of Medium Tactical Vehicles (FMTV) 5-ton truck and can launch the entire MLRS family of munitions. The company claims that with a recognised and proven range of 300 km, HIMARS delivers affordable, quick, long-range precision strikes.

What is a PATRIOT?

According to North Atlantic Treaty Organisation (NATO), the Phased-Array Tracking Radar to Intercept On Target (PATRIOT) weapons system combats enemy air threats varying from aircraft and helicopters to mid-range ballistic missiles such as SCUD missiles. A PATRIOT battery primarily consists of an Engagement Control Station (ECS, fire control centre), a radar and six launching stations. The launching stations are loaded with a combination of PATRIOT missiles, depending on the threat. The PAC-3 missile is the most advanced missile and has 'Hit-

to-Kill' capability. This missile has an extensive range, permitting intercepts of ballistic missiles more effectively and at greater altitudes. The horizontal range can be significantly increased by positioning the launching stations further away from the radar. The PATRIOT radar is a fixed radar that employs an electronically controlled radar beam for the detection, classification and identification of targets as well as for guidance of the system's own missiles. A PATRIOT battery is capable of tracking a large number of targets simultaneously and carrying out several interceptions at once.

Russia-Ukraine war

Notably, the Biden administration has been providing military aid to the Ukrainian army ever since Russia attacked its neighbouring territory. Since the start of the "special military operation", US Secretary of State Antony Blinken said that the administration has provided military aid worth \$3.9 billion to Ukraine. Earlier last month, in a bid to support Ukraine amid the ongoing war with Russia, the Biden administration sent at least 100 switchblade drones to the Ukrainian military. It is pertinent to mention that Russia initiated a full-fledged war against Ukraine nearly two days after Vladimir Putin signed a decree recognising the independence of the Donetsk and Luhansk regions, on February 24. Since then, it has been bombarding several cities in Ukraine, resulting in the killing of thousands of civilians and the loss of infrastructure. Despite repetitive warnings from the West, Russian Foreign Minister Sergei Lavrov, during an interview with Russian media, said, "Russia is not in the mood to wrap up the ongoing "military operations" without achieving the goal.

<https://www.republicworld.com/world-news/russia-ukraine-crisis/explainer-know-about-himars-and-patriot-air-defence-systems-that-us-may-deliver-to-ukraine-articleshow.html>



Sun, 22 May 2022

S-400 missile: China, Pak threat and Pentagon's take on India's defence

India to deploy S-400 By June 2022

India intends to deploy the S-400 missile defence system that it has received from Russia to defend itself against threat from Pakistan and China, a Pentagon spymaster has told US lawmakers. India started receiving the delivery of the S-400 missile defence system from Russia in December last year, Lt Gen Scott Berrier, Director, Defense Intelligence Agency told members of the Senate Armed Services Committee during a recent Congressional hearing. As of October 2021, India's military was seeking to procure advanced surveillance systems to strengthen its land and sea borders and boost its offensive and defensive cyber capabilities.

S-400 to combat Chinese and Pakistani threats

“In December, India received its initial delivery of the Russian S-400 air defence system, and it intends to operate the system to defend against Pakistani and Chinese threats by June 2022,” Berrier said. “India continued to develop its own hypersonic, ballistic, cruise, and air defence missile capabilities, conducting multiple tests in 2021. India has a growing number of satellites in orbit, and it is expanding its use of space assets, likely pursuing offensive space capabilities,” he said.

India’s Military modernisation

Berrier told lawmakers that New Delhi is pursuing an extensive military modernisation effort encompassing air, ground, naval, and strategic nuclear forces with an emphasis on domestic defence production. India is taking steps to establish Integrated Theatre Commands that will improve its joint capability among its three military services. Since 2019, Indian Prime Minister Narendra Modi has given priority to strengthening India’s economy by expanding its domestic defence industry, and establishing a negative import list to curtail defence purchases from foreign suppliers. According to Berrier, throughout 2021, New Delhi continued to implement foreign policy aimed at demonstrating India’s role as a leading power and net provider of security in the Indian Ocean region.

India eyes strategic partnerships India

seeks to promote prosperity and ensure stability in the Indo-Pacific region by seeking strategic partnerships to build influence through bilateral and multilateral mechanisms such as the Quadrilateral Security Dialogue and the Association of Southeast Asian Nations (ASEAN), he said. Following the collapse of the Afghan government, New Delhi is increasingly concerned about potential attacks against India by terrorist groups such as Lashkar-e-Taiba and Jaish-e-Mohammed — empowered by a Taliban-controlled Afghanistan, he said. Berrier said that Chinese-Indian relations remain strained following the fatal clashes in summer 2020 between their respective forces along the Western sector of the Line of Actual Control (LAC).

India -China row

During 2021, both sides held multiple rounds of high-level diplomatic and military talks that resulted in a mutual pullback of forces from several standoff points. However, both sides maintain close to 50,000 troops along with artillery, tanks, and multiple rocket launchers, and both are building infrastructure along the LAC, he said. “Despite recommitting to the 2003 cease-fire, India remains postured to respond to perceived militant threats, and it has continued counterterrorism operations inside Kashmir. Occasional skirmishes between Indian and Pakistani troops will continue, and a high-profile attack in India by Pakistan-based terrorists risks an Indian military response,” he said.

<https://www.wionews.com/photos/s-400-missile-china-pak-threat-and-pentagons-take-on-indias-defence-481198#india-china-row-481192>



Sat, 21 May 2022

Unique Quantum Material could enable incredibly powerful, ultra-compact Computers

Columbia University chemists and physicists find a link between tunable electronic and magnetic properties in a 2D semiconductor, with potential applications in spintronics, quantum computing, and fundamental research. Information in computers is transmitted through semiconductors by the movement of electrons and stored in the direction of the electron spin in magnetic materials. To shrink devices while improving their performance—a goal of an emerging field called spin-electronics (“spintronics”)—researchers are searching for unique materials that combine both quantum properties. Writing in the journal *Nature Materials* on May 5, 2022, a team of chemists and physicists at Columbia University finds a strong link between electron transport and magnetism in a material called chromium sulfide bromide (CrSBr).

Created in the lab of Chemist Xavier Roy, CrSBr is a so-called van der Waals crystal that can be peeled into stackable, 2D layers that are just a few atoms thin. Unlike related materials that are quickly destroyed by oxygen and water, CrSBr crystals are stable at ambient conditions. These crystals also maintain their magnetic properties at the relatively high temperature of -280F, avoiding the need for expensive liquid helium cooled to a temperature of -450F. CrSBr is infinitely easier to work with than other 2D magnets, which lets us fabricate novel devices and test their properties,” said Evan Telford, a postdoc in the Roy lab who graduated with a PhD in physics from Columbia in 2020. Last year, colleagues Nathan Wilson and Xiaodong Xu at the University of Washington and Xiaoyang Zhu at Columbia found a link between magnetism and how CrSBr responds to light. In the current work, Telford led the effort to explore its electronic properties. The team used an electric field to study CrSBr layers across different electron densities, magnetic fields, and temperatures—different parameters that can be adjusted to produce different effects in a material. As electronic properties in CrSBr changed, so did its magnetism.

“Semiconductors have tunable electronic properties. Magnets have tunable spin configurations. In CrSBr, these two knobs are combined,” said Roy. “That makes CrSBr attractive for both fundamental research and for potential spintronics application.” Magnetism is a difficult property to measure directly, particularly as the size of the material shrinks, explained Telford, but it’s easy to measure how electrons move with a parameter called resistance. In CrSBr, resistance can serve as a proxy for otherwise unobservable magnetic states. “That’s very powerful,” said Roy, especially as researchers look to one day build chips out of such 2D magnets, which could be used for quantum computing and to store massive amounts of data in a small space.

The link between the material’s electronic and magnetic properties was due to defects in the layers—for the team, a lucky break, said Telford. “People usually want the ‘cleanest’ material

possible. Our crystals had defects, but without those, we wouldn't have observed this coupling," he said. From here, the Roy lab is experimenting with ways to grow peelable van der Waals crystals with deliberate defects, to improve the ability to fine-tune the material's properties. They are also exploring whether different combinations of elements could function at higher temperatures while still retaining those valuable combined properties.

<https://scitechdaily.com/unique-quantum-material-could-enable-incredibly-powerful-ultra-compact-computers/amp/>



Sun, 22 May 2022

Tiny Microdrones propelled by Light-driven Nanomotors

A hand-held laser pointer produces no noticeable recoil forces when it is “fired” — even though it emits a directed stream of light particles. The reason for this is simply because of its relatively enormous mass compared to the very tiny recoil impulses that the light particles cause when they leave the laser pointer. However, it has long been clear that optical recoil forces can indeed have a significant effect on correspondingly small particles. For example, the tails of comets point away from the Sun partly due to light pressure. The propulsion of light spacecraft via light sails has also been discussed repeatedly, most recently in connection with the “starshot” project, in which a fleet of miniature spacecraft is to be sent to Alpha Centauri.

Ordinary Quadcopter Drones as models

In the journal *Nature Nanotechnology*, Würzburg physicists led by Professor Bert Hecht (Chair of Experimental Physics 5, Nano-Optics Group) have now shown for the first time that it is possible to not only efficiently propel micrometer-sized objects in an aqueous environment with light, but also control them precisely on a surface with all three degrees of freedom (two translational plus one rotational). In doing so, they were inspired by ordinary quadcopter drones, where four independent rotors allow complete control of the movements. Such control possibilities offer completely new options for the usually extremely difficult handling of nano- and micro-objects, for example, for the assembly of nanostructures, for the analysis of surfaces with nanometre precision, or in the field of reproductive medicine.

Polymer discs with up to four light-driven nanomotors

The Würzburg microdrones consist of a transparent polymer disc measuring 2.5 micrometers in diameter. Up to four independently addressable nanomotors made of gold are embedded in this disc. “These motors are based on optical antennas developed in Würzburg, – that is, tiny metallic structures with dimensions less than the wavelength of light,” says Xiaofei Wu, a postdoc in the Hecht research group. “These antennas were specifically optimized for receiving circularly polarised light. This allows the motors to receive the light regardless of the orientation of the drone, which is crucial for applicability. In a further step, the received light energy is then emitted by the motor in a specific direction to generate optical recoil force, which depends on the sense of rotation of the polarisation (clockwise or counterclockwise) and on either of two different wavelengths of light.” It was only with this idea that the researchers were able to control their microdrones efficiently and precisely. Due to the very small mass of the drones, extreme

accelerations can be achieved. The development of the microdrones was challenging. It started back in 2016 with a research grant by the VW Foundation dedicated to risky projects.

Precise fabrication based on single-crystal Gold

The extremely precise fabrication of the nanomotors is crucial for the function of the microdrones. The use of accelerated Helium ions as a means to cut nanostructures from monocrystalline gold has turned out to be a game changer. In further steps, the drone body is produced using electron beam lithography. Finally, the drones must be detached from the substrate and brought into solution. In further experiments, a feedback loop is being implemented to automatically correct external influences on the microdrones to control them more precisely. Furthermore, the research team strives to complete the control options so that the height of the drones above the surface can also be controlled. And of course, another goal is to attach functional tools to the microdrones.

<https://scitechdaily.com/tiny-microdrones-propelled-by-light-driven-nanomotors/amp/>



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Scientists finally create Graphyne, the next generation wonder material

For over a decade, scientists have been trying to synthesise a new form of carbon called graphyne with next to no success. But researchers from the University of Colorado Boulder have finally succeeded in creating the elusive allotrope of carbon. This research fills a long-standing gap in carbon material science and opens up brand new possibilities for electronics, optics and semiconductor research. The researchers have documented their process in a study titled, "Synthesis of γ -graphyne using dynamic covalent chemistry," published in Nature Synthesis. The creation of different carbon allotropes (forms) has long interested scientists because of the element's versatility and usefulness in various industries. For over a decade, scientists have been trying to synthesise a new form of carbon called graphyne with next to no success. But researchers from the University of Colorado Boulder have finally succeeded in creating the elusive allotrope of carbon. This research fills a long-standing gap in carbon material science and opens up brand new possibilities for electronics, optics and semiconductor research.

The researchers have documented their process in a study titled, "Synthesis of γ -graphyne using dynamic covalent chemistry," published in Nature Synthesis. The creation of different carbon allotropes (forms) has long interested scientists because of the element's versatility and usefulness in various industries. Carbon allotropes can be constructed in different ways depending on how hybrids of carbons and their corresponding bonds are utilised. The most well known such allotropes include graphite used in pencil and diamonds. They are created out of 'sp²' carbon and 'sp³' carbon respectively. Scientists have used traditional methods to create various such allotropes over the years, including fullerene and graphene. Researchers working on these materials were awarded the Nobel Prize in Chemistry in 1996 and 2010 respectively. But unfortunately, these methods do not allow for different types of carbon to be synthesised together in any kind of large capacity and this is required for creating graphyne. Due to this obstacle,

graphyne remained a theoretical material speculated to have unique electrical, mechanical and optical properties.

Researchers in the field approached Wei Zhang, the co-author of the research article, and his lab group. Zhang is a professor of chemistry at CU Boulder and studies reversible chemistry. Reversible chemistry allows bonds to self-correct, thus opening possibilities to create new kinds of ‘lattices’ (ordered structures) like synthetic polymers that resemble DNA. The team used a process called alkyne metathesis along with thermodynamics and kinetic control to create a new kind of material that could rival the conductivity of graphene, but with control. Alkyne Metathesis refers to an organic reaction that involves the redistribution (cutting and forming) of alkyne chemical bonds. Alkynes are hydrocarbons with at least one carbon-carbon triple covalent bond. The material has successfully been created. But the team still needs to look into many more details, including how to create it on a large scale and how to manipulate it for various different use cases. These efforts will help figure out more of the material’s electrical and optical properties, allowing it to be used in applications like lithium-ion batteries.

<https://indianexpress.com/article/technology/science/scientists-finally-graphyne-wonder-material-why-is-it-important-7930030/>

