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समाचार पत्रों से चयित अंश Newspapers Clippings

A Daily service to keep DRDO Fraternity abreast with DRDO Technologies, Defence Technologies, Defence Policies, International Relations and Science & Technology

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Fri, 11 March 2022

फिफ्थ जेनरेशन स्टेल्थ फाइटर जेट बनाने की दिशा में बड़ा कदम, विशेष सामाग्री का निर्माण शुरू

डीआरडी के मुताबिक, एयरोस्पेस डिफेंस एजेंसी (एडीए) द्वारा डिजाइन किए गए फिफ्थ जेनरेशन डिजाइन के मैटेरियल के आधार पर एमका के लीडिंग-एज के फैब्रिकेशन का काम शुरू हो गया है।

रूस-यूक्रेन के बीच छिड़ी जंग के बीच भारत ने स्वदेशी लड़ाकू विमानों की कड़ी में फिफ्थ (5) जेनरेशन स्टेल्थ फाइटर जेट, 'एमका' बनाने की दिशा में एक बड़ी उड़ान भरी है। डीआरडीओ और एडीए ने डिजाइन के आधार पर एमका लड़ाकू विमान के लिए विशेष सामाग्री का निर्माण शुरू कर दिया है। डीआरडीओ ने स्टेल्थ फाइटर जेट बनाने की दिशा में इस कदम को मील का पत्थर कहा है।

डिफेंस रिसर्च एंड डेवलपमेंट ऑर्गेनाइजेशन (डीआरडीओ) के मुताबिक, एयरोस्पेस डिफेंस एजेंसी (एडीए) द्वारा डिजाइन किए गए फिफ्थ जेनरेशन डिजाइन के मैटेरियल के आधार पर एमका के लीडिंग-एज के फैब्रिकेशन का काम शुरू हो गया है। ये काम एचएलए यानी हिंदुस्तान एयरोनोटिक्स लिमिटेड में शुरू हुआ है। एचएलए की जिस यूनिट में एमका के प्रोटो-टाइप को तैयार किया जाएगा उसे पहले संरचनात्मक और अन्य परीक्षण से गुजरना होगा।

पांचवे श्रेणी का स्वदेशी लड़ाकू विमान

एमका यानी एडवांस मीडियम कॉम्बेट एयरक्राफ्ट भारत का पांचवे श्रेणी का स्वदेशी लड़ाकू विमान है। पिछले साल यानी फरवरी 2021 में भारत ने एयरो-इंडिया शो में एमका के डिजाइन और मॉडल को पहली बार दुनिया को दिखाया था। लड़ाकू विमानों के डिजाइन तैयार करने वाली स्वदेशी एजेंसी, एयरोनोटिकल डेवलपमेंट एजेंसी (एडीए यानी आडा) और डीआरडीओ ने इस मॉडल को पेश किया था। ये भारत का पहला टूइन यानी दो इंजन वाला फाइटर जेट होगा, जिसके स्टेल्थ फीचर्स के चलते दुश्मन के रडार को इसे पकड़ना बेहद मुश्किल होगा।

भारत अगर एमका बनाने में कामयाब हो जाता है तो अमेरिका, रूस और चीन सहित उन चुनिंदा देशों की श्रेणी में शामिल हो जाएगा, जिनके पास पांचवें जेनरेशन के लड़ाकू विमान बनाने की

क्षमता होगी. हाल ही में थलसेना प्रमुख, जनरल एम एम नरवणे ने यूक्रेन युद्ध से सीख लेते हुए स्वदेशी हथियारों की निर्माण पर जोर देने की बात कही थी.

खास मैटेरियल से बनी होती है स्टेल्थ फाइटर जेट की बाँडी

आपको बता दें कि स्टेल्थ फाइटर जेट की बाँडी ऐसी खास मैटेरियल से बनी होती है, जिसके चलते दुश्मन के रडार की तरंगों को ये खुद ऑब्जर्व कर लेता है और वापस रडार को नहीं जाने देता. इसके चलते स्टेल्थ फाइटर जेट्स को रडार डिटेक्ट नहीं कर पाती हैं.

भारत का ये एमका फाइटर जेट एक मल्टी-रोल लड़ाकू विमान होगा, जिसमें वियॉड विजुयल रेंज यानी बीवीआर मिसाइल, प्रेसिसयन स्ट्राक क्षमता सहित क्लोज-कॉम्बेट डॉडफाइट करने की भी क्षमता है. स्टेल्थ एयर-फ्रेम के अलावा इसमें आइसा रडार, नेटसेंट्रिक वॉरफेयर, एडवांस इंटीग्रेटेड सेंसर सूट और सेंसर डाटा फ्यूजन भी होगा.

माना जा रहा है कि भारत का ये फिफ्थ जेनरेशन फाइटर जेट वर्ष 2025 तक बनकर तैयार हो जाएगा और वर्ष 2030 तक वायुसेना की फाइटिंग-स्कॉवड्रन का हिस्सा बन जाएगा.

अमेरिका के पास एफ-22 रेपेटर और एफ-35 लाइटनिंग स्टेल्थ फाइटर जेट्स हैं तो रूस के पास सुखाई-57 है. चीन भी दावा करता है कि उसके पास जे-20 स्टेल्थ फाइटर जेट है. लेकिन देश-विदेश के रक्षा मामलों के जानकार जे-20 (चेंगदू-20) में स्टेल्थ फीचर्स पर सवाल खड़े कर चुके हैं. एयर-स्पेस में लड़ाई के वक्त स्टेल्थ फाइटर जेट ही बाकी सभी लड़ाकू विमानों का नेतृत्व करता है और दुश्मन की सीमा में सबसे पहले दाखिल होता है.

<https://www.abplive.com/news/india/big-step-towards-making-fifth-generation-stealth-fighter-jet-manufacturing-of-special-material-started-ann-2079010>

NewsOnAIR

Thu, 10 March 2022

HAL begins manufacturing of India's Advanced Medium Combat Aircraft (AMCA)

India's state-owned aerospace & defence firm Hindustan Aeronautics Limited (HAL) has started manufacturing India's Advanced Medium Combat Aircraft (AMCA) in association with DRDO's Aeronautical Development Agency.

The AMCA programme entered a crucial phase with the starting of manufacturing activities. It is noteworthy that, the plan envisages to equip the Indian Air Force (IAF) and Indian Navy with a 5.5 Generation twin-engine stealth fighter.

Inside the design & development

While the design and development will be carried out by HAL and ADA, private defence firms will also be roped in to manufacture the combat jet. The advanced stealth aircraft will be a multirole fighter capable of carrying out air superiority, ground strike, suppression of enemy air defences and electronic warfare missions.

Notably, the first two squadrons in AMCA Mark 1 configuration will be powered by an imported engine, another five squadrons with advanced features (Mark 2) will use made-in-India 125-kilonewton engines along with 6th Generation technologies.

It is important to note that the new engine for the fighter will be jointly developed by India's Defence Research and Development Organisation (DRDO) and Safran of France.

The advanced stealth aircraft will bolster India's air arsenal by enhancing air superiority. Further, the naval version of aircraft will become the primary combat jet operating from the Indian Navy's aircraft carriers.

Apart from stealth features, the advanced aircraft will encompass three-dimensional thrust vectoring, made-in-India Uttam active electronically scanned array (AESA) radar, and internal weapons bay to bolster the stealth capabilities of the aircraft.

AMCA can clock a maximum speed of over 2,600 kilometres per hour (Mach 2.15), along with the combat range of 1,620 km. The fighter will be equipped with 23 mm cannon and will have 14 hardpoints in non-stealth version to carry armaments weighing 6,500 kilogrammes.

Presently, Aeronautical Development Agency (ADA) is in process of manufacturing Mk2 version of Light Combat Aircraft (LCA) Tejas along with Hindustan Aeronautics Limited (HAL), as well as the AMCA and the Twin Engine Deck Based Fighter (TEDBF), for the Indian Navy.

Addressing the media, Girish S. Deodhare, Director General of ADA stated, "The configuration has been frozen, Preliminary Service Quality Requirements (PSQR) are finalised and the preliminary design review is complete. The Critical Design Review (CDR) is expected later this year with the rollout planned in 2024 and first flight planned in 2025."

<https://newsonair.com/2022/03/10/hal-begins-manufacturing-of-indias-advanced-medium-combat-aircraft-amca/>

रॉयल बुलेटिन

Thu, 10 March 2022

भारत की धनुष तोप के फायरिंग ट्रायल को मंजूरी, अंतिम परीक्षण की तैयारी शुरू

भारत की धनुष तोप के फायरिंग ट्रायल को मंजूरी मिल गई है। भारतीय सेना के औपचारिक आदेश से पहले इसी महीने एडवांस्ड टोड आर्टिलरी गन सिस्टम (एटीएजीएस) का अंतिम परीक्षण करने की तैयारी शुरू कर दी गई है। डीआरडीओ ने भारतीय सेना में पुरानी तोपों को बदलने के लिए यह परियोजना 2013 में आधुनिक 155 मिमी. आर्टिलरी गन के साथ शुरू की थी। एटीएजीएस ने 2017 में 47.2 किलोमीटर की दूरी तक राउंड फायर करके 155 मिमी. तोप का विश्व रिकॉर्ड तोड़ा था।

पूरी तरह स्वदेशी रूप से विकसित एडवांस्ड टोड आर्टिलरी गन सिस्टम (एटीएजीएस) के विकास परीक्षण पूरे होने के बाद पहली खेप में 40 तोपों का निर्माण किया गया था। सितम्बर, 2020 में उपयोगकर्ता परीक्षण के दौरान राजस्थान के पोकरण फील्ड फायरिंग रेंज में एक बैरल फटने से

तीन विशेषज्ञ घायल हो गए। बैरल फटने का कारण पता लगाने के लिए एक समिति गठित की गई। नवम्बर, 2020 में जांच के बाद आगे के परीक्षणों के लिए मंजूरी मिलने के बाद भारतीय सेना ने फिर से एटीएजीएस के परीक्षण शुरू किए। विभिन्न इलाकों और मोड में फायरिंग से जुड़े आकलन के बाद परियोजना की गहन समीक्षा किए जाने के बाद भारत की धनुष तोप के फायरिंग ट्रायल को मंजूरी मिल गई है।

एडवांस्ड टोड आर्टिलरी गन सिस्टम (एटीएजीएस) 155 मिमी/52 कैलिबर हॉवित्जर है जिसे रक्षा अनुसंधान और विकास संगठन (डीआरडीओ) ने भारतीय सेना के लिए विकसित किया है। स्कूल ऑफ आर्टिलरी के ट्रायल विंग ने परीक्षणों को अंजाम दिया है, जिसके बाद इस पर एक व्यापक रिपोर्ट सेना प्रशिक्षण कमान को भेजी जाएगी ताकि भविष्य की कार्रवाई के बारे में निर्णय लिया जा सके। परीक्षणों के दौरान टैंक के आकार और लक्ष्यों पर दिन-रात की फायरिंग, पांच राउंड बस्ट के लिए परीक्षण, लगभग तीन मिनट में 15 राउंड की रैपिड-फायर दर और हर घंटे 60 राउंड की निरंतर फायरिंग क्षमता आंकी गई है। एटीएजीएस के गतिशीलता परीक्षण रेगिस्तान में रेत के टीलों पर नेविगेशन के साथ और 70 सड़कों पर हाई-स्पीड ट्रायल हुए हैं।

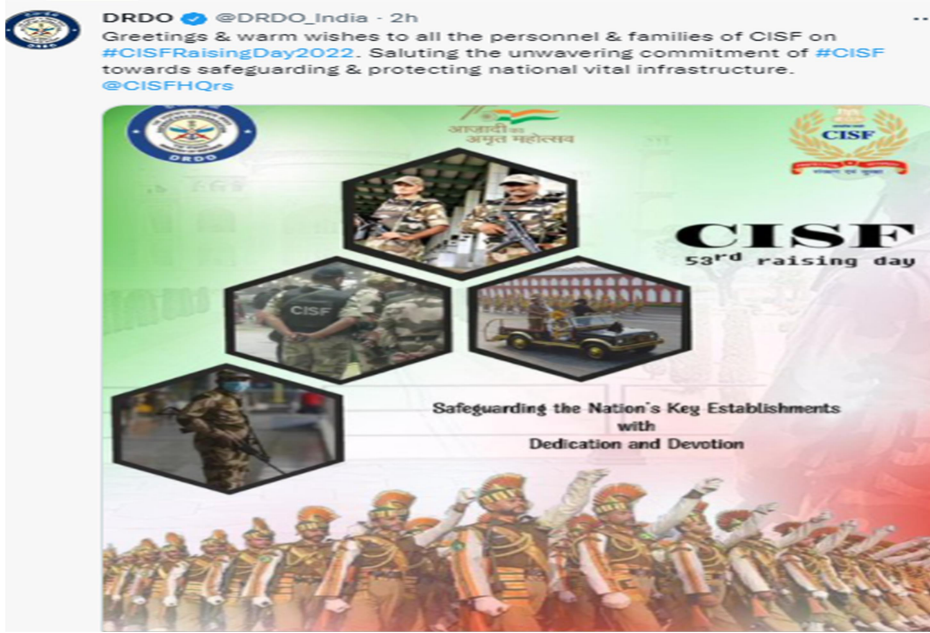
एटीएजीएस को भारत फोर्ज लिमिटेड और टाटा पावर एसईडी कम्पनियों ने निर्मित किया है। उन्नत टोड आर्टिलरी गन सिस्टम (एटीएजीएस) परियोजना 2013 में डीआरडीओ ने भारतीय सेना में पुरानी तोपों को बदलने के लिए आधुनिक 155 मिमी. आर्टिलरी गन के साथ शुरू की थी। एटीएजीएस को विकसित करने में डीआरडीओ प्रयोगशाला आयुध अनुसंधान और विकास प्रतिष्ठान (एआरडीई) ने निजी कंपनियों भारत फोर्ज लिमिटेड, महिंद्रा डिफेंस नेवल सिस्टम, टाटा पावर स्ट्रेटेजिक इंजीनियरिंग डिवीजन और सार्वजनिक क्षेत्र की इकाई आयुध निर्माणी बोर्ड (ओएफबी) के साथ भागीदारी की।

एडवांस्ड टोड आर्टिलरी गन सिस्टम के अब तक हुए परीक्षण

डीआरडीओ ने 14 जुलाई, 2016 को 155/52 कैलिबर एडवांस्ड टोड आर्टिलरी गन सिस्टम के लिए आयुध की प्रूफ फायरिंग की जो पूरी तरह सफल रहा। आर्टिलरी गन ने 14 दिसम्बर, 2016 को ओडिशा के बालासोर में प्रूफ एंड एक्सपेरिमेंटल एस्टाब्लिशमेंट (पीएक्सई) में अपने पहले राउंड गोला बारूद को दागा। 2017 में परीक्षण के दौरान एटीएजीएस ने 47.2 किलोमीटर की दूरी तक राउंड फायर करके 155 मिमी. तोप का विश्व रिकॉर्ड तोड़ा। एटीएजीएस ने उच्च विस्फोटक-बेस ब्लीड (एचई-बीबी) गोला-बारूद के साथ अधिकतम 48.074 किलोमीटर की दूरी दर्ज करके इस श्रेणी में किसी भी आर्टिलरी गन सिस्टम द्वारा दागी गई अधिकतम सीमाओं को पार किया।

<https://royalbulletin.in/National-News/Firing-trial-of-Indias-Dhanush-cannon-approved-preparations/cid6798144.htm>

DRDO on Twitter



Defence News

Defence Strategic: National/International



पत्र सूचना कार्यालय
भारत सरकार

Thu, 10 Mar 2022 5:28PM

रक्षा मंत्रालय

ऑस्ट्रेलिया के सेना प्रमुख ने लोंगेवाला का दौरा किया, पोखरण स्थित समेकित फायर पावर प्रदर्शन का अवलोकन किया

ऑस्ट्रेलिया के सेना प्रमुख लेफ्टिनेंट जनरल रिचर्ड मैक्सवेल बर् एओए डीएससीए एमवीओ वर्तमान में 08 मार्च 2022 से भारत की चार दिवसीय यात्रा पर हैं।

ऑस्ट्रेलिया के सेना प्रमुख ने 10 मार्च, 2022 को राजस्थान में लोंगेवाला, पोखरण तथा जोधपुर का दौरा किया। लोंगेवाला पहुंचने पर ऑस्ट्रेलिया के सेना प्रमुख का डेजर्ट कॉप्स के जीओसी

लेफ्टिनेंट जनरल राकेश कपूर ने स्वागत किया, जिसके बाद उन्होंने 1971 में हुए भारत-पाकिस्तान युद्ध में भारतीय सेना के शहीद हुए जवानों की याद में लोंगेवाला युद्ध स्मारक पर श्रद्धांजलि अर्पित की। उन्होंने 'युद्ध स्मारकों' के निर्माण तथा उसके रखरखाव और भारतीय जवानों के मूल्यों तथा वीरता का अवलोकन करने के लिए आम आदमी की पहुंच बनाने के लिए सेतु की स्थापना करने पर भारतीय सेना के प्रयासों की सराहना की।

लेफ्टिनेंट जनरल रिचर्ड मैक्सवेल बर् ने पोखरण स्थित फील्ड फायरिंग रेंज का भी दौरा किया जहां उन्होंने आर्मेड, आर्टिलरी, इंफैंट्री तथा उड्डयन परिसंपत्तियों से संबंधित संयुक्त हथियार चलाने से जुड़े अभ्यास में प्रचालनगत करतबों को निष्पादित करते स्वदेशी अस्त्र प्लेटफॉर्म के प्रदर्शन का अवलोकन किया। आगंतुक जनरल ने भारतीय जवानों की मजबूती तथा तैनाती के विभिन्न क्षेत्रों और दुर्गम तराइयों एवं कठिन परिस्थितियों में काम करने की उनकी क्षमता की सराहना की।

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Press Information Bureau
Government of India

Thu, 10 Mar 2022 5:28PM

Ministry of Defence

Australian Army Chief Visits Loungewala, Witnesses Integrated Fire Power Demonstration at Pokharan

Lt Gen Richard Maxwell Burr AO, DSC, MVO, Chief of Australian Army is currently on a four day visit to India from 08 March 2022.

On 10 March 2022, the Australian Army Chief visited Laungewala, Pokharan and Jodhpur in Rajasthan. On arrival at Laungewala, the Australian COAS was received by Lt Gen Rakesh Kapoor, GOC, Desert Corps after which he paid homage at the Laungewala War Memorial in memory of the fallen heroes of Indian Army in the Indo-Pak war 1971. He appreciated the efforts of Indian Army in creating and maintaining the 'War Memorials' and establishing a bridge for common man's outreach to witness the values and valour of the Indian Soldier.

Lt Gen Richard Burr also visited the Pokharan Field Firing Ranges where he witnessed a demonstration of indigenised weapons platforms executing operational manoeuvres in a combined arms firing exercise involving Armour, Artillery, Infantry and Aviation assets. The visiting General complimented the robustness of the Indian soldier and his ability to operate in varied terrain and difficult conditions, across various spectrums of engagement.

<https://pib.gov.in/PressReleasePage.aspx?PRID=1804809>



रक्षा मंत्रालय

संयुक्त सैन्य अभ्यास 'धर्म गार्जियन-2022' बेलगाम (कर्नाटक) में संपन्न

भारतीय सेना और जापानी ग्राउंड सेल्फ डिफेंस फोर्स के बीच एक वार्षिक सैन्य अभ्यास 'धर्म गार्जियन-2022', जो 27 फरवरी 2022 को विदेशी प्रशिक्षण नोड, बेलगाम में शुरू हुआ था, 12 दिनों के गहन संयुक्त सैन्य प्रशिक्षण के बाद 10 मार्च 2022 को सफलतापूर्वक संपन्न हुआ। दोनों देशों के सशस्त्र बलों के बीच तालमेल स्थापित करने का एक अनूठा अवसर प्रदान वाला यह अभ्यास भारत-जापान मैत्री के कालातीत संबंधों को मजबूत करने की दिशा में केंद्रित है। इस अभ्यास ने पेशेवर और सांस्कृतिक तौर पर मिली कई सीखों के साथ-साथ सामाजिक अंतःक्रियाओं के लिए भी एक मंच प्रदान किया है। इसका लक्ष्य हिंद-प्रशांत क्षेत्र में सह-अस्तित्व की ओर ज्ञान और सहयोग की दिशा में अपने क्षितिज को व्यापक बनाना भी था।

इस अभ्यास का आयोजन एक शानदार सफलता रही है। इसमें क्रॉस ट्रेनिंग और फील्ड परिस्थितियों में मुकाबला कंडीशनिंग से लेकर खेल और सांस्कृतिक आदान-प्रदान तक एक विशाल स्पेक्ट्रम शामिल था। फायरिंग रेंज में और विभिन्न सामरिक अभ्यासों के दौरान दोनों सेनाओं ने विभिन्न प्रदर्शनों में भाग लिया। दोनों टुकड़ियों ने न केवल आतंकवाद विरोधी अभियानों के समकालीन विषयों पर अपनी विशेषज्ञता साझा की, बल्कि इस अवसर का उपयोग ड्रोन और ड्रोन विरोधी हथियारों जैसी बेहद जरूरी प्रौद्योगिकियों के इस्तेमाल पर अपने अनुभवों को साझा करने के लिए भी किया।

'धर्म गार्जियन-2022' भारतीय सेना और जापानी ग्राउंड सेल्फ डिफेंस फोर्स के बीच रक्षा सहयोग के स्तर को बढ़ाएगा और भविष्य में ऐसे कई संयुक्त कार्यक्रमों के लिए उत्प्रेरक के रूप में कार्य करेगा ताकि इससे प्राप्त लाभों को और मजबूत किया जा सके।

<https://pib.gov.in/PressReleasePage.aspx?PRID=1804842>



Ministry of Defence

Exercise Dharma Guardian-2022 Culminates at Belgaum (Karnataka)

Ex DHARMA GUARDIAN-2022, an annual exercise between Indian Army and Japanese Ground Self Defence Force which commenced on 27 February 2022 at Foreign Training Node, Belgaum successfully culminated on 10 March 2022 after twelve days of intense joint military training,

providing an unique opportunity of achieving synergy between Armed Forces of both the Nations which is focused towards strengthening the timeless bonds of India - Japan friendship. The exercise also provided a platform for professional and cultural learning as well as social interactions which in-turn broadened their horizon towards knowledge and cooperation aiming towards co-existence as one in the Indo-Pacific Region.

The conduct of this exercise, which covered a vast spectrum from cross training & combat conditioning in field conditions, to sports and cultural exchanges has been a grand success. The two armies rubbed shoulders attending various demonstrations, at firing ranges and during various tactical exercises. Both contingents not only shared their expertise on contemporary subjects of counter terrorism operations, but also utilised this opportunity to share their experiences on exploiting disruptive technologies like Drone and Anti-Drone weapons.

“Exercise Dharma Guardian” will enhance the level of defence cooperation between the Indian Army and Japanese Ground Self Defence Forces and will act as a catalyst for many such joint programs in future to further consolidate on the gains achieved.

<https://pib.gov.in/PressReleasePage.aspx?PRID=1804800>



Press Information Bureau
Government of India

Thu, 10 Mar 2022 12:30PM

Ministry of Defence

Defence Secretary calls for innovative methods to deal with Volatile, Uncertain, Complex and Ambiguous environment

Four-day Indo-Pacific Military Health Exchange conference concludes

The four-day Indo-Pacific Military Health Exchange (IPMHE-2021-22) conference, co-hosted by Armed Forces Medical Services (AFMS) and US Indo-Pacific Command (USINDOPACOM), concluded on March 10, 2022 with the valedictory address by Defence Secretary Dr Ajay Kumar. Congratulating AFMS and USINDOPACOM for successfully organising the conference despite limitations of a virtual mode, he pointed out the vital role played by a uniformed health professional in providing health care in the most trying circumstances.

The theme of the conference was ‘Military Healthcare in a Volatile, Uncertain, Complex and Ambiguous (VUCA) World’. The conference, organised to enhance cooperation and jointmanship in military medicine, was virtually inaugurated by Raksha Mantri Shri Rajnath Singh on March 07, 2022. Delegates discussed, over four days, many important topics including operational/combat medical care, tropical medicine, field surgery, field anaesthesia, aviation & marine medicine emergencies. Over 600 Indian and foreign delegates from more than 38 countries participated.

Stressing on the need to remain updated in all spheres by continued research and training, the Defence Secretary lauded IPMHE for deliberating on diverse topics such as operational & combat medical care, global health security, challenges of COVID-19, military disaster drills and research & innovation in a VUCA world. He expressed hope that the knowledge gained during the conference would help all stakeholders to better plan their contingencies and come up with innovative methods to deal with a VUCA environment. Dr Ajay Kumar assured India’s full support to IPMHE to achieve this objective while commending it for providing a global platform for shared & meaningful learning and addressing contemporary real-time & relevant issues pertaining to military medicine, humanitarian assistance and disaster relief.

Dr Ajay Kumar said, the assessment and handling of combat casualties by these health professionals during wars & conflicts has a long term impact on not just the individual, but also the moral of the troops of the unit and the nation at large. “Medical services is an important supporting arm of the military which provides stellar services during peace and war. They are entrusted with the most vital role of delivering preventive, curative and rehabilitative medical care to the military personnel and their families,” he added.

The last day of the conference saw discussions between Indian and US experts on the role of Artificial intelligence as compared to Clinical Intelligence in the practice of medicine in a VUCA world. Dr Kayvon Modjarrad from the US, whose team developed a novel SARS-CoV-2 vaccine based on nanoparticle technology, addressed the audience on various aspects of infectious disease response and future pandemic management.

Selected researchers from India, US and Indonesia were given the opportunity to present their best scientific papers at an international platform and awards in different categories of posters, platform and research innovations were announced by the scientific committee.

<https://pib.gov.in/PressReleasePage.aspx?PRID=1804683>



Thu, 10 Mar 2022

Weak Investment in Defence R&D: Key Factor Behind India’ Poor Defence Indigenization

In the Budget of 2022 presented by Union Finance Minister (FM) Nirmala Sitharaman in early February 2022 allocated a total of 70,23 billion USD to the defence budget for the year 2022-23, which is roughly 13.3 percent of the national budget. The share allocated for Research and Development (R&D) in the latest budget stands at pitifully small sum of 1.24 billion USD, which is 1.7 percent of the total defence budget. An allocation of 25 percent of the R&D budget at a sum of 310 million to private sector industries, start-ups and academic institutions is not just worryingly, but laughably small. This figure and the entire R&D budget are being treated as a significant allocation. Consider Defence Minister (DM) Rajnath Singh’ statement on social media following FM Seetharaman’s budget speech: “Substantial amounts have been allocated towards Research and Development in several sectors including Defence. The proposal to reserve 25 percent of the R&D Budget for Start-ups and Private entities is an excellent move.” Reassuringly, the Indian government has also sought to allay fears of private industry that it will extend guaranteed orders and source equipment. The private industrial enterprises that are likely to gain from the government’s acquisitions will include Tata group, Mahindra Defence, Kalyani group, Larsen and Toubro, Adani Aerospace & Defence, VEM Technologies, Tara Systems and Technologies, SEC Industries, Cyient, Alpha Design, Astra Microwave Products, Sigma Electro Systems, Economic Explosives, MKU, SSS Defence and Indo-MIM.

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To be sure, the figure of 1.24 billion potentially excludes expenditure in strategic sectors such as nuclear and missile related R&D. Nevertheless, the R&D budget is too small by any standard compared to major military spenders across the world explaining why India lags behind in building

a credible and capable domestic defence industry. The foremost test for India will have to be how its expenditure on R&D compares with China. A glance at Peoples Republic of China (PRC)' spending on defence R&D in Table 1 will give the reader a glimpse of why India will struggle to compete effectively with one of the world's major military powers and a neighbour against whom India faces serious military competition. Between the years 2017 and 2019, the Chinese spent roughly 9 to 10 percent of their defence budget on defence R&D as shown in Table 1. The data given below is for the three years between 2017-2019 drawn from the Stockholm International Peace Research Institute' 2020-21 report. All data in Table 1 has been converted specifically by the author to round figures with only slight variation drawn from data in SIPRI's "A New Estimate of China's Military Expenditure" authored by Nan Tian and Fei Su. For the years 2020 to 2021, the author was unable to access data. Despite this limitation, readers should note that the differential in the amount spent on R&D by the PRC is unlikely to be great for years 2020 and 2021 from the data shown in Table 1.

Year	2017	2018	2019
Defence Expenditure (DE) in USD Billions	228	254	260
Research and Development, Testing and Evaluation in USD Billions.	20	23	25
R&DT&E expenditure in percent.	9.00	9.10	9.60

Even if the SIPRI data from Table 1 is considered a very conservative estimate, India still stacks up poorly against the Chinese in relation to defence spending on R&D and if one were to go by Indian data, India fares even worse than what SIPRI estimates about China's budgetary allocation for defence R&D. Indeed, data obtained by the Lok Sabha Standing Committee on Defence 2019-2020 put the PRC's R&D at 20 percent of the Chinese defence budget. That figure is twice as high as the SIRPI estimate as shown in Table 1. The MoD in its submission in the 2019-20 report stated that the DRDO – India's leading defence R&D organization was consistently allocated 5-6 percent (very likely excluding what the MoD calls "strategic schemes" or strategic sectors) of the defence budget. This figure would still be roughly two times less than the SIPRI's estimate and four times less than the Lok Sabha Standing Committee' estimate on China's allocation for defence R&D. However, in the current defence budget of 2022-23, R&D allocation is less than 2 percent of the total defence budget revealing an even greater differential. In the absence of greater budgetary support for defence R&D, the government and the MoD have sought other avenues. In the Lok Sabha Standing Committee report 2020-21, the MoD again noted in a quest to gain more technology, the Modi government which announced a 74 percent hike in Foreign Direct Investment (FDI) in 2020 through the automatic route, will offset or compensate for limits on budgetary support for defence R&D by attracting "...cutting edge defence technologies". Although evidence for such gains is unclear and the decision to hike FDI to 74 percent from 49 percent will take more time to bear fruit or if it is as attractive to foreign vendors to dole out high-end technology as the MoD claims.

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If the Indian government does not spend as much on defence R&D through its government run defence research institutions, are Indian private sector companies making up for lack of governmental investment? Here the data is even more scant or at least obscure. It is hard to find concrete evidence on how much investment Indian private sector companies plough into in-house defence R&D. For instance, India's largest private engineering company and a leading player in defence hardware development and manufacturing Larsen and Toubro (L&T) does have in-house R&D investments based on the revenue it earns, yet the precise amount is unknown. Further, the incentive for in-house R&D, especially in defence, as one senior L&T executive averred, must be

subject to tax deduction and treated on par with government funded defence R&D programmes, if defence indigenization is to be consolidated in the long term and private enterprise is to pick up slack for low government funded defence R&D. It is entirely possible, L&T and other Indian private enterprises involved in the development and production defence equipment do not want to divulge their internal R&D investment in the interests of corporate confidentiality and secrecy. Thus, unless more information is available in the public domain establishing the scope, nature and pattern of in-house private sector investments in defence R&D will remain speculative and indeterminate.

<http://www.indiandefensenews.in/2022/03/weak-investment-in-defence-r-key-factor.html>



Fri, 11 Mar 2022

Breaking with Russia on Defence is Difficult

India could be heading to become a collateral casualty of the devastating Russian attack on Ukraine. The United States-European Union (US-EU) sanctions can derail our ties with Russia. So far, India has remained neutral and abstained from voting against Russia at the United Nations (UN). But soon, there may be no more wiggle room left and the seas could become rougher, even stormy. This could push the US to place sanctions through the Countering American Adversaries Through Sanctions Act (CAATSA). This action can have its own geopolitical fallout on the growing Indo-us alignment aimed at checking China.

India's stand on the Russian invasion of Ukraine is shaped by two factors. The first is the history of the relationship, and the second is our significant reliance on Russia for military equipment, spare parts, and ancillaries, along with strategic weapons such as missiles and nuclear-propelled submarines. A 2021 study by Stimson Centre scholars suggests the share of major Russian systems in our military is an astonishing 85%. Between 2000 and 2020, Russia accounted for 66.5% of India's arms imports.

India's current acquisitions include four more high performance S-400 surface-to-air (SAM) systems, four Grigorovich frigates (two to be built in India), 21 MiG-29 fighters, and an Akula nuclear-powered attack submarine on lease. There is also an order for Kalashnikov 203 assault rifles — 20,000 off the shelf and more than 500,000 licence-built in India. At the planning stage are some missile acquisitions, including the hand-held anti-aircraft missile for the Indian Army.

There are several ongoing projects — licence producing more T-90S tanks, Sukhoi Su-30MKI fighters and upgrading the Brahmos missile to a hypersonic version. Note that ancillaries and components routinely imported from Russia are essential for maintaining existing equipment and licence production, though Indo-Russian projects for nuclear-propelled submarines are presumably already sanctions-proof.

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India's geopolitical posture in Eurasia has been remarkably stable, unlike the US, China, and Russia, which have shifted alignments and preferences. We have had close ties with the former Soviet Union since the mid-1950s and maintained Russia favouring neutrality when it invaded Hungary in 1956, Afghanistan in 1980, and now, Ukraine.

For its part, the former Soviet Union and now, Russia, has unreservedly endorsed India's South Asia policy. It backed the liberation of Goa in 1961, maintained a largely neutral stand in the Sino-Indian war of 1962, and played a key role in helping India win the Bangladesh war in 1971. It has, all through, backed India on Kashmir, down to the 2019 effective nullification of Article 370, which bifurcated the state and demoted it to a Union Territory.

The Soviets came through in the 1950s and 1960s with equipment such as MIG-21 fighters and Foxtrot submarines, whose equivalent our erstwhile mentor Britain refused to give. The Soviet Union had no concept of market prices, and so, all of it came at throwaway prices under rupee-rouble exchange arrangements along with technology transfer. We would never have been able to afford the size of the military that we have had since the 1980s with western equipment. The Soviet systems, grumbled a critic, were a drug habit that India could not break.

New Delhi did seek to overcome the addiction in the 1980s by buying from the West, and also tried to design its own systems. Imports often got entangled with corruption, and domestic programmes, like that of the Tejas fighter and the Arjun tank, proved to be disappointing. India has not been able to field an aerial drone of any consequence, even though we have been working on this since the 1990s.

After Russia emerged from the Soviet Union, arms purchases began to be designated in dollars, but there were still good deals available such as the licensed manufacture of the formidable Sukhoi Su-30MKI fighter and the T-90S tanks that give India an edge against the People's Liberation Army (PLA) today.

Can we break away from the Russians? In the last two decades, India has enhanced arms purchases from countries such as France, Israel, and the US. Even if India were to stop all Russian purchases today, it would take decades before it would show. This is because systems such as tanks, fighter aircraft and ships, and artillery are routinely upgraded and often remain in service for decades.

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The Russian arms industry is now in the cross-hairs of the Americans, and New Delhi and Moscow will have to come up with creative solutions to keep the relationship going. One obvious move would be to revert to the old rupee-rouble trade.

A major problem for India is the lack of an adequate general industrial capacity that can feed the domestic defence industry. Indian defence manufacturing may be on the point of take-off. But whether it can fly remains to be seen. As my colleague, Kartik Bommakanti, has pointed out, government investments in defence research and development (R&D) are "not just worryingly, but laughably small". Just what can be achieved through effective policy and investment can be seen in South Korea which has, since the 1990s, developed its own tanks and submarines, and is working on a fifth-generation fighter and is one of the largest arms exporters in the world. India has a long way to go.

<http://www.indiandefensenews.in/2022/03/breaking-with-russia-on-defence-is.html>

Fri, 11 Mar 2022

India-China Tensions Along Lac 'Worst' In Over 4 Decades: Us Admiral John Aquilino

Tensions between India and China along the Line of Actual Control are the "worst" in over four decades, a top American Admiral has told lawmakers during a Congressional hearing on the Indo-Pacific, a strategic region which has seen aggressive moves by Beijing.

The statement of Commander of US Indo-Pacific Command Admiral John Aquilino on Wednesday came ahead of the 15th round of high-level military talks between India and China on March 11.

"Tensions along the Line of Actual Control (LAC) between the PRC (People's Republic of China) and India are the worst in over four decades," Admiral Aquilino told members of the House Armed Services Committee during the Congressional hearing on the Indo-Pacific region.

Aquilino said that in October 2021, the Chinese legislature passed a land borders law that asserts "sacred and inviolable" sovereignty and territorial integrity and provides a domestic legal framework for greater PLA (People's Liberation Army) involvement in border security.



Commander of US Indo-Pacific Command Admiral John Aquilino

This law took effect on January 1, 2022, representing a continuation of PRC's use of domestic law as a pretext to the use of force to resolve territorial disputes, he said.

Ely Ratner, Assistant Secretary of Defence for Indo-Pacific Security Affairs, said that the United States is closely watching developments along the Line of Actual Control at the India-China border.

Responding to a question from Congressman Andy Kim, Ratner said that India has faced tough situations from China along the LAC.

"In the case of India, we have seen a test case of this in the last several years when the Indians were facing aggression from China on the Line of Actual Control where the United States rapidly provided capabilities in intelligence and in the context of trying to improve trust and the nature of the defence relationship.

"That was a defining moment. So this is about them being ready to support our efforts, but also us being ready to support theirs. And these are precisely the kind of conversations that we're having at a political military level with a number of our closest partners," Ratner said.

Aquilino said that the Chinese have taken lives on the Indian Line of Actual Control, referring to the clash at Galwan Valley in which 20 Indian military personnel died.

In February last year, China officially acknowledged that five Chinese military officers and soldiers were killed in the clashes with the Indian Army though it is widely believed that the death toll was higher.

"They have discounted their agreement as it applied to Hong Kong. They have locked up a million Muslims in Xinjiang. So, their actions, the PRC actions, not US actions, not any other nations' actions, are the things that give us concern," he said.

Aquilino said that China seeks to become a global military power and acquire the ability to seize Taiwan, while developing conventional weapons that can reach the US Homeland.

China views Taiwan, a self-ruled island, as a rebel province that must be reunified with the mainland, even by force.

China also seeks to establish a network of overseas military installations that would extend its reach, allowing support for an increasingly global PLA capable of power projection far beyond the Indo-Pacific, Aquilino said.

China claims nearly all of the disputed South China Sea, though Taiwan, the Philippines, Brunei, Malaysia and Vietnam all claim parts of it. Beijing has built artificial islands and military installations in the South China Sea. Beijing is also involved in a maritime dispute with Japan over the East China Sea.

"Beijing's entwined economic and military influences are apparent in the coercive economic actions the PRC has taken against US allies and like-minded partners. President Xi (Jinping)'s signature One Belt, One Road (OBOR) initiative (more widely known as the Belt and Road Initiative) is one of Beijing's attempts to increase its influence and access globally.

"The PRC's military-civil fusion makes even academic research cooperation with PRC entities in certain sectors fraught with potential national security risk," he said.

"The PRC's pressure campaign against Taiwan, deliberate undermining of autonomy in Hong Kong, activities along the Sino-Indian Line of Actual Control, and excessive maritime claims are creating instability and increasing the risk of unintended incidents," Aquilino added.

According to Indian officials, India and China will hold the next round of high-level military talks at Chushul Moldo meeting point in Ladakh on Friday to end the 22-month standoff at the remaining friction areas.

India has been talking with China about a quick disengagement on remaining friction points in eastern Ladakh such as Patrolling Point 15 (Hot Springs), Depsang Bulge and Demchok.

The eastern Ladakh border standoff between the Indian and Chinese militaries erupted on May 5, 2020, following a violent clash in the Pangong lake area. Both sides gradually enhanced their deployment by rushing in tens of thousands of soldiers as well as heavy weaponry.



Thu, 10 Mar 2022

‘Incredible momentum’ in India-US defence relationship: Pentagon

The last meeting of the 2+2 dialogue was held in New Delhi in 2020 and the next meeting is to be hosted by the US in Washington.

There is an “incredible momentum” in the US-India defence relationship and the much awaited 2+2 dialogue between the two countries will take place here in early April, a top Pentagon official has said during a Congressional hearing on the Indo-Pacific region. The last meeting of the 2+2 dialogue was held in New Delhi in 2020 and the next meeting is to be hosted by the US in Washington. The 2+2 ministerial dialogue takes place between foreign and defence ministers of both sides.

India and the United States held a bilateral 2+2 Inter-sessional meeting at the official level on 1 September 2021 in Washington DC. They reviewed progress made since the last 2+2 Ministerial Dialogue in October 2020. Ely Ratner, Assistant Secretary of Defence for Indo-Pacific Security Affairs, told members of the House Armed Services Committee during a Congressional hearing on Wednesday on the Indo-Pacific region that he perceives the US-India defence relationship as one with “incredible momentum”.

At the same time, he acknowledged that there are challenges with the relationship with India. “But I think they’re manageable and we are moving forward very rapidly in deepening the partnership,” he said. “We’re going to hold our highest senior-level engagement with them in early April. “That’s a two plus two with Secretary (of State Antony) Blinken, Secretary (of Defence Lloyd) Austin and their (Indian) counterparts (External Affairs Minister S Jaishankar and Minister of Defence Rajnath Singh); in that meeting we’ll discuss a number of activities that not only are unprecedented, but are the kinds of things that would have been unimaginable 10 years ago or even five years ago,” Ratner said.

“We are also seeing accelerated progress in our Major Defence Partnership with India as we continue to work alongside our Indian counterparts to better integrate and operationalise our day-to-day defence cooperation and logistics, enhance information sharing, and grow our bilateral cooperation in emerging domains such as space and cyberspace,” Ratner said.

The US recognised India as a “Major Defence Partner” in 2016, a designation that allows India to buy more advanced and sensitive technologies from America at par with that of the US’ closest allies and partners, and ensures enduring cooperation into the future.

Ratner further said: “We are expanding the geographic scope of military cooperation with India to include greater coordination and cooperation in the Western Indian Ocean and Southeast Asia, where we share common goals and security interests. This progress is particularly evident in our expanding naval cooperation – bilaterally and with regional partners – to promote freedom of navigation and enhance maritime domain awareness across the region”.

China claims nearly all of the disputed South China Sea, though Taiwan, the Philippines, Brunei, Malaysia and Vietnam all claim parts of it. Beijing has built artificial islands and military installations in the South China Sea. Beijing is also involved in a maritime dispute with Japan over the East China Sea. Admiral John C Aquilino, Commander of US Indo-Pacific Command said that the world’s largest democracy India is a strong, capable partner with a closely aligned vision of a free and open Indo-Pacific.

“Recently, we entered into information sharing agreements, and we continue to expand our operations together. USINDOPACOM maximises cooperation, information sharing and interoperability in exercises like SEA DRAGON, TIGER TRIUMPH and MALABAR,” he said. Over the past decade, India substantially increased its acquisition of US defence equipment by purchasing US-sourced platforms such as MH-60Rs, P-8s, C-130Js, C-17s, AH[1]64s, CH-47s, and M777 howitzers. India may purchase other US systems such as F-21s (former F-16s), F/A-18s, additional P-8s, and UAVs in the future, he said.

<https://www.financialexpress.com/defence/incredible-momentum-in-india-us-defence-relationship-pentagon/2456699/>

Colombo Security Conclave identifies 5 pillars to strengthen security in Indian Ocean Region

The Member states agreed upon a roadmap for further cooperation and collaboration on these pillars of cooperation. The roadmap will facilitate robust mechanisms for coordinated responses capacity building and strengthening information flow between member states, according to a joint statement.

Delegations of the founding members of Colombo Security Conclave; Maldives, India and Sri Lanka, and the newest member of the Conclave, Mauritius, held the 5th National Security Adviser level meeting held on March 9-10 in Maldives. Delegations from Bangladesh and Seychelles participated as Observers.



India's national security advisor (NSA) Ajit Doval with Maldives defence minister Mariya Didi and other dignitaries at the 5th NSA-level Colombo Security Conclave (CSC) Meeting on Thursday.

Mariya Ahmed Didi, Minister of Defence of the Republic of Maldives; Ajit Doval, National Security Adviser; General Kamal Gunaratne(Retd.), Secretary to the Ministry of Defence of the Democratic Socialist Republic of Sri Lanka; and Kumaresan Ilango, National Security Adviser to the Republic of Mauritius, identified key areas of cooperation to enhance and strengthen regional security in the following five pillars: Maritime Safety and Security; Countering Terrorism and Radicalisation; Combating Trafficking and Transnational Organised Crime; Cyber Security, Protection of Critical

Infrastructure and Technology and Humanitarian Assistance and Disaster Relief.

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Delegation from Bangladesh was led by Tarique Ahmed Siddique, Defence and Security Adviser to the Prime Minister of Bangladesh and Seychelles was represented by Simon Archange Dine, Chief of Staff of Seychelles Defence Forces.

<https://economictimes.indiatimes.com/news/defence/colombo-security-conclave-identifies-5-pillars-to-strengthen-security-in-indian-ocean-region/articleshow/90133043.cms>



Missile Defense Agency fires Patriot missile from THAAD system

The U.S. Missile Defense Agency successfully launched the most advanced version of the Patriot missile from a Terminal High Altitude Area Defense system in a Feb. 24 test at White Sands Missile Range, New Mexico, Lockheed Martin told Defense News.

The Patriot Advanced Capability-3 Missile Segment Enhanced — or PAC-3 MSE — was fired using the THAAD system against a simulated incoming target, Scott Arnold, vice president of

integrated air and missile defense at Lockheed Martin Missiles and Fire Control, said in a March 9 statement.

Lockheed manufactures both the MSE and the THAAD system.

The PAC-3 MSE interceptor flew to the intercept point and subsequently self-destructed as planned, Arnold said. The test proves PAC-3 MSE can be integrated directly into the THAAD weapon system, providing the capability to launch MSE missiles separately from a Patriot fire unit,



MDA has hit a milestone for integrating the Terminal High Altitude Area Defense system, shown, with the Patriot air and missile defense system, firing an advanced Patriot missile from THAAD.

Arnold said.

The Raytheon Technologies-made Patriot is the U.S. Army's regional air and missile defense system. The service is working to replace the system with a new integrated air and missile defense system.

THAAD, which is operated by the Army but owned by MDA, provides defensive capability in the terminal — or final — phase of a threat missile's flight.

“With this successful demonstration, the Patriot M903 Launching Stations and PAC-3 MSE interceptors can be deployed with the THAAD Weapon System using only the THAAD radar and TFCC (Fire Control & Communication) for support,” Arnold explained.

The ability to do this means the U.S. military now has a “critical multi-tier missile defense capability” with the ability to go up against both current and emerging threats, he said. Having upper-tier and lower-tier interceptors within one battery expands the battlespace, increases the area of defensive coverage and adds flexibility to combatant commanders in how they use the systems, he noted.

The Army and MDA have worked rapidly over the past several years to integrate THAAD and Patriot in response to an urgent operational need from the service on the Korean Peninsula, where there is a need for a defensive capability for maneuver forces.

Multiple tests were conducted to progressively integrate the systems. In a previous test, for example, the THAAD AN/TPY-2 radar detected and tracked a threat target missile and provided information to the Patriot system, which then launched a PAC-3 MSE to destroy the target.

The most recent test only required the need of the Patriot launcher and interceptors — and not its fire control system. The integration effort uses some of the principles of decoupling launchers and radars so an operator, for instance, can use a THAAD radar — which can see farther than a Raytheon-made Patriot radar — but decide to engage a Patriot interceptor depending on the threat picture.

The ability to use the THAAD radar also gets more out of the PAC-3 MSE weapon fired from Patriot units, which outperforms the organic Patriot radar. “We’re wrapping up that urgent operational need and we’ll get that out the door soon,” Vice Adm. Jon Hill, MDA director, said March 9 at the McAleese & Associates defense conference in Washington. “We’re pretty stoked about that.”

<https://www.defensenews.com/pentagon/2022/03/10/missile-defense-agency-fires-patriot-missile-from-thaad-system/>



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Novel strategy to synthesize solid adsorbents for CO₂ capture and utilization discovered

Indian Scientists have discovered a strategy to synthesize novel solid adsorbents for CO₂ capture and utilization.

Carbon capture and utilization are growing fields of research focusing on reducing CO₂ emissions. Although several industrial advancements have already been demonstrated, none of the technologies can provide an economically viable and complete CO₂ capture and utilization solution. Therefore, fundamental research on novel solid adsorbents might offer a critical material for CO₂ capture and CO₂ utilization.

Professor Rahul Banerjee's group at IISER-Kolkata, with support from Department of Science & Technology, Govt. of India under Mission Innovation program, has demonstrated a strategy to synthesize novel solid adsorbents, especially for CO₂ capture and CO₂ utilization. Prof. Banerjee's group has discovered special types of nanoparticles or microparticles which can capture CO₂ in their micro and mesoporous voids.

The novel materials with distinct physical properties on its surfaces that have been synthesized include porous Covalent organic frameworks like COF-graphene Janus thin films published in 'Journal of American Chemical Society' porous covalent bonded organic nanotubes published in Nature Chemistry, and COF coated zeolite published in 'Journal of American Chemical Society'.

The judicious choice of 2D graphene sheets as a grafter helped the researchers to design and create COF-graphene Janus thin films through the interactions (non-covalent) between the COF and graphene, rendering flexible porous Janus films at the DCM-water interface. The newly designed COF-coated zeolites could be an excellent candidate for CO₂ storage in the industry due to their high surface area and increased chemical stability.

The high CO₂ uptake for the COF coated zeolites, even after treatment with weak acids makes it appropriate for industrial purposes. The COFs coating prevented the degradation of zeolite structure from moisture, weak acids, and water. The CO₂ uptake data for COF coated zeolite at 1 bar, 293K is 132 cc/g, supersedes the CO₂ uptake data of zeolite under the same condition.

Rahul Banerjee's group has recently discovered purely covalent bonded organic nanotubes (CONTs) with a hitherto unavailable structure via a novel bottom-up approach. Although zero-dimensional covalent organic cages and two- and three-dimensional covalent organic frameworks were previously reported, the synthesis of one-dimensional organic nanotubes was hitherto unheard of. The synthesized CONTs have the edge over the analogous carbon nanotubes (CNTs) in functionalization, synthetic conditions, and porosity which exhibits a BET surface area of 321 m² g⁻¹. They are also promising candidates for the efficient CO₂ adsorption with a CO₂ uptake capacity of 60-80 cc g⁻¹ at 1 bar and 293 K. These CONTs have also showcased photosensitizing ability, which can convert the adsorbed CO₂ into CO (130-200 μmol g⁻¹ h⁻¹) upon irradiation of visible light (400-700 nm).

<https://pib.gov.in/PressReleasePage.aspx?PRID=1804748>

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Thu, 10 Mar 2022

INNOVATION: Indian scientists design system for energy-efficient hydrogen production

Indian scientists have designed an electrocatalyst system for energy-efficient hydrogen production with the help of electrolysis of urea, which is helpful towards urea-based waste treatment with low-cost hydrogen production, an official statement said on Wednesday.

The energy requirement for production of hydrogen through water electrolysis can be reduced by 70 per cent through urea electrolysis. The energy-intensive counterpart of water splitting, oxygen evolution, can be replaced with urea oxidation in urea electrolysis. Low-cost, earth-abundant Ni-based catalysts are widely applied for this process.

The main challenge associated with urea oxidation is retaining the prolonged activity of the catalyst as the strong adsorption of the reactive intermediate (CO_x) on the active site, referred to as catalyst poisoning, causes activity loss," the Science and Technology Ministry statement said.

<https://energy.economictimes.indiatimes.com/news/renewable/innovation-indian-scientists-design-system-for-energy-efficient-hydrogen-production/90112524>

