

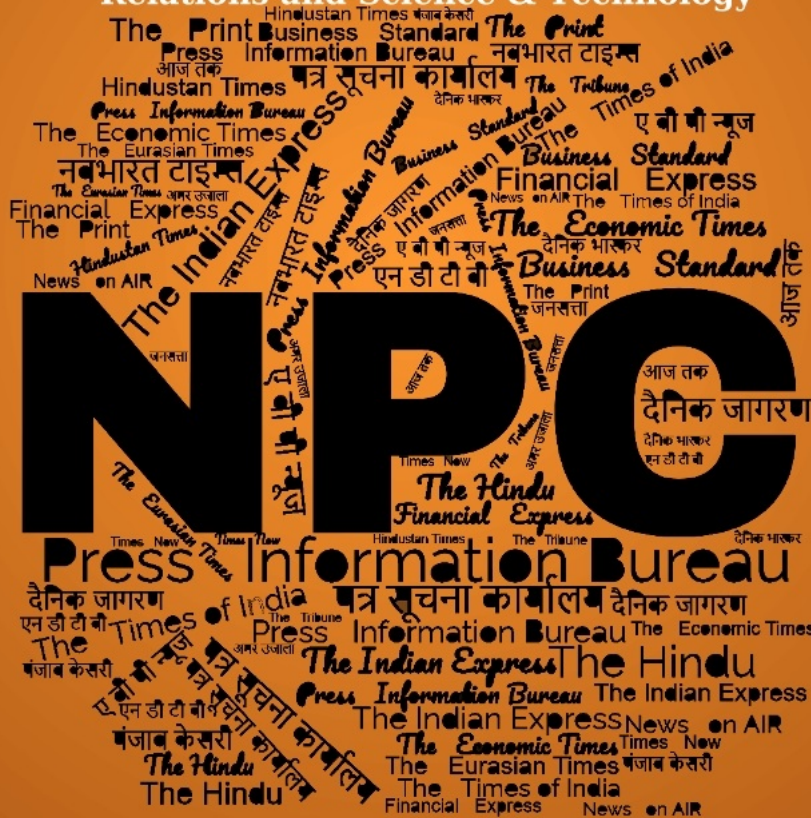
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# समाचार पत्रों से चयनित अंश Newspapers Clippings

डीआरडीओ समुदाय को डीआरडीओ प्रौद्योगिकियों, रक्षा प्रौद्योगिकियों, रक्षा नीतियों, अंतर्राष्ट्रीय संबंधों और विज्ञान एवं प्रौद्योगिकी की नूतन जानकारी से अवगत कराने हेतु दैनिक सेवा

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# अमरउजाला

Wed, 04 Sep 2024

## **Defence Sector:** रक्षा क्षेत्र में देश ने हासिल की दो बड़ी उपलब्धियां; समुद्र से लेकर आसमान तक रहेगी नजर

नौसेना अब और ताकतवर होने जा रही है। उसे दुश्मन के ड्रोन झुंडों (स्वार्म) के हमले को बेअसर करने के लिए आधुनिकतम एचईपीएफ फायरिंग शेल मिलने जा रहा है। यह रक्षा अनुसंधान एवं विकास संगठन (डीआरडीओ) की ओर से विकसित किया गया है। इससे नौसेना ड्रोन झुंडों को बेअसर करने में सफल होगी। डीआरडीओ ने मंगलवार को 30 एमएम हाई एक्सप्लोसिव प्रीफॉर्मर्ड फ्रैगमेंटेशन (एचईपीएफ) शेल के उत्पादन का दस्तावेज नौसेना आयुध निरीक्षण महानिदेशक को सौंपा है।

इसके साथ ही रक्षा मंत्रालय के एकीकृत मुख्यालय (नौसेना)/ डीजीएनएआई ने एचईपीएफ शेल के समावेशन की मंजूरी हासिल कर ली। रक्षा अनुसंधान एवं विकास विभाग के सचिव और डीआरडीओ के अध्यक्ष डॉ. समीर वी कामत ने उत्पादन दस्तावेज सौंपे जाने के लिए एआरडीई को बधाई दी है। इस समारोह के दौरान डीआरडीओ के वरिष्ठ वैज्ञानिक और नौसेना मुख्यालय के अधिकारी मौजूद थे।

मौजूदा एके-630 गन से दागा जा सकता है

रक्षा मंत्रालय के मुताबिक, इसे मौजूदा एके-630 नेवल गन से दागा जा सकता है। इस आधुनिक शेल की विशेषताएं इन-सर्विस एम्युनिशन के समान हैं। एचईपीएफ शेल हार्डवेयर का निर्माण तीन भारतीय फर्मों की ओर से किया गया है। यह निर्माण आयुध अनुसंधान एवं विकास स्थापना (एआरडीई) के निर्देशों और नौसेना आयुध निरीक्षणालय, जबलपुर के सहयोग से गन फायरिंग प्रूफ परीक्षणों के अधीन किया गया है।

स्वदेशी बमवर्षक मानव रहित विमान की पहली उड़ान सफल

देश ने रक्षा क्षेत्र में आत्मनिर्भरता की दिशा में उस समय एक ऐतिहासिक उपलब्धि हासिल की, जब स्वदेशी बमवर्षक मानव रहित विमान (यूएवी) ने सफलतापूर्वक उड़ान भरी। बंगलूरु के फ्लाइट वेज डिफेंस एंड एयरोस्पेस (एफडब्ल्यूडीए) कंपनी ने इस बमवर्षक यूएवी को तैयार किया है, जिसे एफडब्ल्यूडी 200 बी नाम दिया गया है। एफडब्ल्यूडीए के संस्थापक और मुख्य कार्यकारी अधिकारी (सीईओ) सुहास तेजस्कंद ने बताया कि 15,000 फीट की ऊंचाई पर उड़ान भरने में सक्षम यूएवी के रूप में वर्गीकृत एफडब्ल्यूडी 200 बी निगरानी के लिए आवश्यक ऑप्टिकल पेलोड और हवाई हमलों व बमबारी के लिए मिसाइल जैसे हथियारों से लैस है। विमान का वायुगतिकी डिजाइन, एयरफ्रेम, प्रणोदन प्रणाली, नियंत्रण प्रणाली, इलेक्ट्रॉनिकी सभी भारत में एफडब्ल्यूडीए की अत्याधुनिक विनिर्माण इकाई में बनाए गए हैं। यह इकाई बंगलूरु में 12,000 वर्ग फुट में फैली है।

अधिकतम गति 250 किमी प्रति घंटा

152 किमी प्रति घंटे की क्रूज गति से उड़ने में सक्षम बमवर्षक यूएवी की अधिकतम गति 250 किमी प्रति घंटे है। इसके पंखों का फैलाव पांच मीटर और लंबाई 3.5 मीटर है। उड़ान भरते समय इसका अधिकतम भार 102 किमी हो सकता है और इसकी पेलोड क्षमता 30 किमी है। छोटी हवाई पट्टियों से भी संचालित हो सकता है।

<https://www.amarujala.com/india-news/defence-sector-indian-navy-will-become-stronger-with-the-latest-hepf-firing-shell-2024-09-04>

## **DRDO hands over documents to Navy for fragmented shells to counter drones**

The Defence Research and Development Organisation (DRDO) on Tuesday (September 3, 2024) handed over the production document of the 30mm High Explosive Preformed Fragmentation (HEPF) shell to the Director General of Naval Armament Inspection at a function in Pune. These shells which can be fired from the AK-630 naval guns on all warships can be used to counter drones on the high seas.

The shells were developed by the Armament Research and Development Establishment (ARDE) of DRDO. “The features of HEPF shell are similar to the in-service ammunition (HE/I Shell) so that it can be fired from existing AK-630 Naval gun. The HEPF shell yields better fragmentation lethality than HE/I shell, making it effective for neutralisation of drone swarms,” a Defence Ministry statement said.

The HEPF shell hardware was manufactured by three Indian firms as per ARDE specifications and subjected to gun firing proof tests in association with Naval Armament Inspectorate, Jabalpur, the statement said. “The test results confirmed the suitability of HEPF Shell for its adaptation in AK-630 Gun paving a way for its induction.”

<https://www.thehindu.com/news/national/drdo-hands-over-documents-to-navy-for-fragmented-shells-to-counter-drones/article68601496.ece>

 **mathrubhumi.com**

## **Dr K Rajalakshmi Menon appointed new Director General (Aero) at DRDO**

K Rajalakshmi Menon has been appointed as the new director general (Aero) of the Defence Research and Development Organisation (DRDO). She will also serve as the director of the Centre for Airborne Systems (CABS).

An official statement released on Tuesday noted that Dr K Rajalakshmi Menon, in her role as DG (Aero), will oversee all programmes within the Aero Cluster, which will benefit from her innovative leadership.

Menon began her career at DRDO in 1988 as a Scientist-B at CABS, then known as ASWAC, following her MSc in Computer Science from the University of Pune. She further pursued a Master’s in Engineering and a PhD in Aerospace Engineering from the Indian Institute of Science.

She played a key role in the design and development of Airborne Surveillance Systems. Her expertise encompasses System Engineering of Complex Systems, Command, Control, Communications, Computers, Intelligence, Surveillance and Reconnaissance (C4ISR), Image Intelligence, Guidance and Control, Battle Management as well as System Design and Analysis of Airborne Radars and Electronic Warfare sensors.

Menon advanced to the position of associate programme director (Airborne Early Warning and Control) in 2015, where she was pivotal in System Engineering, Mission System Integration and Flight Testing. Her efforts led to the induction of the AEW&C system into the Indian Air Force in February 2017, making India the fifth country globally to have an indigenous Active Electronically Scanned Array-based AEW&C system.

As the new DG (Aero), she has also guided the design and development of Imaging Radars for UAVs, fighters, satellites and manned platforms. In her previous role as Associate Director at CABS, she managed various projects and programmes focused on Air-to-Ground Surveillance, specifically advancing technologies for Intelligence, Surveillance, and Reconnaissance (ISR).

<https://english.mathrubhumi.com/news/india/drdo-appoints-k-rajalakshmi-menon-dg-aero-1.9872066>

## Defence News

## Defence Strategic: National/International



**Press Information Bureau**  
**Government of India**

**Ministry of Defence**

*Tue, 03 Sep 2024*

## **India and Kenya holds 3rd Joint Defence Cooperation Committee meeting**

The third edition of Joint Defence Cooperation Committee (JDCC) meeting between India and Kenya was held in New Delhi on September 3, 2024. The two countries discussed a wide range of avenues for defence cooperation in areas like military cooperation, training, defence industries, R&D etc.



The Kenyan delegation has met Indian defence industry representatives in Delhi. The delegation is also slated to visit Pune where they would interact with representatives of defence industries to get first-hand experience of their capabilities.

India shares a longstanding, friendly and close relationship with Kenya. The MoU on Defence Cooperation signed in July 2016 has provided a legal framework to cooperate in various areas of defence for mutual benefit.

JDCC is an ideal platform to discuss the defence cooperation issues at length and make an effective roadmap to further the defence ties between the two countries. The Indian delegation was led by Joint Secretary Shri Amitabh Prasad and the Kenyan side by Major General David Kipkemboi Ketter.

<https://pib.gov.in/PressReleasePage.aspx?PRID=2051336>



**Press Information Bureau  
Government of India**

**Ministry of Defence**

*Tue, 03 Sep 2024*

## **Joint Commanders' Conference to be held at Central Command HQs in Lucknow**

Raksha Mantri Shri Rajnath Singh & Chief of Defence Staff General Anil Chauhan to address the apex-level military leadership during the conference

The Joint Commanders' Conference, with the theme 'Sashakt aur Surakshit Bharat : Transforming the Armed Forces', will be held at Headquarters, Central Command in Lucknow, Uttar Pradesh on September 04 & 05, 2024. Raksha Mantri Shri Rajnath Singh will review the defence preparedness and address the apex-level military leadership on 5th September. Chief of Defence Staff General Anil Chauhan will deliver the opening address on 4th September.

The conference will factor in the prevailing volatility in the regional and global environments to deduce plausible operational & employment scenarios, and simultaneously undertake threat and resource matching to develop a robust concept for future wars. It will provide an opportunity for the Commanders to review modernisation plans of the Armed Forces and discuss ways to improve the nation's defence capability through jointness & enhanced synergy among the three Services.

<https://pib.gov.in/PressReleasePage.aspx?PRID=2051346>

## **Defence Acquisition Council accords preliminary approval for 10 procurement proposals worth ₹1.44 lakh crore**

The Defence Acquisition Council (DAC) chaired by Defence Minister Rajnath Singh on Tuesday (September 3, 2024) accorded Acceptance of Necessity (AoN), the preliminary step on the long procurement process, for 10 capital acquisition proposals amounting to ₹1,44,716 crore. These include procurement of seven stealth frigates under Project-17B, Future Ready Combat Vehicles (FRCV) for Army as a replacement for the main battle tanks, Air Defence Fire Control Radars (FCR), Dornier-228 aircraft, next generation Fast Patrol & Offshore Patrol Vessels.

Of the total cost of AoNs, 99% is from indigenous sources under Buy (Indian) and Buy (Indian-Indigenously Designed Developed and Manufactured) categories of the defence acquisition procedure, the Ministry said.

“The FRCV will be a futuristic Main Battle Tank with superior mobility, all terrain ability, multilayered protections, precision & lethal fires over and real-time situational awareness,” the Ministry said in a statement. There have been earlier attempts at the FRCV project which didn’t take off and eventually scrapped. This is a long drawn project to resolve the large number of T-72 and T-90 main battle tanks with the Army.

Defence sources confirmed that DAC has accorded AoN for construction of seven advanced stealth frigates under Project-17B with the public sector defence yards Garden Reach Shipbuilders and Engineers (GRSE) and Mazagon Dock Shipbuilders Limited (MDL) among the lead contenders for their construction. In the past too, orders have been split between the two shipyards.

The AoN was also accorded for procurement of Air Defence FCRs, which will detect & track aerial target and provide firing solution. “The proposal has also been approved for Forward Repair Team (Tracked) which has suitable cross country mobility for carrying out in-situ repair during mechanised operations,” the statement said and this equipment is designed and developed by Armoured Vehicles Nigam Limited, for both mechanised Infantry battalions and armoured regiments.

Three AoNs have been accorded to enhance the capabilities of the Indian Coast Guard (ICG), the statement said. These include procurement of Dornier-228 aircraft, Next Generation Fast Patrol Vessels having high operational features in rough weather conditions and Next Generation Offshore Patrol Vessels with advanced technology and enhanced long-range operations, the Ministry added and these will enhance the capability of ICG to carry out surveillance, patrolling of maritime zone, search and rescue and disaster relief operations. At the end of the meeting, Mr. Singh took a moment to honour late ICG Director General Rakesh Pal, who was also a member of DAC. The DG passed away due to a heart attack in Chennai on August 18, 2024.

<https://www.thehindu.com/news/national/government-approves-procurement-of-frcvs-air-defence-fire-control-radars-dornier-228-aircraft/article68601298.ece>

## **Future-ready combat vehicles centrepiece of ₹1.45 lakh cr defence buys cleared**

The defence acquisition council (DAC) on Tuesday gave its go-ahead to the procurement of military hardware worth Rs145 lakh crore to sharpen the country's defence readiness with locally made future-ready combat vehicles (FRCVs), air defence fire control radars, aircraft, and fast attack and offshore patrol vessels, the defence ministry announced.

The FRCVs form the centrepiece of the projects cleared by the government.

The Indian Army plans to induct 1,770 FRCVs (the platform will be a futuristic battle tank) to modernise the armoured corps at a cost of around ₹60,000 crore.

“For modernisation of the tank fleet, the proposal for procurement of FRCVs has been cleared. It will be a futuristic main battle tank with superior mobility, all terrain ability, multi-layered protection, precision, lethal firepower and real-time situational awareness,” the defence ministry said in a statement.

Defence minister Rajnath Singh chaired the meeting of DAC, the country's apex military procurement, which gave its acceptance of necessity (AoN) for 10 capital acquisition proposals worth ₹1,44,716 crore. Under India's defence procurement rules, AoN by the council is the first step towards buying military equipment.

Indigenous sources will account for 99% of the total value of the projects cleared by DAC under the Buy (Indian) and Buy (Indian-IDDM) categories. The Indian-IDDM category is the most important category of acquisition for indigenisation under the defence procurement policy. IDDM stands for indigenously designed, developed and manufactured.

DAC approved the purchase of air defence fire control radars to detect, track and engage aerial targets, the ministry said. Equipment, with cross-country mobility, for carrying out repair of armoured and mechanised infantry platforms was also cleared.

Called ‘forward repair team (tracked), this equipment will be produced by Armoured Vehicles Nigam Limited, one of the seven new defence companies carved out of the erstwhile Ordnance Factory Board (OFB) three years ago in a long-awaited reform in the country's defence manufacturing sector.

Three proposals were cleared to boost the capabilities of the Indian Coast Guard (ICG).

“The procurement of Dornier-228 aircraft, next-generation fast patrol vessels having high operational features in rough weather conditions, and next-generation offshore patrol vessels with advanced technology and enhanced long-range operations will enhance the capability of ICG to carry out surveillance, patrolling of maritime zone, search and rescue, and disaster relief operations,” the statement added.



According to an army note, the FRCV, with capability to act as a multiple weapon platform along with infusion of niche technology, will cater for the future capability requirements and enhance the overall operational effectiveness index of the Indian Army.

It will offer multiple options for rapid operational employment enabling the army to execute operations across the entire continuum of conflict against diverse threats and equipment profile of the adversaries, the note said. “The FRCV would be in-service for the next 35 to 45 years and, therefore, should be designed to deliver the highest lethality, survivability and agility on the battlefield combined with a fully digitised data backbone architecture to enable next-generation operational capabilities and automation.”

The FRCVs are expected to be inducted in three phases.

Self-reliance in the defence manufacturing sector is one of the government’s top priorities. India has taken a raft of measures to boost self-reliance, with phased bans on the import of hundreds of weapons and systems, and thousands of sub-systems and components topping the list.

The other steps include creating a separate budget for buying locally made military hardware, increasing foreign direct investment (FDI) from 49% to 74% and improving ease of doing business.

In July, India set aside almost ₹6.22 lakh crore for defence spending in the union budget for 2024-25, with the chunk of the modernisation outlay allocated for buying weapons, systems and equipment from domestic suppliers to achieve the self-reliance goal.

This year’s allocation ( ₹6,21,940.85 crore) includes a revenue expenditure of ₹2.82 lakh crore, a capital expenditure of ₹1.72 lakh crore and a pension outlay of ₹1.41 lakh crore. The capital outlay includes ₹1.05 lakh crore for domestic procurement.

<https://www.hindustantimes.com/india-news/futureready-combat-vehicles-centrepiece-of-defence-buys-worth-rs-1-45-lakh-cr-101725372893464.html>

## THE ECONOMIC TIMES

*Tue, 03 Sep 2024*

### **Australia makes first combat aircraft deployment in India for phase-II of 'Tarang Shakti' exercise**

The Royal Australian Air Force has made its first deployment of combat aircraft in India for participation in exercise 'Tarang Shakti', Australia's Defence department said in a statement.

The second leg of India's largest multilateral air exercise, 'Exercise Tarang Shakti 24' is being held at Air Force Station Jodhpur from 30 August to 13 September. Australia, Greece, Sri Lanka, UAE, Japan, Singapore and the United States are participating in it.

Three EA-18G Growler aircraft from No 6 Squadron, and up to 120 personnel have been sent by Australia.

"This is the first time India has conducted Exercise Tarang Shakti, with 11 participating nations and 18 observer nations attending," the statement read. Chief of Air Force, Air Marshal Stephen Chappell said Australia's participation in Exercise Tarang Shakti demonstrated a commitment to supporting regional partners and fostering international cooperation to address shared security challenges.

"India is a top-tier security partner for Australia, and through the Comprehensive Strategic Partnership between Australia and India, the Government is continuing to prioritise practical and tangible cooperation that directly contributes to Indo-Pacific stability," Air Marshal Chappell said.

He said Australia's participation in such exercise showcases its advanced capabilities. The Chief of Air Force said the exercise will provide aviators with the opportunity to develop interoperability with foreign militaries.

"Participation in international exercises such as Tarang Shakti 24, showcases our advanced capabilities that ensure rapid response and adaptability to emerging threats and security challenges in the Indo-Pacific region," Chappell said.

"Exercise Tarang Shakti 24 will provide our aviators with the opportunity to develop interoperability with foreign militaries, develop a mutual understanding of tactical operations, and foster international relations," he added. Australia and India have enjoyed increased air defence cooperation in recent years, including hosting Indian Air Force Flankers at Exercise Pitch Black in 2018, 2022, and 2024, the Australian Defence Department said.

Air Force also conducts a number of training and engagement activities with Indian Navy P-8I Neptune surveillance aircraft. Australia will continue to support India's key role in the region by increasing the depth and complexity of our defence cooperation, the statement added.

The first phase of Exercise Tarang Shakti concluded in Tamil Nadu in August. The first phase of India's largest multilateral air exercise 'Tarang Shakti' involved the air forces of Germany, France, Spain, and the UK.

<https://economictimes.indiatimes.com/news/defence/australia-makes-first-combat-aircraft-deployment-in-india-for-phase-ii-of-tarang-shakti-exercise/articleshow/113012295.cms>

# THE ECONOMIC TIMES

*Tue, 03 Sep 2024*

## **Bengaluru-based FWDA announces successful maiden flight of indigenous unmanned bomber aircraft**

Bengaluru-headquartered Flying Wedge Defence and Aerospace (FWDA) on Tuesday announced the successful maiden flight of indigenous unmanned bomber aircraft, the FWD 200B.

Classified as a Medium Altitude (15,000 feet) Long Endurance (MALE) Unmanned Aerial Vehicle (UAV), the FWD 200B is equipped with optical payloads for surveillance and missile-like weapons

for air strikes and bombing, the FWDA Founder and CEO Suhas Tejaskanda told reporters here. "The aircraft's aerodynamics design, airframe, propulsion systems, controls systems, electronics are all made in India at FWDA's state-of-the-art manufacturing facility of 12,000 sq.ft built on 1.5 acre land, located at Electronic City, Bengaluru," he said.

FWD 200B features a wingspan of five metres and a length of 3.5 metres. It has a maximum take-off weight of 102 kg and a payload capacity of 30 kg, the company said. It can fly at a cruise speed of 152 kms per hour, with a maximum speed of 250 km per hour.

Its runway requirement is just 300 metres allowing it to operate from shorter airstrips, Tejaskanda said. "With an endurance of seven hours and a range of 800 km, the FWD 200B ensures extended mission capabilities, providing substantial coverage without the need for frequent refueling or landing," he said.

<https://economictimes.indiatimes.com/news/defence/bengaluru-based-fwda-announces-successful- maiden-flight-of-indigenous-unmanned-bomber-aircraft/articleshow/113014727.cms>

# THE ECONOMIC TIMES

*Tue, 03 Sep 2024*

## **Defence dept authorised to issue licenses for export of munitions**

The commerce ministry's arm DGFT on Tuesday said the Department of Defence Production has been authorised as the licensing authority for export of all items falling under the munitions category for military end use.

The Directorate General of Foreign Trade (DGFT) has notified the updated SCOMET (Special Chemicals Organisms Materials Equipment and Technologies) list for 2024.

It said that India's export control list (SCOMET) has been updated, incorporating the recent changes in the control lists of the multilateral export control regimes, and certain policy amendments on the basis of inputs from relevant government organisations and stakeholders.

"With the recent update, DGFT has also authorised the Department of Defence Production (DDP), Ministry of Defence, to be the licensing authority for export of all items falling under Category 6 of SCOMET for military end use," it said in a statement.

Category 6 list includes munitions such as weapons, rifles and magazines. India is a member of the major multilateral export control regimes, viz. the Missile Technology Control Regime, Wassenaar Arrangement, and Australia Group, and harmonises its guidelines and control lists with that of these regimes and the Nuclear Suppliers Group.

The country regulates the exports of dual-use items, nuclear-related products, and military goods, including software and technology under the SCOMET list, which is notified by DGFT under the Foreign Trade Policy. As the exports under the SCOMET have increased substantively during the

last three years, the directorate has taken several initiatives, based on regular interactions with the industry to facilitate authorised and responsible export of these high-end goods and technologies.

<https://economictimes.indiatimes.com/news/defence/defence-dept-authorised-to-issue-licenses-for-export-of-munitions/articleshow/113031271.cms>

## Science & Technology News



**Press Information Bureau**  
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Ministry of Science & Technology

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### **Removing toxic chromium using sunlight can lower cost of waste water treatment**

A low-cost method has been developed by INST researchers to remove toxic Chromium from wastewater of industries such as leather tanning and electroplating by using “sunlight” as catalyst in combination with microfluidic technology.

Toxicity of hexavalent chromium is a serious concern and as per reports by WHO the tolerable concentrations of hexavalent and trivalent chromium in drinking water are limited to 0.05 mg/L and 5 mg/L. Thus, it becomes imperative to reduce this hexavalent form of chromium to the trivalent form.

Several chemical and physiochemical methods, such as ion exchange, adsorption, and bacterial and chemical reduction, have been employed for the removal of Cr(VI). Most of these techniques are costly, with low removal efficiencies of Cr(VI).

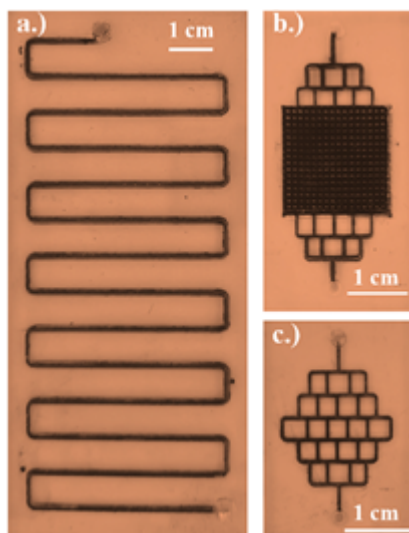
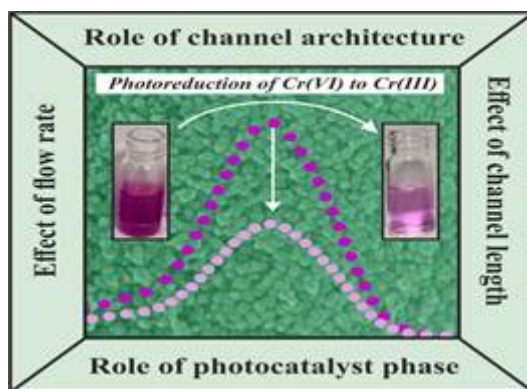
Dr. Bhanu Prakash’s research group from Institute of Nano Science and Technology (INST), Mohali, an autonomous institute of Department of Science and Technology has developed a new technique of removing toxic Cr(VI) ions by utilizing sunlight for the catalytic process in combination with microfluidic technology for the conversion of the toxic hexavalent form of chromium to a less toxic trivalent form. They used a process called continuous flow photoreduction and validated this process in wastewater using TiO<sub>2</sub> nanoparticles with the help of a smartphone based colorimetric technique.

Besides, the cost effectiveness of the process and the usage of renewable energy, with the microfluidics route, the reduction efficiency can also be tailored by fine-tuning the flow rate of the organic pollutant, reactor dimension, and architecture, precisely. One of the most advantageous features of using microreactors is the reusability of the photocatalyst without any recovery agents or cumbersome processes. Various microfluidic parameters such as reactor design, flow rate and channel length along with different catalyst phases were fine-tuned to bring about superior

degradation efficiency. A superior degradation efficiency of 95 % was attained by utilizing a serpentine microreactor coated with a photocatalyst in the pure anatase phase at a flowrate of 50  $\mu\text{l}/\text{min}$ .

The researchers started the process with the fabrication of microfluidic reactors and the synthesis of nanocatalysts. Next, the nanocatalyst was immobilized onto the microreactor bed and flow experiments were performed. The extent of conversion was monitored using a change in absorbance via UV-Vis spectroscopy. This was followed by evaluating the reactor performance on basics of long-term stability of microreactor and photocatalyst with respect to the number of cycles or volume processed.

This work published in Chemical Engineering Journal holds potential in industrial translation by increasing the throughput of the approach. This is possible by setting up microfluidic reactors in a parallel approach (arrays) or by microtexturing of the bulk reactor surface to increase the efficacy of the process after repetitive use.



Optical image of the microreactors fabricated using laser micromachining technique with a.) Serpentine ( $\mu\text{R-S}$ ), b.) branched ( $\mu\text{R-B}$ ) and c.) micropillars ( $\mu\text{R-M}$ ) based architectures.

<https://pib.gov.in/PressReleasePage.aspx?PRID=2051320>





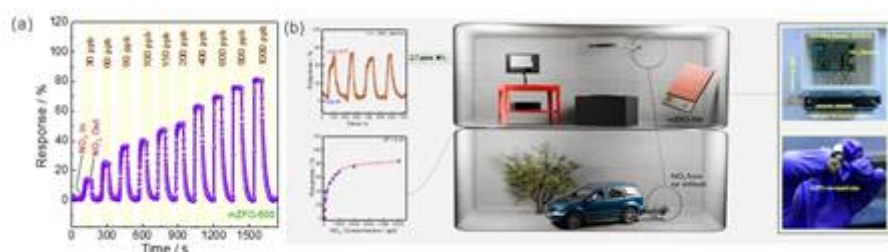
## New high-performance gas sensor can monitor low level nitrogen oxides pollution

A novel nanostructure developed by scientists can detect oxides of nitrogen at very low concentrations at room temperature, addressing the urgent need for precise air quality monitoring systems in urban and industrial areas.

Gas sensors play a pivotal role in modern technology, facilitating environmental monitoring, industrial safety, and healthcare diagnostics. The field of gas sensors is continuously evolving through innovative research in materials and technology, aiming to enhance key parameters such as sensitivity, selectivity, response and recovery times, stability, and operating temperature. Achieving a sensing device that shows superior performance across these parameters remains a primary objective of current research and development activities in sensor technology, although it poses significant technical challenges. The choice of materials for gas sensors is critical, exerting a profound influence on their operational performance.

In the last few decades, chemiresistive gas sensors, which detect the gas molecules based on variation in materials resistance, using various types of binary metal oxide semiconductors have been extensively studied for detecting different gases. However, most of these sensors commonly lack selectivity for specific gases and face challenges like low sensitivity at ppb levels and the need for high-temperature operation, limiting their practical use.

Addressing the limitations of existing sensing materials, researchers from Centre for Nano and Soft Matter Sciences (CeNS), an autonomous institute of DST have developed a gas sensor based on mixed spinel zinc ferrite ( $\text{ZnFe}_2\text{O}_4$ ) nanostructures. This sensor detects nitrogen oxides ( $\text{NO}_x$ ) at ultra-low concentrations of parts-per-billion (ppb) levels, even at room temperature marking a significant breakthrough in gas sensing technology.



- Dynamic response of the mixed spinel  $\text{ZnFe}_2\text{O}_4$  sensor to different concentrations of  $\text{NO}_2$ .
- Schematic illustration of the experimental steps to assess the concentration of  $\text{NO}_x$  molecules from the vehicle emission.

A team of scientists including Mr. Vishnu G Nath and Dr. S. Angappane, deliberately synthesized the mixed spinel ZnFe<sub>2</sub>O<sub>4</sub> structure, where the occupation of Zn and Fe ions within the tetrahedral and octahedral lattice sites deviates from the commonly observed normal spinel configuration.

Advanced techniques such as X-ray diffraction (XRD), X-ray photoelectron spectroscopy (XPS), and Fourier-transform infrared spectroscopy (FTIR) revealed that the distribution of cations in the tetrahedral and octahedral lattice can be effectively adjusted by varying the calcination temperature during nanoparticle synthesis.

Detailed sensing studies underscored the exceptional performance of the sensor based on the mixed spinel ZnFe<sub>2</sub>O<sub>4</sub> structure in detecting NO<sub>x</sub> molecules under ambient conditions. The sensor exhibited notably high response values (detecting down to 30 ppb), operated at room temperature with rapid response and recovery times, demonstrated superior selectivity, and maintained excellent cyclic stability (approximately 100 cycles) and long-term durability (over 3 months).

The calculated limit of detection (LOD) for NO<sub>2</sub> was significantly lower ( around 9 ppb) than the United States Environment Protection Agency (US EPA) recommended limit (53 ppb). Furthermore, the research team validated the practical applicability of the developed sensor by analyzing gas samples collected from vehicle exhaust emissions. They successfully detected trace levels of NO<sub>x</sub> gas concentrations in the exhaust air samples and accurately quantified the concentration using calibration data derived from known NO<sub>x</sub> concentrations and corresponding sensor responses. The reduced energy demand for the developed sensor can significantly lower operational costs, paving the way for more affordable and accessible environmental monitoring solutions.

Computational calculations conducted in collaboration with Dr. Subhasmita Ray and Dr. Kartick Tarafder from the Department of Physics, National Institute of Technology Karnataka, validate the experimental findings. These calculations confirm that the formation of the mixed spinel structure leads to higher adsorption energy for NO<sub>x</sub> molecules compared to the commonly observed normal spinel ZnFe<sub>2</sub>O<sub>4</sub> structure.

Their research published in the Chemical Engineering Journal, not only underscores the significance of mixed spinel ZnFe<sub>2</sub>O<sub>4</sub>-based sensors as potential competitors to future high-performance gas sensors but also highlights an effective strategy for leveraging the properties of spinel ferrites through cation distribution modifications. Continued advancements in this area could lead to comprehensive air quality monitoring systems, crucial for mitigating pollution and protecting public health.

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