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Vol 34 | Issue 2 | March-April 2026 | ISSN No. 0971 - 4413

PRODUCTS & SPECIALITY MATERIALS FOR THE SERVICES



Technology Focus highlights on the technological achievements in the organization covering the products, processes and technologies.

March-April 2026

Vol. 34 | Issue 2 | ISSN No. 0971-4413

Editor-in-Chief: Kiran Chauhan

Assoc. Editor-in-Chief: Sudhanshu Bhushan

Editor: Dipti Arora

Design & Prepress: Raj Kumar

Printing: Rajesh Kr Singh

Distribution: Pratyaksh Sharma



Readers may send their suggestions to

The Editor, Technology Focus

DESIDOC, Metcalfe House
Delhi-110 054

Telephone: 011-23902403, 23902472

Fax: 011-23819151; 011-23813465

E-mail: director.desidoc@gov.in;

techfocus.desidoc@gov.in

<https://www.drdo.gov.in>

Laboratory Correspondents

Ahmednagar	: Col Atul Apte, Shri RA Shaikh, VRDE
Ambernath	: Dr Ganesh S Dhole, NMRL
Bengaluru	: Shri Satpal Singh Tomar, ADE
	: Smt MR Bhuvanewari, CABS
	: Smt Faheema AGJ, CAIR
	: Dr Sanchita Sil & Dr Sudhir S Kamble, DEBEL
	: Dr V Senthil, GTRE
	: Smt Saima Bashir, LRDE
	: Dr Sushant Chhatre, MTRDC
Chandigarh	: Dr Pal Dinesh Kumar, TBRL
	: Dr Anuja Kumari, DGRE
Chennai	: Shri K Anbazhagan, CVRDE
Dehradun	: Shri DP Tripathi, DEAL
	: Dr SK Mishra, IRDE
Delhi	: Dr (Mrs) Pritam Sangwan, CFEES
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	: Shri Santosh Kumar Choudhury, DIPR
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	: Shri AK Pandey, ARDE
	: Dr Anoop Anand, R&DE(E)
Tezpur	: Dr Sibnarayan Datta, DRL

From the Desk of Special Editor



As India is striving hard with confidence towards the national vision of Viksit Bharat @ 2047, the centenary of its independence; the importance of strong, self-reliant, and future-ready defence capabilities cannot be ignored. Technological leadership, indigenous innovation and strategic autonomy will form the foundation stone of a developed nation and institutions engaged in cutting-edge defence research will play a defining role in this journey. In this context, the Defence Materials and Stores Research and Development Establishment (DMSRDE), Kanpur, emerges as a vital enabler of India's long-term national and strategic objectives.

Functioning under the aegis of the Defence Research and Development Organisation (DRDO), Ministry of Defence, DMSRDE has consistently contributed to strengthening India's defence preparedness through advances in non-metallic materials, protective systems and soldier-centric technologies. Its work in areas such as ballistic protection, CBRN defence, advanced polymers and composites, technical textiles, camouflage materials, specialty fuels and extreme-environment clothing directly enhances the survivability, mobility, and operational effectiveness of the Indian Armed Forces.

As India charts its course towards becoming a developed, secure, and technologically self-reliant nation by 2047, DMSRDE's emphasis on indigenisation, innovation-driven research and seamless technology transfer to Indian industries assumes strategic significance. By reducing dependence on imports, nurturing domestic defence ecosystems, and enabling high-value manufacturing, the establishment actively supports national priorities including Aatmanirbhar Bharat, Make in India, and reducing defence imports.

The current issue of *Technology Focus* showcases DMSRDE's contributions as an integral part of DRDO's collective mission to build a secure, technologically empowered and future-ready India. As DRDO continues to support the nation's journey towards Viksit Bharat @ 2047, establishments like DMSRDE will remain pivotal in providing the material strength, innovation capability and strategic depth essential for safeguarding India's sovereignty and aspirations.

Dr RV Hara Prasad

Distinguished Scientist & Director General
Naval Systems & Materials (NS&M)

From the Desk of Guest Editor



Defence Materials and Stores Research and Development Establishment (DMSRDE), Kanpur, is one of the premier and unique laboratory of DRDO with mandate of research, development, testing, and indigenisation of materials and stores required by the Indian Armed Forces. The laboratory focuses on a wide spectrum of technologies including polymers and elastomers, polymer matrix composites, nano technology, ceramic and carbon-based materials, technical textiles, camouflage and stealth materials, specialty fuels and lubricants, and advanced protective systems.

DMSRDE has played a pivotal role in the indigenous development of bullet-proof jackets, ballistic helmets, bomb disposal suits, fire-retardant and extreme-climate clothing and field stores for soldiers. The laboratory also supports strategic programmes by developing special materials for missiles, aerospace applications and high-temperature environments.

Through active and consistent collaboration with services, production agencies, academia and industries, DMSRDE facilitates technology transfer and productionisation, thereby contributing significantly to the national goal of Aatmanirbhar Bharat in defence and fulfilling the requirements of our security forces. Its continued efforts enhance operational efficiency, survivability and self-reliance of India's defence forces.

This issue of "Technology Focus" seeks to highlight not only the technological achievements of DMSRDE, Kanpur, but also its long-term commitment to self-reliance, excellence, and service to the nation. As India advances towards becoming future-ready global defence power, institutions like DMSRDE continue to form the material backbone of our strategic strength and resilience.

Dr Kingsuk Mukhopadhyay
Outstanding Scientist and Director, DMSRDE

PRODUCTS & SPECIALITY MATERIALS FOR THE SERVICES

Defence Materials and Stores Research and Development Establishment (DMSRDE) in its present form was constituted in 1976 by the merger of three establishments erstwhile Defence Research Laboratory (Materials) (DRL (M)), Textiles & Stores Research & Development Establishment (TSRDE) and Defence Institute of Stores Preservation and Packaging (DISPP). It was realized that the synergy between the three units will lead to enhanced capabilities by meeting all the present and future requirements of Defence services in the area of non-metallic materials in a consolidated manner with better utilization of manpower and infrastructure

DMSRDE has continuously progressed as an important laboratory of DRDO earmarked to plan and conduct R&D activities in non-metallic materials keeping in mind the present and future materials requirement of the Services and the major programmes of DRDO. DMSRDE has contributed extensively towards these aims on a continuous basis.

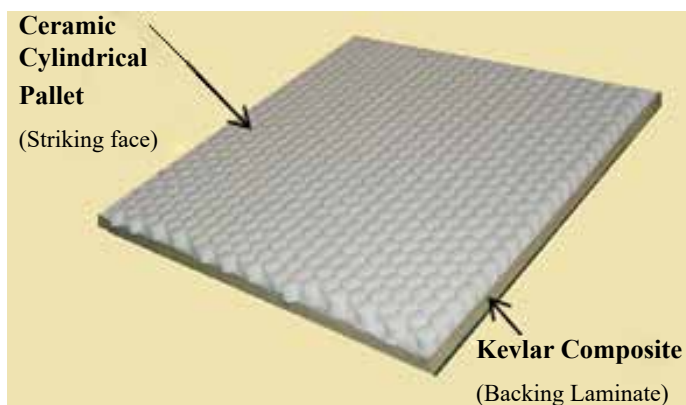
The establishment has evolved into an important centre, with qualified and competent manpower and sophisticated modern instruments to carry out studies which offers a deep insight into continuous and quantum effects occurring at macro, micro and nano scale in various non-metallic materials.

Since its inception DMSRDE has developed core competence in many important technology areas, such as advanced, smart and intelligent polymers, elastomers, advanced composites, high performance fuels & lubricants, engineering fluids, advanced ceramics and CMCs, stealth & camouflage materials, advanced paints & coatings, lightweight & ultra-high-performance materials & technologies for personal protection systems, advanced fibres & technical textiles for strategic applications and new generation nanomaterials. DMSRDE strives to be a centre of excellence in the area of strategic non-metallic and specialty materials and technology leader to make country Aatmanirbhar Bharat.

Polymers & Rubber Related Products

Ceramic-faced Composite Armor Protection Panels for Advanced Light Helicopter

Ceramic-faced composite armour protection panels have been designed and developed for Advanced Light Helicopter (ALH; Army Variant) to provide protection to air crew and critical parts of helicopter against 12.7 mm API bullets at 84° and 6° strike from 300 metre distance. The product is accorded airworthiness clearance by CEMILAC.



Salient Features:

- High strength, stiffness and flexibility

- Aerial density: 55 kg/m²
- Thickness of armour panel: 22.5 mm
- Protection to aircrew and critical parts of helicopter

LAToT: 04 Industries

Advanced Riot Protection Suit

The Advanced Riot Protection Suit (ARPS) is a modular and formidable impact resistant full body protector providing comprehensive safety to the police and paramilitary personnel during riots, civil unrests and mob handling in low-intensity conflicts. It helps to absorb the impact/shock from stone or any other hard objects such as baton dagger, etc. and also provides protection against 9x19 mm ammunition. ARPS protects vital parts/ organs of the body i.e. chest, shoulder, back, thigh, groin and pelvis, etc.



ARPS

Salient Features:

- Developed as per MHA requirements
- Qualified against standard test protocols. (IS 17051:2018 and VPAM KDIW: 2004).
- Comprehensive 360° body protection
- Lightweight (≤ 6.5 Kg for protection area > 1.5 m²).
- Ergonomic and snug fit.

LAToT: 09 Industries

Nuclear Shielding Pads for Combat Vehicles

Nuclear shielding polymeric pads are indigenously developed by DMSRDE to meet the requirement of the Armed Forces. Two types of nuclear shielding materials: DMS-PE (M) and DMS-PEC-II are developed to replace Russian anti-radiation pads for combat vehicles.



Nuclear Shielding Pads

Salient Features:

- Better shielding efficiency with respect to Russian pads against fast neutron, primary gamma and fallout radiations
- Enhanced physico-mechanical, chemical and Ozone-resistance properties

LAToT: 05 Industries

Polymeric Seals for Hydro-Pneumatic Control System of Aircraft

The laboratory has developed variety of elastomeric and thermoplastic seals to prevent the leakage of air/oil between the annular space of shaft and housing. Four types of polymeric materials (elastomeric and thermoplastic) are used in the development of such seals which are already certified for airworthiness application. Beside defence, it also has a number of civil applications as well.



Salient Features:

- Working pressure : 394 kg/cm²
- Fluid temperature : 130 °C
- Design temperature : -45 °C to +150 °C
- Velocity (max.) : 60 mm/sec
- Fluid : Hydraulic oil

Compact Protected Memory Module Unit for Flight Data Recorder of Aircrafts

DMSRDE has designed and developed four-layer protection Compact Protected Memory Module (CPMM) to protect the Flight Data Recorder (FDR) memory device from the harsh environment during

accidents. CPMM unit of FDR have the capability to withstand extreme heat, violent crashes and tons of pressure in case of aircraft accident.

CPMM unit has qualified the crash survival test as per TSO C 124a and ED-112 specification and CEMILAC (RCMA) has issued the airworthiness clearance for induction into the various aircrafts—Light Combat Aircraft, Jaguar Darin-II/III, Dornier DO-228, Chetak/Chetal, etc.



Compact Protected Memory Module

Salient Features:

- Impact shock at 3400 g for 6.5 ms half sine wave
- Low temperature test at 260 °C for 10 h
- High temperature fire test at 1100 °C for 60 min., Heat flux: 158 kW/m²
- Penetration resistance test at 230 kg drop weight from 3 m height
- Static crush test at 22.25 kN static load for 5 min
- Deep sea pressure test at 6000 m for 24 h

LAToT: 01 Industry

High Temperature Resistant Phthalonitrile Resins

DMSRDE has developed Phthalonitrile (PN) resins having different moieties like hydrazide-, biphenyl-, resorcinol-, Hydroquinone-, silicon-, nadimide-, phosphorus-containing and adamantane- substituted

PN resin. The high temperature PN resins could be used for making high performance composites for various defence applications



Biphenyl- substituted PN Resin



Oligomeric Form of biphenyl-PN Resin

Salient Features:

- Stable chemical, physical, and thermo-mechanical properties for more than 3 years under ambient conditions.
- Resins dielectric constant between 3.4-5 and dielectric loss 0.01-0.02.
- The resins showed solubility in industrial solvents.

- Fully cured polymers have no glass transition up to 400 °C.
- The cured resins have high thermal stability up to 450 °C and low-degradation rate.

Personal Protection Systems and Related Technologies

Smart Featured Bullet Proof Jacket: Level 6

The laboratory has developed level-6 (highest threat level) Bullet Proof Jacket (BPJ) as per IS 17051:2018/Indian Army GSQR-1707 based on monolithic ceramic plate and other advanced materials for the first time in India. The innovative design and inventive approach resulted in lowest areal densities of Hard Armour Panel (HAP) and Soft Armour Panel (SAP) ever achieved and reported in India. The jacket has been tested successfully at TBRL, Chandigarh as per standard testing protocols.



Smart Featured Bullet Proof Jacket

Salient Features:

- Technology driven ergonomic modular, In-Conjunction With (ICW) and standalone design.

- Front Hard Armour Panel (FHAP) defeats 06 shots of 7.62 x 54 R API bullets.
- Weight: 6 to 10.5 kg (Modular Design: As per protection area requirement).
- Equipped with smart features: Quick Release Mechanism (QRM), Weight Distribution System (WDS), Damage Detection System (DDS), and Health Monitoring System (HMS).

LAToT: 05 Industries

Ballistic Helmet

DMSRDE successfully developed light-weight Ballistic Helmet based on Advanced Combat Helmet (ACH) design for Indian Armed Forces and CAPFs. It provides protection against 9 mm x 19 mm (SMC/MP-5) ammunition from 5 metre distance.



Ballistic Helmet

Salient Features:

- Weight less than 1.2 kg (Medium size) and 1.0 kg (Two Variant).
- Ergonomically designed, covering ears and neck.
- Comfortable inner cushioned harness (seven pad system) with soft leather head band

and four-point chin strap retention system (Adjustable).

- Provision of suitable arrangements in helmet to attach communication equipment's & Night Vision Devices.

LAToT: 10 Industries

Boot Anti Mine Infantry

DMSRDE has developed Boot Anti Mine Infantry (BAMI) as per Army GSQR 1059 for 35 gm (HE) CE Pellet. The boot has been tested at TBRL, Chandigarh and transmitted over pressure below 100 Kg/cm² has been obtained and provides protection against amputation injuries. The boot can be used in temperature range of -20 °C to +60 °C. The upper part has been made of chrome tanned leather for comfort of troops and fatigue free walk.



Boot Anti Mine Infantry

Salient Features:

- Weight less than 3.0 Kg/pair and can be used in temperature range of – 20 °C to + 60 °C.
- Indigenously developed technology of hybrid composite inserts to attenuate blast overpressure.
- The boot is suitable for assault operation in

plane, desert and mountain regions and meant for infantry troops.

- Performance of the boot found superior in comparison to the boots of foreign origin (USA, Israel and Canada).

LAToT: 03 Industries

Anti-Mine Blast Protection Suit

The suit has been developed for protection to soldier's vital organs against accidental blast of anti-personnel land mine (35 g high explosive APNM M-14 or equivalent) during de-mining or mine breaching operations. It also provides protection against fragment to torso area as per MIL-STD 662F. Successful blast evaluation test has been carried out at TBRL, Chandigarh.

Salient Features:

- Total Suit Weight: 5.4 ± 0.1 kg
- Hard Armour Panels (HAP) protection on throat; thorax; upper arm; lower arm; groin; thigh; and lower leg; soft protection joints and remaining front
- Ergonomic and modular design makes it easy to don/doff and first level field repairable.
- Fast removal in < 60 sec in case of injury.
- No secondary fragments.
- Water proof and flame retardant carrier.
- HAP is reusable due to use of high impact strength HAP layer and adhesive composite materials.



LAToT: 05 Industries

Integrated Damage Detection System for Bullet Proof Jacket

It is a smart sensing and monitoring system that can be embedded to existing bullet proof jacket for sensing the impact and transmitting the information to command centre for rescue the wearer and raising an alert for the back-up reinforcements.



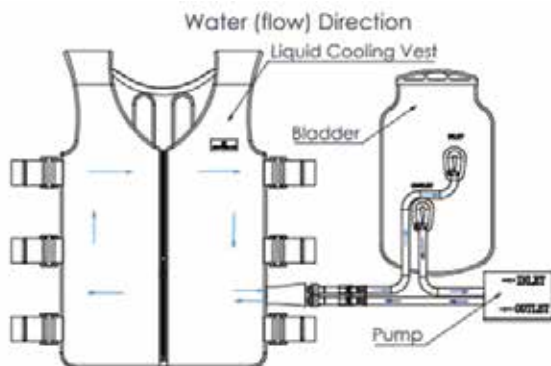
Damage Detection System

Salient Features:

- Light weight: 350 g. Transmission range: 2.5 Km. Operation time: 15-18 hrs.
- Real-time status monitoring of soldier with location.
- Flexible, modular, easy deployment and system lock.
- Military grade data encryption and security.
- Complete autonomous and wireless operation.

Sheet Kavach for Bullet Proof Jacket and Blast Protection Suit

The Sheet Kavach is designed and developed to provide thermal comfort and soldier endurance without compromising ballistic protection efficiency. It can be easily done with the existing BPJ and BPS and intended to enhance the battleground efficiency of the soldier /security personnel in hot territories.



Sheet Kavach (Cooling System)

Salient Features:

- Light weight: < 1000 g
- Operation time: 2-3 hrs/ Pouch
- Design concept: Modular
- Weight distribution: Shoulder to waist
- Operation: easy mounting/dismounting

Fuel and Lubricants and Related Products and Technologies
DMS HIDEN Fuel (Equivalent to JP10)

DMSRDE has developed a liquid fuel HIDEN equivalent to JP-10, the most successful high energy density liquid missile fuel meeting the specifications of MIL-DTL-87107D standard.



HIDEN Fuel

Features:

- DMS HIDEN has 19 % more energy density than ATF fuel.
- The minimum heat of combustion is 42.1 MJ/kg and has 0.935-0.943 kg/L density.

TECHNOLOGY FOCUS

- The maximum kinematic viscosity of fuel at -54 °C and -18 °C is 40 mm²/s and 10 mm²/s, respectively.
- The minimum freezing point and flash point is -79 °C and 54.4 °C, respectively.

LAToT: 03 Industries

DMS HOTS Oil

HOTS oil is lubricant developed for specific application in Small Turbo Fan Engine (STFE). The inlet temperature of STFE is approximately 135 °C, which increases up to maximum of 250 °C - 280 °C. Thermal and oxidative stability are the major characteristics of HOTS oil and it is able to sustain max temperature up to 280 °C.

Salient Features:

- Developed oil has shown very high flash point along with very low temperature fluidity.
- Oxidative stability was found to be optimum for the STFE application.
- Power run with developed oil on STFE was successful and delivered satisfactory performance compared to imported oil.

LAToT: 03 Industries

Naphthyl Fuel for Sustainer Motor of BrahMos Missile System

Naphthyl fuel is a high density hydrocarbon fuel; Mixture of normal paraffin, Isoparaffin and Naphthenes. This indigenously developed high energy fuel significantly boosts performance and enhances range of the BrahMos cruise missile. It is a part of indigenization efforts for BrahMos missile system by reducing dependency on foreign sources.

Salient Features:

- Density at 20 °C (kg/m³): 833±3
- Heat of Combustion (kJ/kg): 43000

- Freezing point, °C: -60
- Flash point, °C: 61
- Thermo-oxidizing stability: At 150 °C, as per GOST -11802-88 Standard
- Aromatic contents (mass %) : <5

Nano-materials Related Products and Technologies

Hollow Porous Polymeric Nano-fibers for Air Droppable Filtration Cartridges

One of the major challenges for portable water filtration is rate of filtration due to insufficient gravitational pressure. Air droppable water filtration cartridges have been developed by DMSRDE to solve this issue to larger extent.



Air Droppable Filtration Cartridges

Salient Features:

- Don't use any chemical or electrical power for purification.
- Hollow porous polymeric fibers have been fabricated to facilitate decontamination of contaminants.
- The pocket size water filtration cartridge has been developed using polymeric membrane and electro spun nanofibers-based changeable prefilters.

- Facilitate mass scale supply of drinkable water during natural calamities.
- Higher filtration rate, easier operation and custom specific design to address the polluted water treatment challenges at much reduced cost.

LAToT: 01 Industry

Shear Stiffening Gel and its Laminates for Impact-Resistant Applications

Shear Stiffening Gel (SSG) is a non-Newton fluid and its viscosity increases when the shear rate exceeds a critical value. More often, the rate of increase of viscosity is slow in this gel which is one of the major challenges for its application in the dissipation of kinetic energy during impact.

DMSRDE has prepared a unique SSG that shows the change in viscosity as a function of shear force and holds great promise for damping and shock energy dissipation.



Types of Shear Stiffening Gels

Salient Features:

- Flexible gelfilled polymeric scaffolds/laminated composites have efficient absorption of low to medium-velocity impact.
- Can be embedded into polymeric foams for developing low-density porous flexible matrix for efficient absorption of low to medium velocity impacts.

LAToT: 02 Industries

Thermally Conducting Light-weight Nano-composite-based Structures for Torpedo Propulsion Motor

Major challenges for materials under water are the stability, multi-functionalities as well as need of elimination of acoustic and vibration signatures. DMSRDE has developed thermally conducting light weight nano-composite materials which are viscoelastic and dimensionally stable. Thermally conducting light-weight nano-composite-based structures have been developed for Torpedo Propulsion Motor.



Nano-composite-based Structures for Torpedo Propulsion Motor

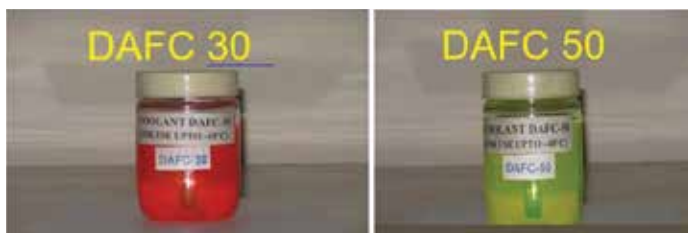
Salient Features:

- Higher stability in marine environments.
- Superior mechanical strength with reduced electrical but increased thermal conduction properties.
- Lower weight, higher viscoelasticity and dimensionally stable compared to contemporary metal alloys.

LAToT: 05 Industries

Antifreeze Coolant: DAFC 30 and DAFC 50

DMSRDE has developed DAFC 30 and DAFC 50, antifreeze coolants to be used in vehicles/radars in plains and desert areas. DAFC 30 can be used as a coolant in the engine cooling systems of cars, trucks, heavy vehicles and auxiliary power units operating on plains up to -10°C whereas DAFC 50 can be used in the engine cooling systems operating in low temperature weather conditions up to -40°C .



Salient Features:

- Glycol-based antifreeze coolant, fortified with corrosion inhibitors.
- DAFC 30 has pour point of -12 °C and DAFC 50 has pour point of -39 °C.
- Ready to use coolant.
- Non-reactive towards rubber parts in the system.
- Non-corrosive towards metallic parts of the system.

LAToT: 07 Industries

Universal Recoil Fluids: URF Plain, URF 75:25 and URF 80:20

DMSRDE has developed fluids: URF Plain, URF 75:25 and URF 80:20 which are used in recoil system of various artillery guns. After exhaustive trials these fluids have been introduced into the Services for use in recoil system of artillery guns operating at both plain and high altitude areas.



Salient Features:

- Miscible with water in all proportions.
- Very low and different freezing points ranging from -55 °C to -60 °C.
- Anticorrosive towards mild steel, brass and bronze metals.
- Non-reactive towards various rubber seals.

LAToT: 14 Industries

Hydraulic Fluid PEGCOL 89 and PEGCOL 113

DMSRDE has developed PEGCOL 89 and PEGCOL 113, hydraulic fluids with the following features.

Salient Features:



- PEGCOL 89: Kinematic viscosity of 19.5-23.5 cSt at 37.8 °C.
- PEGCOL 113: Kinematic viscosity of 46-48 cSt at 37.8 °C.
- Low freezing point, High boiling point
- Wear resistant and lubricative.
- Non-foaming and anticorrosive towards mild steel, cast iron, stainless steel, copper and brass metals.
- Ineffective toward various types of synthetic rubber and fiber washers.
- Miscible with water in all proportion.

LAToT: 05 Industries (PEGCOL 89)

LAToT: 03 Industries (PEGCOL 113)

Nano-material-based Energy Storage Devices

Asymmetric Super-capacitor

DMSRDE has developed several prototype asymmetric super-capacitor devices using synthesized

metal oxide nanostructures like nano-rods, nano-particles, nano-flowers, nanospheres, nanofibers (solid and hollow) by hydrothermal, co-precipitation and electro spinning/co-electro spinning techniques.



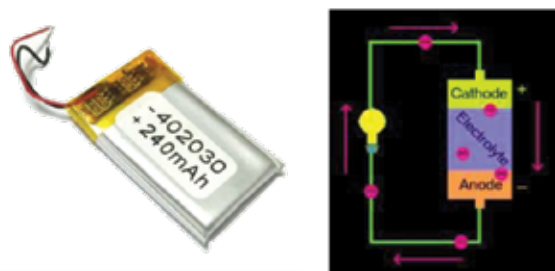
Asymmetric Super-Capacitor

Salient Features:

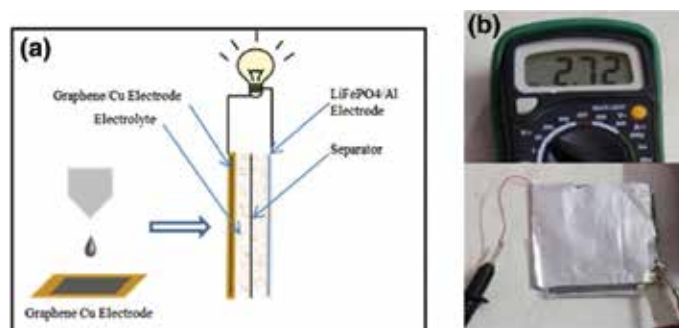
- Long term cycling stability up to 10000 cycles as well as energy and power density.
- Total capacitance up to 50 F.

Li-ion Battery

Lithiumion batteries are known for their increased energy density, light-weight and high cyclability. DMSRDE, has fabricated prototype lithium ion batteries utilizing LiFePO_4 (LFP) cathode and functionalized-Graphene (f-G) based anode. Optimization of the electrodes were carried out by varying the ratio of conducting carbon and functionalized graphene prepared by two different methods i.e. Fenton's method and modified Hummer's method.



Digital Image and Schematic of Battery Cell Configuration



Cell Configuration and Actual Image of the DMSRDE Fabricated Li-ion- Graphene-based Pouch Cell

Salient Features:

- Excellent cyclability and durable cell performance.
- Specific capacity of 163 mAh/g without capacity decay during 30 charge-discharge cycles and also exhibited an excellent cycling stability with a 200-300 mA/g charge/discharge rate demonstrating its potential to be used as high-performance LIBs.

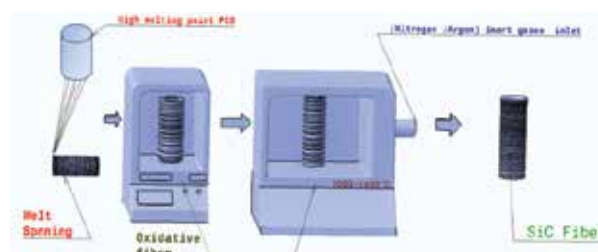
Ceramics and CMCs for High Temperature Applications

Silicon Carbide Fiber

Fabrication of Silicon Carbide (SiC) fibers is a complex and multi-step process. The steps involved in SiC fiber processing can vary depending on the specific method used to produce the fibers, but the general steps involve in melt-spun route are as follows:

Precursor Synthesis, Fiber Spinning Pyrolysis and Post-treatment

Melt spun SiC fibers have following advantages/features over other types of SiC fibers.



SiC Fiber Fabrication Scheme

Salient Features:

- High Tensile Strength: Melt spun route SiC fibers have tensile strengths of up to 3 GPa, which is significantly higher than the tensile strengths of other types of SiC fibers.
- Good Thermal Stability: These fibres can withstand temperatures of up to 2000°C for short duration and
- SiCf/SiC composites are a versatile material with a wide range of potential applications. They are used in a variety of industries, including aerospace, defence, and energy. i.e. gas turbine blades, nozzles, combustion chambers, heat shields, structural components, etc.

Textile Related Products and Technologies

Glacier/ECW Textile and Clothing Items

Glacier clothing items are intended to provide climatic protection in snow bound and extreme cold regions. Main items are personal clothing (Poncho Glacier, Jacket and Trousers, Wind Cheater, men's Shirt and Drawers, Cold Weather thermal Undergarment, Gaiters Glacier, Gloves Glacier, Cap Glacier and Face Mask); Combat gears (Combination Harness, Mattress, Rope climbing, Survival blanket, Cord Avalanche, Splint inflatable, and Rescue bag) and habitats (Tent glacier).



Glacier and Extreme Cold Weather Clothing

Salient Features:

- Designed in multi layered system and protection up to -40°C .
- Waterproof and windproof.
- White/olive green outer for better camouflaging.

LAToT: o6 Industries (ECW Gloves)

Synthetic Camouflage Net

DMSRDE has designed and developed Synthetic Camouflage Net (SCN) for snow bound area (SBA) and desert and green belt area. The SCN for SBA provides effective camouflage in visual and UV region in snow bound area. The SCN for green belt area and desert has been developed in two colour scheme; one side for green belt area and other side for desert. This net provides effective camouflage in visual and NIR region in green belt and desert terrains.



SCN for Green Belt and Desert Area



SCN for Snow Bound Area

Synthetic Multi Spectral Camouflage Net for Plain/Jungle Terrains

Camouflage protection of ground-based targets is paramount for mission success with enhanced survivability. SMSCN provides protection against detection in multispectral regions in plain/jungle terrains.



Synthetic MSCN

Salient Features:

- Made of incised PVC coated nylon zari fabric in different camouflage shades & PU coated mesh structure polyester fabric, gsm ~ 330±10.
- Matt/dull finished fabrics/SMSCN (gloss ~ 6).
- Visual range: detection range 750 m in daytime and 100 m in night.
- Colour scheme: OG: 33.33 %, LG: 33.33 % and DB: 33.33 %.
- NIR: detection range of 300 m by in service passive NVD.
- Thermal: Thermal transmission ≤ 20 % in 3-5 and 8-12 μm .
- MW (8-18 GHz): transmission loss > 6 dB in two-way transmission.
- Water absorption: < 10 %.
- Flame retardant and self-extinguishable.
- Robust modular structure.

LAToT: o7 Industries

Modular Gloves

DMSRDE has developed modular gloves (three layers) for high altitude applications.



Modular Gloves

Salient Features:

- Thermal resistance, modular design
- Gloves-in-gloves principle
- Prepared in light-weight with adequate protection in each layer
- Waterproof and windproof

Activated Carbon Fabric-based CBRN Suit Mk-VI

CBRN Suit Mk-VI is a low-burden chemical protective suit based on new generation Advanced Adsorbent Media (ACF). It comprises of two layers. The first layer worn next to the skin is laminated Activated Carbon Fabric providing improved performance in terms of adsorption & carbon shedding. Next to laminated activated carbon fabric is a multifunctional outer fabric from blended yarn of different fibres in appropriate composition.



Salient Features:

- Adsorbent layer: State-of-Art Activated Carbon Fabric (ACF)
- Outer layer: Blended fabric (Inherent FR, Antistatic, Water & Oil repellent)
- Size: -S, M, L & XL
- Launderability: $> \text{Six times}$

- Weight: ~2.3 Kg
- HD BTT: >24 h (Sulphur Mustard)

LAToT: 03 Industries

CBRN Gloves and Over-boots

Gloves and over-boots are integral parts of CBRN protective clothing and are worn for protection of hands and feet in contaminated environment.



Gloves



Over-boot

Salient Features of Gloves Mk-II:

- Ambidextrous design.
- Serrations on palm and finger for better grip.
- Sulfur mustard break through time > 24 h.
- Cotton inner for sweat absorption.
- Better Flame retardancy and antistatic properties.
- Weight: 270 g.

Salient Features of Over-boot Mk-II:

- Provides protection to feet and lower calf portion.
- Break through time (BTT) > 24 h.
- Special sole design (low thickness ~ 5 mm).
- Seamless design.
- Developed in two sizes 5-7, 8-11.
- Antistatic, skin Friendly with better gripping properties.

- Weight: 1.0 kg.

LAToT: 02 Industries (Gloves Mk-II)

02 Industries (Overboot Mk-II)

Multi-functional Regenerated Jute Fibres

It is an antimicrobial, inherently coloured and eco-friendly regenerated jute fibre developed from dissolving grade jute pulp indigenously at laboratory scale.



Regenerated Jute Fibres

Salient Features:

- Fineness-106-124 denier
- Tenacity-3.02-3.75 gpd
- Crystallinity- >71 %.
- Regenerated synthetic fibre from natural fibre pulp.
- Antimicrobial and biodegradable.

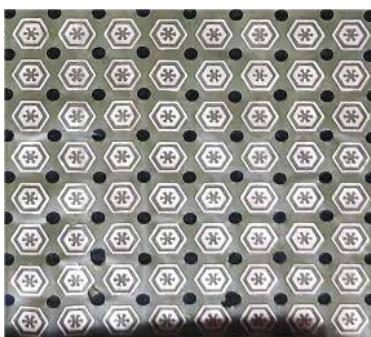
Camouflage and Stealth Materials and Technologies

CV-FSS Radar Absorbing Structure

Hybrid Radar Absorbing Structures (RAS) comprises of conventional radar absorbing materials as well as engineered structures. These hybrid RAS structures provide broadband radar absorption properties with smaller thickness in comparison of conventional radar absorbers.



Glass Carbon Veil



Frequency Selective Surface

Salient Features:

Glass Carbon Veil:

- Glass carbon veils are light-weight reinforcement made from randomly dispersed glass and carbon fibres bonded into a thin sheet.

Frequency Selective Surface:

- Frequency Selective Surface is a periodic structure designed to reflect, transmit or absorb energy based on their design and working frequency range.

Testing and Characterization Facilities

Terahertz Spectroscopy and Non-Destructive Testing System

The system is being utilized for material characterization in THz domain, structural defect analysis (NDT testing) for polymeric composites, RAS composites, UHMWPE composites, etc.



Terahertz Spectroscopy & NDT System

Specifications:

- Spectral range: 0.06 to 4 THz.

- Frequency resolution: 1 GHz.
- Scan rate: 60 sec for 1 cm² at 0.5 mm step size.
- Spatial Resolution: < 500 micron.
- Functional modes: Spectroscopy.
(Transmission mode) and NDT (Reflection mode).
- Scan area (reflection mode): 30 cm x 30 cm.

Physical Properties Measurement System

The Physical Properties Measurement System (PPMS) has been recently installed in the laboratory for characterization of magnetic, electrical and thermal properties of materials which are used for development of camouflage and stealth composites.



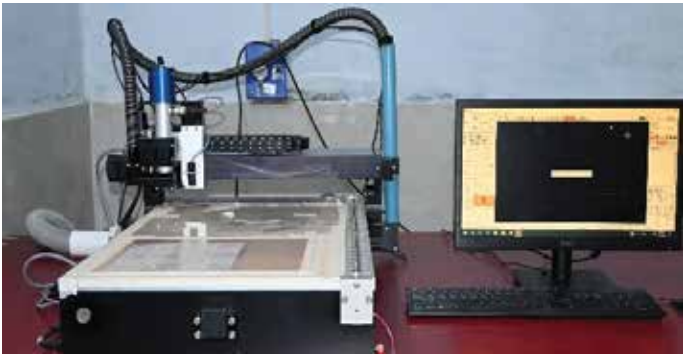
Physical Properties Measurement System

Specifications:

- Temp range: 1.6 - 400 K
- Max. Magnetic field: ± 9 T
- Low Field Option: ± 25 mT
- Sample nature: Powder, pellet, thin film, single crystal, wire, etc.

Metamaterial Fabrication Unit

The unit facilitates fabrication of meta materials, metasurfaces and frequency selective surfaces on rigid as well as flexible substrates such as FR-4, Rogers, Polyimide films, etc. The unit is capable of fabrication of single layer, multilayer and Plated Through Hole (PTH) metamaterial sheets.

**Metamaterial Fabrication Unit****Specifications:**

- Working area (X x Y x Z): Min 580 x 380 x 30 mm
- Minimum track size: 0.1 mm
- Minimum gap size: 0.1 mm
- Substrate holding system: Automatic vacuum table
- Provision of PTH features.
- Capability for layered circuit design upto 4 layers.

Composite Cutting Machine

The Composite Cutting Machine enable cutting of various laminates such as glass and carbon composites, PTFE, PMMA for day-to-day characterization and research activities.

**Composite Cutting Machine****Specifications:**

- Minimum cutting bed size : 500 mm X 500 mm.
- Sample thickness: 1 mm to 40 mm.

- Provision of customized program setting and data Storage up to 25 programmes.
- Automatic composite plate feeding with servo system.
- Capable of cutting laminates of glass, carbon, PTFE and PMMA-based materials.

Free Space Microwave Measurement System

The system is meant for microwave characterization of materials for electromagnetic properties, complex permittivity, and permeability, reflection and transmission loss at room temperature and with temperature variation of -20 °C to 1200 °C as well.

**Microwave Measurement System****Specifications:**

- Frequency range: 5.8 GHz to 40 GHz.
- Sample size: 6" x 6" (15 cm x 15 cm).
- Sample Type: Plane sheet/ composite/ powder/ liquid.
- Temperature range: -20 °C – 150 °C. (low temp. cell), RT- 1200 °C (high temp cell).

Radar Cross-Section Measurement Facility: Anechoic Chamber

The facility is helpful in measuring Radar Cross Section (RCS)/RCS reduction. Return loss, RCS Vs. Frequency and RCS Vs. Angle, Vertical Pol and Horizontal Pol.



RCS Measurement Facility

Specifications:

- Frequency range: 2 to 18 GHz
- Sensitivity: -30 dBsm
- Quiet zone: 30 cm x 30 cm x 30 cm
- Polarization: VV, HH.
- Aspect angle: Azimuth: 0° to 360°
- Elevation: -10° to +10°

Waveguide and Co-axial Microwave Measurement Setup

The facility is established for characterization of materials for electromagnetic properties, complex permittivity, permeability, and reflection and transmission loss at room temperature.



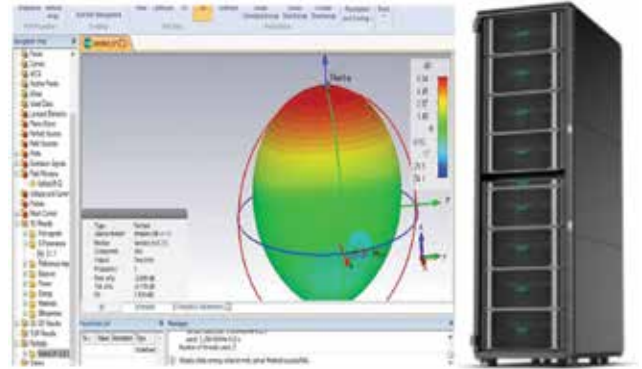
Waveguide and Co-axial Microwave Measurement Setup

Specifications:

- Frequency range: 1.12 GHz to 40 GHz For waveguide: In pallet forms depends on microwave band and waveguide aperture size.
- For co-axial: Toroidal form (OD-7mm and ID-3mm)

Advanced Electromagnetic Simulation Facility

The facility encompasses different solver packages used for electromagnetic simulation studies of various structures and components based on applications.



Electromagnetic Simulation Facility

Specifications:

- Time domain solver (based on Finite Integration Technique (FIT) & Transmission Line Matrix (TLM)). Frequency domain solver (based on Finite Element Method (FEM)).
- Integration equation solver (based on Method of Moments (MoM) technique with Multi-level Fast Multipole Method (MLFMM).
- Asymptotic solver (based on Shooting and Bouncing Ray).
- Multilayer solver (based on Method of Moments (MoM) technique).
- Eigen mode solver.

PCB Prototyping Machine

The machine is used to make single and multilayer frequency selective surfaces.

Specifications:

- Working area : 580 mm x 380 x 30 mm
- Min Track size: 0.1 mm
- Min gap size: 0.1 mm



PCB Prototyping Machine

Thermal Imaging Facility

Non-destructive testing to identify structural defects in electrical systems and electronic components.

Specifications:

- Spectral range: MWIR (3.7 – 4.8 μ m) & LWIR (7.7 – 9.3 μ m)
- Detector: MWIR- InSb & LWIR- HgCdTe
- FPA: 320 x 256, NETD: <20 mK
- Temperature Range (Calibrated)
- MWIR: 5 -300°C & LWIR: 5 -150°C
- Optics:

MWIR: 50mm (11°x8.8°) & 100mm (5.5°x4.4°)

LWIR: 50mm (11°x8.8°) & 100mm (5.5° x4.4°)



Thermal Imaging Facility

Fiber Testing Machine

Specifications:

- Titer range: 0.33–200 dtex
- Fiber length: min. 28 mm VP std.
- Force measurement Range: 0 – 500 cN (0– 1000 cN on request)



Fiber Testing Machine

- Elongation: Max. 100 % at 10 mm gauge length.
- Gauge length: Variable, 5 mm – 50 mm

High Temperature Dielectric Impedance Spectrometer

High performance Turnkey Dielectric Spectrometer with Alpha- AT analyzer including ZGS active Sample cell with gold plated electrodes. Heating arrangement with automatic Win TEMP s/w



Dielectric Impedance Spectrometer

Specifications:

- Frequency range 3 μ Hz - 40 MHz
- Measuring voltage range: 0-3 Vrms
- DC-Bias voltage: +- 40V/70 mA
- Impedance range: 0. 01 Ω - 100T Ω
- Capacitance range: 1 fF to 1 F
- Temp. range: -160°C to +400 °C
- Temperature stability: 0.01 °C
- Loss factor tan(δ) resolution: 10⁻⁵
- Loss factor tan(δ) accuracy < 3x10⁻⁵
- Highest phase resolution: 0.001°
- High phase accuracy: 0.002 °

Dynamic Thermo-Mechanical Analyzer

Specifications:

- Force: 0.0001- 18 N
- Force resolution: 0.00001 N
- Frequency range: 0.001 to 200 Hz
- Dynamic deformation range: ± 0.005 to 10,000 μm



Dynamic Thermo-Mechanical Analyzer

- Strain resolution: 0.1nm
- Modulus range: 10^3 to 3×10^{12} Pa
- Modulus precision: $\pm 1\%$
- Tan δ Resolution: 0.00001
- Temperature range: -160°C to 600°C

Liquid Nitrogen Generation Plant

Liquid Nitrogen Generation Plant has been installed in the laboratory which is a unique in-house facility and is very much essential for characterization of different R&D samples in the laboratory.



Universal Testing Machine

Universal testing machine instrument is to determine tensile strength and tensile modulus of single filament and mini composites.

Specifications:

- Max tensile load: 1 kN

- Load Cells: 5 N, 25 N, 100 N, 1 kN
- Max cross head travel: 755 mm
- Extensometer: Video/non-contact



Universal Testing Machine

Lyophilizer

Freeze drying, also known as lyophilization or cryodesiccation, is a low temperature dehydration process that involves freezing the product and lowering pressure, removing the ice by sublimation. This is in contrast to dehydration by most conventional methods that evaporate water using heat.



Lyophilizer

Specifications:

- Model: LMC 22068
- Sample Load Capacity: 1.2 – 2.7L
- Condenser Capacity: 4 Kg/24 h
- Condenser Temperature: $< -55^\circ\text{C}$

High Temperature Casting Instrument

High temperature casting instrument is a processing instrument. This instrument is used for fabrication of sheets (size: 6" x 6") of nano-fillers, fibres, etc. filled polymers. This instrument can apply pressure upto 20 Tons.

Specifications:

- Tan δ Resolution : 0.00001
- Temperature Range : -160 °C to 600 °C



High Temperature Casting Instrument

Modulated Differential Scanning Calorimeter

It is used for the measurement of phase transitions, enthalpy, glass transition, crystallinity and heat capacity of various polymers, elastomers, composites, ceramics other engineering materials.

Specifications:

- Model: Waters (TA instruments) Discovery DSC25.
- A Heat Flux Modulated Differential Scanning Calorimeter (MDSC) whereby the sample and the reference are measured in the same furnace.
- Working temperature range (total range) is -90 °C to 700 °C with mechanical cooling and FACS.
- Heating Rate (RT- 700 °C) is 0.01 °C to 200 °C/min and cooling rate is 0.02 °C to 100 °C/min.



Modulated Differential Scanning Calorimeter

- Measurement atmosphere are both inert and oxygen.
- DSC furnace is made of silver with the capability of full range from -180 °C to 700 °C.
- DSC has a fusion cell, which is a user replaceable cell. Fusion cell of the DSC is integrated with the sensor platform and the heating system.
- Dynamic range of DSC is ± 350 mW.

Multifunctional Tribometer

The instrument provides complete solution for tribological characterization. It offers very precise measurement of tribological parameters, e.g. friction, wear, lubrication, etc. as per international standards (ASTM/DIN/ISO/IP).

Specifications:

- It can be used at load 1-2000 N and with effective frictional force variation 0.5 N to 1500 N with frictional load resolution of 100 μ N.
- It is highly specialized instrument for performing wide variety of lubricant characterization.
- It accommodates interchangeable modules for ease of performing experiments with fully programmable controlled loading system.
- Fully automated computerized control, data acquisition and processing system.



Multifunctional Tribometer

Editors are thankful to Mohammad Imamuddin, Sc 'F'; Shri Awanish Kumar Sonkar, Sc 'E'; Dr Jyoti Prakash Singh, Sc 'E'; Shri Abhishek Singh, Sc 'C' and Shri Ankit Kumar, Sc 'B' for preparing the write-up for this special issue of Technology Focus

डेसीडॉक द्वारा प्रकाशित

Published by DESIDOC

RNI No. 55787/93