IGC Newsletter

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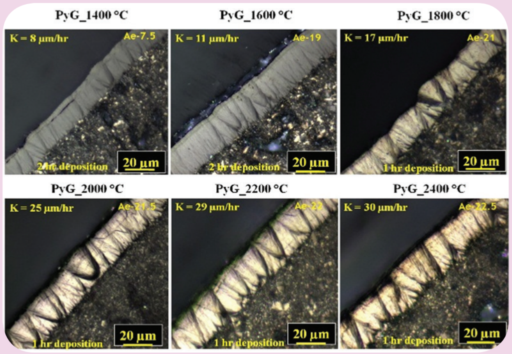
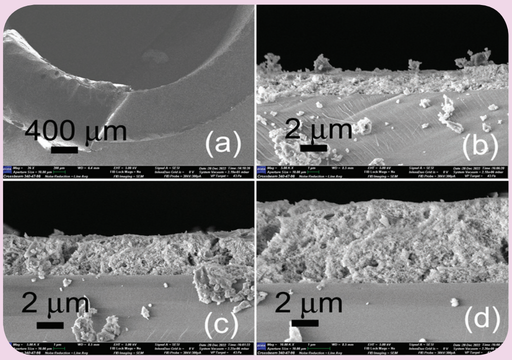
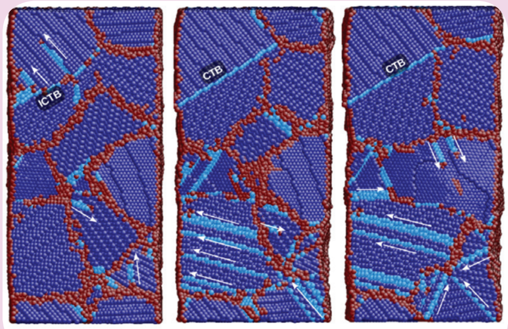






(a) 1st cycle (b) 5th cycle (c) 10th cycle

Indira Gandhi Centre for Atomic Research
http://www.igcar.gov.in/lis/nl146/igc146.pdf

Editor's Desk

Dear Reader

Greetings

It is my pleasant privilege to forward the latest issue of IGC Newsletter (Volume 146, January 2026, Issue 1). I thank my team for their timely inputs, cooperation, and support in bringing out this issue.

The Young Officer's Forum article of this issue highlights on "Development, Testing and Characterization of Highly Oriented Pyrolytic Graphite Coatings for Pyroprocessing" by Dr. E. Vetrivendan from MMG, IGCAR.

The IGCAR Lectures Series articles on "Quality Assurance Division – Glimpse of Activities and Way Forward" by Shri M.V. Kuppusamy; "Centrifugal Contactors for Fast Reactor Fuel Reprocessing" by Dr. M. Balamurugan; "Atomic-Scale Simulations of Deformation and Failure Mechanisms in Model Materials" by Dr. G. Sainath; "Design of CSRDM, DSRDM and Hydraulically Suspended Absorber Rod for Fast Breeder Reactor" by Shri L. Suresh; and "Development of Coating Protocols for Metal Fuel Casting and Characterizations" by Shri Soumen Das are included in this Newsletter.

In the back cover, We have Green Bee-Eater bird found in IGCAR campus.

The Editorial Committee would like to thank all the contributors. We look forward to receiving constructive suggestions from readers towards improving the IGC Newsletter content.

We express our deepest gratitude to Director IGCAR for his keen interest and guidance.

With best wishes and regards

Shri J. Rajan
Chairman, Editorial Committee, IGC Newsletter and
Head, Scientific Information & Networking Division, IGCAR

New Year Message of Director, IGCAR

Shri C.G. Karhadkar
Distinguished Scientist & Director, IGCAR

Dear Colleagues,

I extend my heartfelt wishes to all the colleagues of the Indira Gandhi Centre for Atomic Research, General Services Organization and their families for a happy, healthy, and prosperous New Year 2026 and a warm greeting for the upcoming Pongal festival.

As we begin this New Year 2026, let us reflect on all that we have accomplished together and move forward with confidence to address the challenges and embrace the opportunities that await us.

The Fast Breeder Test Reactor (FBTR), which is the flagship reactor of the second stage of our nuclear power programme, continued to operate at its design power of 40 MWt. During the current 34th irradiation campaign of FBTR, the cumulative thermal energy generated was 32,590 MWth, and the total electrical energy delivered to the grid was 6.355 million units. We cherished the moments of criticality on its 40th anniversary, through former colleagues, who had contributed and witnessed then.

As a step forward towards achieving net zero emission, works related to integrating the Copper–Chlorine thermo-Chemical Cycle Based Hydrogen production facility at FBTR has commenced, and the required steel structure with platforms and staircases has been fabricated, erected and installation of equipment is in progress, it is expected that we may be able to demonstrate production of nuclear Hydrogen by the end of Jan 2026.

IGCAR has been consistently supporting various milestone activities of PFBR. Last year, there was a major setback with the transfer pot of the Inclined Fuel Transfer Machine (IFTM) facing an obstruction and could not reach the bottom. Investigations using a specially designed "Under Sodium Ultrasonic Scanner" revealed that one of the two 31° tilting rails in the Primary Tilting Mechanism (PTM) was dislocated. To address this, a direct fuel loading system was conceived, designed, fabricated, erected and commissioned through the dedicated efforts of colleagues from IGCAR and BHAVINI. For retrieval of the displaced rail, a full-scale mock-up facility was created at BHAVINI, where teams from BHAVINI and BARC successfully developed and tested the required tools. It is heartening that fuel loading into the reactor core for the First Approach to Criticality has commenced and is progressing smoothly and around 35% core loading has been completed.

Simultaneously, the NDE inspection module of the DISHA-V2 in-service inspection vehicle, consisting of eight ultrasonic transducers and one eddy current probe for inspecting the dissimilar weld between the main vessel and the roof slab, has been successfully deployed at PFBR after qualification at high-temperatures and inspection in one of the sectors has been completed.

The U233 fuelled Kalpakkam Mini Reactor (KAMINI) is continuing its successful operation for testing of various neutron detectors, Neutron Activation Analysis (NAA), Neutron radiography of fresh & irradiated fuels and Shielding experiments.

In-principle approval has been obtained from the Atomic Energy Commission (AEC) for a 100-120 MWth FBTR-II, along with associated facilities for metal fuel fabrication, post-irradiation examination, and pyro-processing of metal fuel. The primary objective of FBTR-II will be the development and testing of metal fuel at a one-to-one scale for a 500/1000 MW fast reactor. Secondary objectives include green hydrogen production, isotope production (both strategic and commercial), material irradiation studies, and minor actinide burning studies.

A conceptual physics design for the 100-120 MWt FBTR-II core has been completed. The design is based on driver carbide fuel and test metal fuel. In addition, approval has also been obtained for sodium intermediate heat exchanger (IHX) and pump test facilities to support the large-scale expansion of the fast reactor programme.

A large experimental sodium test facility has been commissioned at the Sodium Technology Complex. The facility, constructed with Austenitic Stainless Steel 316L(N), includes major sodium handling systems such as test vessels, storage tanks, a heater vessel, heat exchangers, an electro-magnetic pump, and a full purification circuit. Sodium flow has been established in all paths, and the facility will serve as a test bed for design optimization and provide valuable inputs for future Fast Breeder Reactors.

In 2025, significant progress was achieved in our Reprocessing Programme. with 67th campaign completing successfully and initiation of 68th campaign at Compact Reprocessing of Advanced Fuels in Lead Cells (CORAL) facility. CORAL continues to achieve high recovery and decontamination rates and remains a unique facility for reprocessing high burn-up carbide fuels.

At the Demonstration Fast Reactor Fuel Reprocessing Plant (DFRP), four campaigns for processing FBTR spent fuel with a burnup of 155 GWd/ton were successfully completed, since its hot commissioning in April 2024. The fifth campaign is currently in progress.

In addition, Recovery of Neptunium-237 (Np-237) from the PUREX process stream has been successfully demonstrated, with approximately 1,800 mg separated from the uranium product stream. Np-237 can be used to produce Plutonium-238, which serves as a source material for Radioisotope Thermoelectric Generators (RTGs). Curium-244 (Cm-244) has also been successfully isolated from the PUREX process stream.

Towards development of Pyro-Processing, Fresh 2 kg U-Zr sodium bonded fuel pin was cut, sodium was distilled out and loaded in the electro refiner. After electro refining about 1.6 kg of uranium was retrieved. Towards R&D related to metal fuel irradiation studies, Irradiation of different composition (Pu/U+Zr) of metallic fuel pins is in progress at FBTR. The maximum burnup attained till date is 37.6GWd/t for 23%Pu-19%EnU-6%Zr fuel pin.

R&D activities in other areas are also progressing well. Notable work includes the development of uniaxial and biaxial fatigue test systems for generating location-specific material properties, completion of long-term performance assessment of SS304HCu and Alloy 617M tubes after 30,000 hours of exposure in the Fireside Corrosion Test Rig at Dadri, and the development of high-performance reinforced green concretes suitable for coastal nuclear plant environments, which have shown excellent resistance to chloride ingress and corrosion.

I am happy to share that the indigenously developed Hydrogen sulphide sensors were tested in Heavy Water Plant, at Manuguru. The performance of in-house developed sensor was found to be comparable with the imported sensor functioning already in the plant.

A significant breakthrough has been achieved in the field of quantum communication; IGCAR is developing an alternative to Quantum Key Distribution, called the Quantum Secure Direct Communication.

A new facility, the In-situ Ion Irradiation and Imaging System with FESEM (i4-FESEM), has been established by integrating a field-emission scanning electron microscope with the 1.7 MV Tandetron accelerator beamline. This facility enables real-time observation of micro-structural evolution under ion-irradiation and is the first-of-its-kind in India and only the third such facility worldwide.

In the areas of safety, environment, and health, several important developments were achieved during the year. The site acceptance testing of Wind Profiler involving performance of radar sub-systems, software, data products and its validation using GPS Sonde experiments were completed. Height coverage under different weather conditions was evaluated and the system was made fully operational. The “Remote Sensing-enabled Chemical Emergency Response System (ROCERS Ver 1.0),” developed collaboratively by IGCAR and NRSC-ISRO for the Department of Factories and Boilers, Government of Kerala, was formally inaugurated on 11th October 2025 during the Surakshitam 3.0 International Conclave on Occupational Safety and Health. Additionally, sustained efforts in CdZnTe single-crystal growth for room-temperature gamma spectrometry applications have resulted in achieving an energy resolution of 2.6% (FWHM) for the 667 keV Cs-137 peak, marking a significant enhancement in detector performance.

Our green energy initiatives have been further strengthened with the installation of the “Thermal Energy Storage System” at the North Plant Site. This smart energy management solution shifts air-conditioning (AC) load from peak to off-peak hours by storing thermal energy as latent heat using Phase Change Material (PCM), which freezes and melts to absorb or release energy efficiently. In addition, a major solar PV plant of 2.29 MWp capacity has been installed, raising the total installed solar capacity at the Centre to 3.1 MWp.

The DAE Incubation Centre at IGCAR, registered as AIC-IGCAR-FAST Foundation, continued its activities during the year. In 2025, MoUs were established with HBNI, Startup TN, and AIC-PECF (Puducherry). An IGCAR-patented technology, remotely operated self-locking fixture for wall-mounted equipment in contaminated enclosures was transferred to a start-up firm, this year. held in November, 2025

In this year, we had celebrations and commemorations for achievement of key milestones. Fortieth anniversary of the Fast Breeder Test Reactor (FBTR) achieving first criticality was celebrated on 18th October, 2025 with Shri K.N. Vyas, Homi Bhabha Chair Professor and former Chairman, Atomic Energy Commission & Secretary, DAE, gracing the day as our Guest. A commemorative Coffee Table Book on FBTR was formally released during the event. Senior dignitaries and former associates of FBTR were present, and their contributions to the reactor’s development and sustained performance were acknowledged.

A significant scientific achievement announced during the event was the successful in-house separation of Phosphorus-32 (P-32) from irradiated Strontium Sulphate ($SrSO_4$) pellets in FBTR for the first time. The separated P-32 was formally handed over to the Chief Executive, BRIT, marking an important milestone in radioisotope production for societal applications. A photo exhibition depicting major milestones in the evolution of FBTR was also inaugurated.

Swachhata Pakhwada-2025 was observed with the same excitement to include, “Shramdaan”, a beach cleaning drive with students from Schools and a cleanliness drive in Sadras Village, alongside systematic cleaning and weeding of records at IGCAR. A Nisargruna bio gas-plant of 500 kg capacity was established at IGCAR to transform biodegradable canteen waste into clean biogas. As part of “World Environment Day 2025”, tree plantation was carried out at north DAE campus during July 2025. As part of the Swachhata Hi Seva-2025 campaign, various activities have been carried out at IGCAR under “Swachhotsav” theme: - ‘Ek Ghanta, Ek Din, Ek Saath’. As part of National Science Day, the Brilliant Bharath Hackathon was conducted, encouraging UG, PG students, and researchers to propose innovative solutions to real-world challenges.

Our flagship Summer Training in Physics and Chemistry (STIPAC) programme was also successfully conducted, offering valuable academic enrichment to 70 M.Sc. students. In addition, 20 M.Sc. students from various engineering and science colleges across Tamil Nadu took part in the Summer Training Programme in Physics (STPP-2025), organized in collaboration with Science City, Department of Higher Education, Government of Tamil Nadu.

The 32nd Prof. Brahm Prakash Memorial Materials Quiz (BPMMQ), a national event was conducted to promote awareness among high school students about the vital role of materials in nation-building, particularly in the peaceful applications of atomic energy. Ninety students participated in this event

Further, in alignment with national capacity-building initiatives, a three-day training programme was conducted as part of the Capacity Building Commission’s Rashtriya Karmayogi - Large Scale Jan Seva Programme, aimed at fostering a spirit of public service (Seva Bhaav). As part of its outreach activities, Anu Awareness Yatra -2025 was organized in collaboration with professional bodies. The yatra commenced from Kalpakkam, Tamil Nadu, and concluded at Kaiga, Karnataka, covering over 1,100 km and many educational institutions, with the active participation of nearly 10,000 students and 500 faculty members and teachers.

Our Centre continues to attract a large number of visitors every year. This year about over 2,800 students and faculty from various schools and colleges, along with 770 visitors including members of the public and VIPs, had visited our centre. Apart from this, more than 150 students have pursued their postgraduate or undergraduate projects at the Centre. As part of OCES outreach programme, Placement Officers Meet was organized at IGCAR on 8th January, 2025. Around 27 placement officers from various colleges across Tamil Nadu actively participated in this meet.

The IGC Lecture Series, which commenced in July 2024 continued this year with a total of 62 lectures completed so far, on diverse topics, highlighting achievements, challenges overcome, and the Centre’s preparedness to meet the Amrit Kaal vision targets.

The General Services Organization (GSO) continues to serve the Kalpakkam and Anupuram Townships with spirit of dedication. The sustained efforts of the employees of GSO to enhance overall services, and in maintaining a clean, green, and well-managed environment is commendable. The Medical Group has further strengthened its facilities and continues to provide reliable and comprehensive healthcare to the residents of both townships. Their dedication and commitment to quality healthcare are highly appreciated.

An online portal has been developed in-house and launched for booking online appointment with the specialist doctors in DAE hospitals at Kalpakkam, Anupuram, IMSc (Chennai) and Pallavaram (Chennai). This digital platform was made available to the serving and retired employees of all the DAE units being served by GSO Hospital, Kalpakkam, to enable them to book appointments for themselves and for their dependant family members.

I greatly acknowledge the dedicated efforts of the principals, teachers, and staff members of all Kendriya Vidyalayas and Atomic Energy Central Schools within our townships for providing quality education in a holistic manner. I am pleased to note that students across all five schools have excelled in their board examinations, achieving outstanding results. The Administration, Accounts and Auxiliary Departments of IGCAR and GSO have continued to provide commendable services guiding and supporting the execution of various programmes of the centre.

As we look ahead to 2026, in addition to ongoing R&D and routine activities across various groups of IGCAR, our focus will remain on several key areas. These include supporting the integrated commissioning activities of PFBR towards the First Approach to Criticality, operating DFRP with spent fuel from fast reactors and ensuring the recovery of strategic materials, sustaining the operation of FBTR at 40 MWt with irradiation of advanced FBR structural materials, isotope production, metal fuel irradiation, and hydrogen production activities, and advancing activities such as detailed project report towards realizing the conceptualized FBTR-II along with its proposed front-end and back-end facilities.

The accomplishments achieved so far reflect the hard work and commitment of all our colleagues, and I look forward to your continued support in the coming year to achieve further professional growth, productivity, and sustained progress across all our endeavors.

Dr. E. Vetrivendan completed his B.Tech in Metallurgy from NIT, Trichy in 2006 and M.E. in Materials Engineering from IISc, Bangalore in 2009. He joined in Corrosion Science & Technology Division, MMG, IGCAR, Kalpakkam as SO/D in March 2014 after 5 years of rich experience in R&D on materials for automotive. Currently, Dr. E. Vetrivendan is working on developing thermal spray and CVD coatings for FBR and reprocessing applications, and corrosion evaluation of advanced materials in simulated environments. He has published 33 research articles in peer-reviewed international journals. Dr. E. Vetrivendan is a recipient of DAE Young Engineer Award in the year 2019.

Young Officer's Forum

Development, Testing and Characterization of Highly Oriented Pyrolytic Graphite Coatings for Pyroprocessing

High-Density Graphite (HDG) happens to be the irreplaceable choice of process material for pyrochemical reprocessing and futuristic material for in-core components for Generation-IV reactors involving high temperatures, corrosive molten salts and molten metal, long and intense irradiation exposures. Nuclear grade HDG with stringent quality parameters has been explored in recent years to meet the functional requirements of hostile conditions posed in nuclear reactors and associated technologies. Despite the advancements in the manufacturing processes, the maximum density achievable in HDG could not exceed 1.9 g cm^{-3}, leaving behind inherent porosity and defects that are deleterious to its applications. The low cohesion strength with the powdery nature of HDG assists in the easy dislodging (both physical and chemical) of carbon from the surface to either contaminate or form reaction products on exposure to process mediums. The porosities and defects significantly deteriorate its resistance to oxidation and corrosion and assist in the formation of graphite intercalation compounds, leading to the exfoliation and erosion of graphite. Pyrolytic Graphite (PyG) is a synthetic form of highly crystalline and oriented graphite with a near theoretical density obtained by pyrolysis of hydrocarbons in a Chemical Vapor Deposition (CVD) process. Depositing a coating of PyG over commercial HDG will effectively seal the surface defects or porosities to enhance the physical and chemical properties at the surface, contributing to improved performance and durability of graphite components. Our work focused on the CVD parameter optimization aimed at the construction of a process map that acts as an operational guide toward the synthesis of high density, defect-free and oriented PyG coatings exhibiting maximum oxidation and corrosion resistance for application in pyrochemical reprocessing. The parameter optimization includes investigation of the influence of hydrocarbon precursor, pyrolysis temperature and reaction pressure on the density, phase structure, microstructure, preferred orientation/texture, chemistry, defects, growth rate and associated nucleation and growth mechanisms of PyG. The thesis concludes with a corrosion evaluation of PyG-coated HDG samples in a simulated pyrochemical reprocessing condition and a demonstration of PyG coatings on actual pyrochemical reprocessing components using optimized CVD process conditions.

The first optimization work discusses the development and characterization of PyG coatings on HDG using different hydrocarbon precursors (different carbon-to-hydrogen ratios), i.e. methane (CH_4) and propane (C_3H_8) under constant gas mixing ratio and flow rates at isothermal (1800 °C) and isobaric (2.5 mbar) conditions. The study concluded that the density, crystal and microstructure of PyG are identical with hydrocarbon precursor types. The marginal difference in texture and growth rates are attributed to the differences in the chemistry and kinetics of final carbon-yielding species

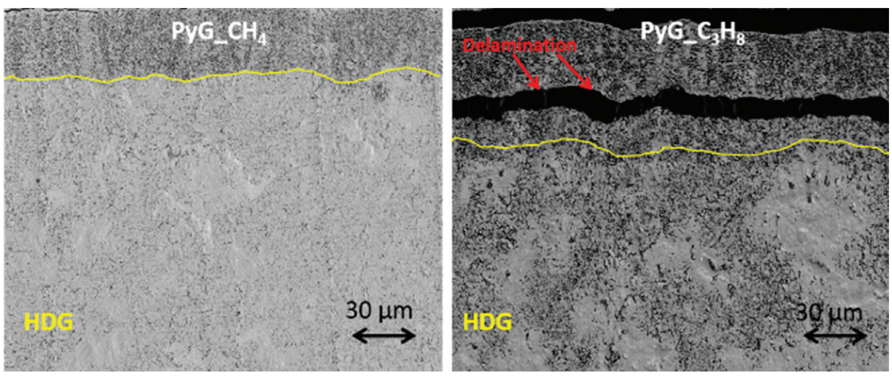


Fig. 1: SEM micrographs of PyG cross-sections showing delaminations when the thickness near ~50 µm in case of C_3H_8 pyrolysis

at the sample substrate while using CH_4 and C_3H_8. The buckling delamination due to internal stresses as a result of a higher growth rate of PyG in case of C_3H_8 pyrolysis is shown in **Fig. 1**. The subsequent optimization work studied the influence of CVD pyrolysis temperatutre from 1400 to 2400 °C using C_3H_8 at isobaric and constant gas flow rates. The results showed that the CVD pyrolysis temperature is a critical parameter significantly influencing the density, texture, microstructure and growth kinetics of PyG. A near theoretical density, >2.2 g/cm^3 is achieved at pyrolysis ≥2100 °C. Increasing pyrolysis temperature increased the deposition rate and degree of preferred orientation or texture. The cross section view in polarized light microscopy, revealing the surface nucleated cone morphologies indicating the extinction angle (a measure of optical texture) and growth rate, are shown in **Fig. 2**. The carbon deposition in surface kinetics control regime operating between 1400 to 2200 °C has an activation energy E_a of 60 kJ/mol. A strong correlation between temperature-dependent kinetic behavior and PyG microstructures could explain the formation of rough laminar structure (highly oriented and anisotropic) and smooth laminar structure (less anisotropic). Figure 2 PLM images for PyG coatings at different pyrolysis temperatures

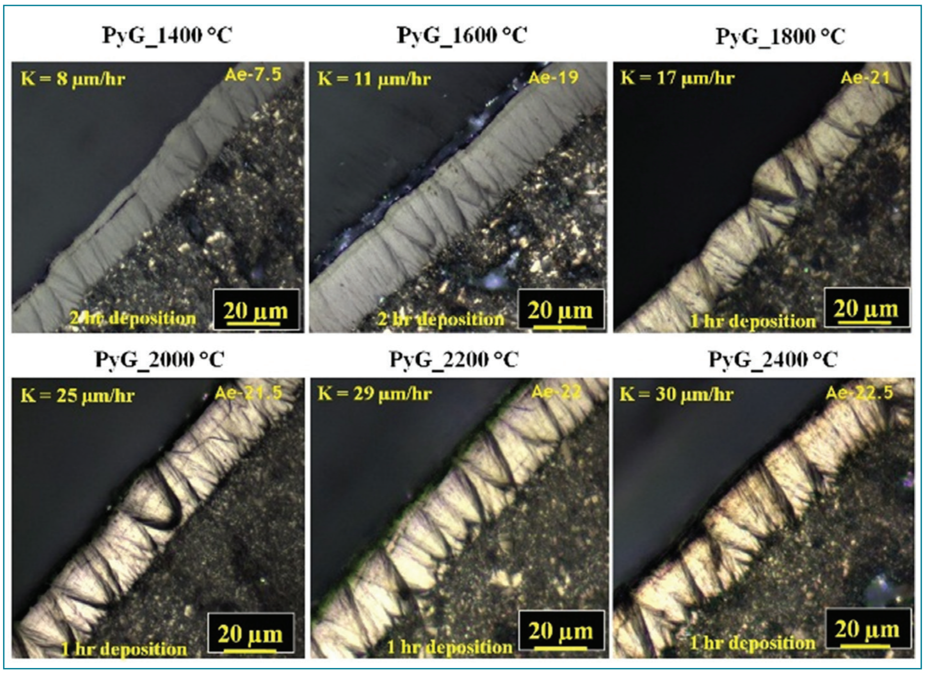


Fig. 2: PLM images for PyG coatings at different pyrolysis temperatures

The final optimization study with respect to CVD pressure showed that, unlike temperature effects, the influence of pressure on the density of PyG is not as significant. While the measure of preferred orientation and defect concentrations showed higher structural ordering with more planar orientations with decreasing pressure from 10 to 2.5 mbar also complemented by thermal stability parameters through thermogravimetry analysis.

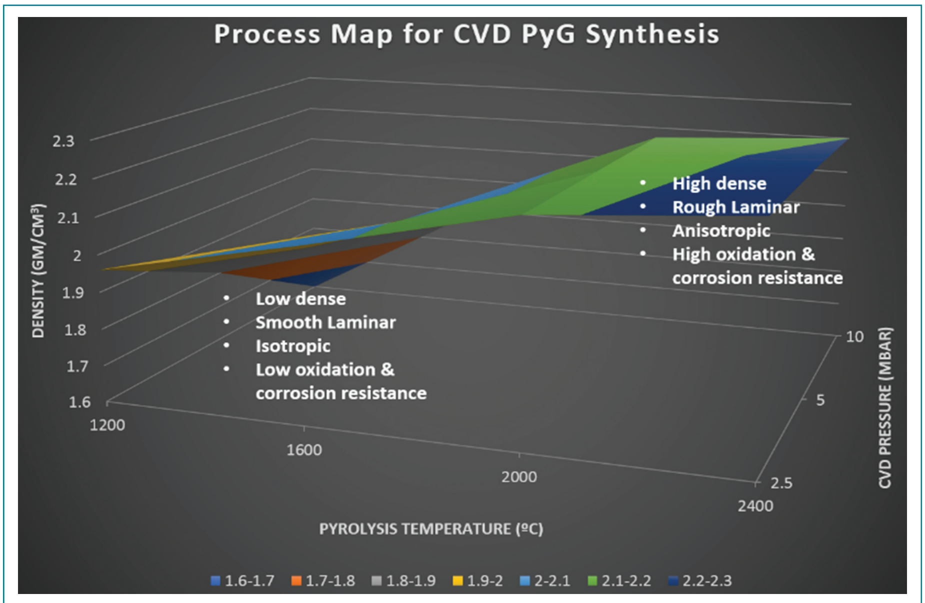


Fig. 3: CVD process map shows the influence of pyrolysis temperature and pressure on PyG density

The CVD process map that concludes the effects of pyrolysis temperature and pressure on PyG density are shown in **Fig. 3**. Towards qualification and demonstration of PyG coatings on HDG components for pyrochemical reprocessing, the performance evaluation in simulated lab-scale testing in LiCl-KCl-5%UCl_3, LiCl-1%Li_2O and Ni melting were carried out. The study on molten salt corrosion of PyG in LiCl-KCl-5 wt.% UCl_3 at 550 °C up to 2000 h showed very good chemical passivity while in LiCl-1 wt.% Li_2O at 650 °C PyG shows the onset of corrosion attack by the formation of pits at 250 h of exposure. Molten metal interaction of PyG with Ni showed reactive infiltration wetting, forming large interfacial exchange reaction zones. Molten metal interaction of PyG with U in a 1 kg melt system showed strong chemical interaction as defined by the U-C binary phase diagram. The carbon pick in U ingot increases linearly with melt cycles.

Shri M.V. KUPPUSAMY
Safety, Quality & Resource Management Group
Indira Gandhi Centre for Atomic Research
Kalpakkam, Tamil Nadu, India

Lecture Series

Quality Assurance Division – Glimpse of Activities and Way Forward

Quality Assurance Division (QAD) of IGCAR has been at the forefront of ensuring the integrity, reliability and safety of critical components and systems used in India's fast reactor and fuel reprocessing programmes. Over the past five decades, QAD has established itself as a cornerstone of the Department of Atomic Energy's technological excellence by providing seamless Quality assurance (QA), Quality Surveillance (QS), Non-Destructive Examination (NDE) and Metrological Inspection Services to all major reactor and reprocessing projects such as FBTR, PFBR, DFRP, and FRFCF. The division's activities encompass project services, metrological evaluation and audit services to ensure that every stage of material procurement, fabrication, and construction as shown in Fig. 1, adheres to the highest quality standards.

1. Major Contributions

FBTR (Fast Breeder Test Reactor)

One of QAD's hallmark contributions has been towards the FBTR, which stands as testimony to the robust quality systems established during its fabrication and operation. Even after over forty years of service, FBTR has not experienced any weld joint failure, highlighting the division's success in implementing rigorous inspection and surveillance protocols (Fig. 2).

PFBR (Prototype Fast Breeder Reactor)

QAD developed high-sensitivity radiography techniques for thick austenitic stainless-steel welds, introduced Phased-Array Ultrasonic Testing (PAUT) and conducted helium leak testing of massive vessels under vacuum. The division also implemented optical alignment verification for large reactor structures and developed procedures for digitization of radiographs, marking a significant advancement in digital inspection practices within the nuclear sector. Expertise extended for Sharp edges smoothening and discriminator diameter reduction of dummy and actual sub assemblies and use of visual and helium leak testing modalities towards ascertaining leaky tubes of IHX 1 and 2 followed by QA during plugging of suspected leaky tubes.

DFRP (Demonstration Fast Reactor Fuel Reprocessing Plant)

QA for more than 70,000 austenitic stainless-steel joints and development of Ti–SS dissimilar metal joint inspection.

FRFCF (Fast Reactor Fuel Cycle Facility)

QA during procurement and fabrication of 3,000+ tonnes of AISI 304L plates, 630 km length of pipes , 15910 forged fittings, 340 nos of cylindrical and annular tanks, 350 nos of fume hoods and glove boxes.

STC (Sodium Technology Complex) and SFCT (Sodium Facility for Component Testing)

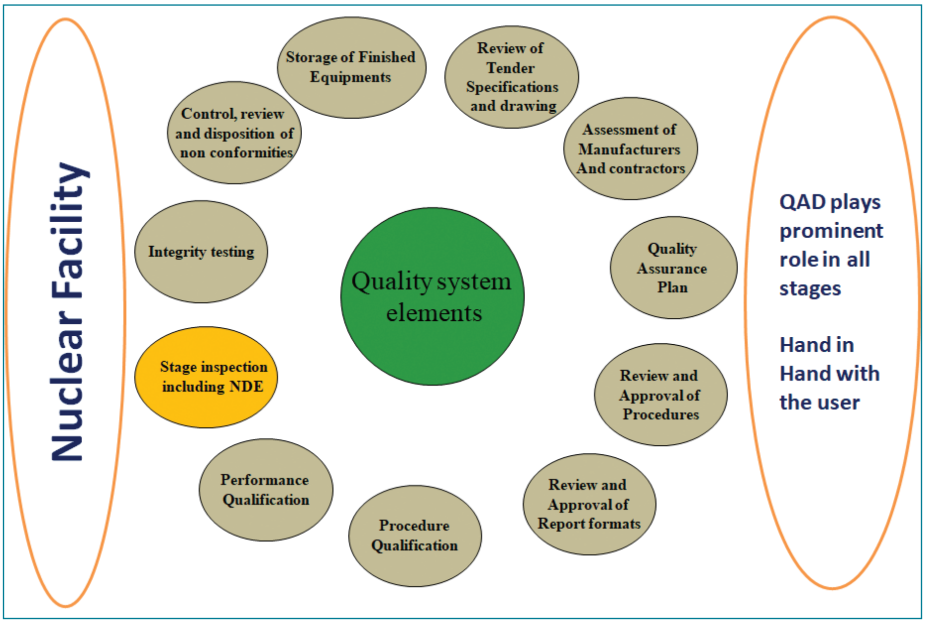


Fig. 1: Role of QAD in fabrication life cycle

Comprehensive QA and NDE services has been provided during fabrication of components such as sodium storage tank, plugging indicator, test vessel at supplier's site and also fabrication of SS piping plant integrating all the components at site.

2. Developmental and Standardization Efforts

QAD has introduced innovative practices such as:

- Use of Flux-covered TIG filler wire for closure welds of small bore pipe welds without purging.
- Use of Perforated flask purging for terminal joints.
- Use Se-75 gamma radiography for thin-walled pipe welds to get required sensitivity.
- Development and implementation of Standard Welding Procedure Specifications (SWPS) and QA templates for uniform documentation.

3. Way Forward

The division aims to expand its frontiers in:

- QA and inspection services for FBTR-2 and reprocessing programs.
- Augmentation of QA and metrological systems.
- Advanced NDE (PAUT, TOFD, Digital RT, Computed Tomography).
- Structural health assessment of ageing mechanical structures.
- Paperless QA systems through digital MIS and ATOMS integration.
- Virtual-reality-based NDT training modules under the National Skill Development Initiative.

Fig. 2: Contributions of QAD to FBTR

4. Conclusion

QAD's contributions have been instrumental in realizing the vision of a self-reliant, safe, and sustainable fast reactor and associated reprocessing programme in India. With continual innovation and standardization, QAD stands as a model for excellence in quality assurance for nuclear components.

Dr. M. BALAMURUGAN
Reprocessing Group
Indira Gandhi Centre for Atomic Research
Kalpakkam, Tamil Nadu, India

Lecture Series

Centrifugal Contactors for Fast Reactor Fuel Reprocessing

Designing of nuclear reprocessing equipment are very challenging and it should satisfy the following criteria: (i) minimum operating life should be 40 to 50 years, (ii) either they should be maintenance free or remotely maintainable, (iii) they should not lose their mechanical and chemical properties due to high radiation background and (iv) shape and size should meet the criticality safe condition.

The type of equipment chosen for solvent extraction operation in nuclear reprocessing are based on several factors and they are (i) process foot print and building size/height, (ii) operational flexibility such as continuous operation or frequent start and shutdown condition, (iii) low inventory which makes the process safer, (iv) processing time should be low to address solvent degradation, (v) it should reach steady state as early as possible, (vi) entrainment of other phase should be low, (vii) tolerance to process upsets, (viii) tolerance to solid handling, (ix) remote maintenance capability and (x) criticality constraints.

Three distinctive equipment are generally used for solvent extraction operation. These include: (i) mixer-settler, (ii) columns (plate, pulsed extraction, etc.) and (iii) centrifugal contactors.

Radioactivity level in fast breeder fuel reprocessing is 10 to 15 fold higher than the thermal reactor fuel reprocessing plant. Because of high radiation, solvent degradation is very high and degradation products (MBP and DBP) form complex with Pu and back extraction of Pu is difficult and it leads to Pu loss in the organic phase. Diluent degradation products alter physical properties of solvent and affect the equipment performance and reduces the decontamination factor. To reduce solvent and diluent degradation, extraction needs to be completed in the order of seconds. Centrifugal contactor is a candid candidate for fast breeder reprocessing applications. Centrifugal contactor comes under stage wise contactor where mixing and settling are accomplished inside a single unit.

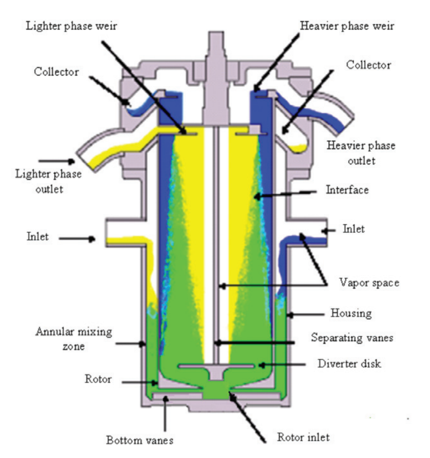


Fig. 1: Schematic of single stage centrifugal contactor

The schematic diagram of single stage of centrifugal contactor, which is based on the annular couette mixing is shown in **Fig. 1**. The cut view of rotating bowl is shown in **Fig. 2**. The centrifugal contactor basically consists of a stationary casing inside, which, spins a rotor suspended from a overhead bearing support. The annular space between rotor and stationary bowl forms the mixing zone into which aqueous and organic streams are fed.

The mixing is achieved by the shearing action of the rotor on the fluids. The radial vanes at the bottom of the casing break the vortex and helps the mixed phase to enter the rotor through its bottom opening. The deflection baffle immediately above the orifice prevents the mixed phase from bypassing part of the settling zone. The phases are separated under the centrifugal force as they flow upward. The aqueous phase flows over the aqueous weir into the

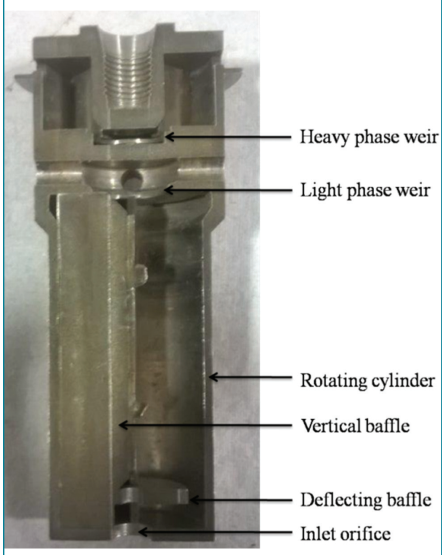


Fig. 2: Cut view of centrifugal contactor rotating bowl

aqueous discharge part. The organic phase flows over inner organic weir into the organic discharge part. For clear phase separation the interface between the two phases is to be maintained within the zone between aqueous underflow port and organic weir radii. This interface position is decided by pressure balance due to column of aqueous stream flowing over the aqueous weir and the column of organic stream flowing over the organic weir.

The following centrifugal contactors are developed in IGCAR. They are (i) 25 mm, (ii) 30 mm, (iii) 40 mm, (iv) 50 mm, (v) 60 mm and (vi) 125 mm ID ACCs.

The 16 stages, 30 mm ID ACC is operating in our CORAL plant for more than two decades and photographic view is shown in **Fig. 3**.

The 20 stages 40 mm ID ACC is installed and successfully operating in our DFRP plant and photographic view is shown in **Fig. 4**.

Other higher diameter ACCs are developed for FRFCF project and commercial applications.

Fig. 3: Photographic view of 16 stages 30 mm ID ACC

Fig. 4: Photographic view of 40 mm ID ACC

Dr. G. SAINATH
Metallurgy & Meterials Group
Indira Gandhi Centre for Atomic Research
Kalpakkam, Tamil Nadu, India

Lecture Series

Atomic-Scale Simulations of Deformation and Failure Mechanisms in Model Materials

Modelling and Simulations in Materials Science

Structural materials used in critical applications such as nuclear reactors, aerospace components etc., fail not because of what we see at the macroscopic level, but due to the events that begin at the scale of atoms (**Fig. 1**). While failure is observed macroscopically as fracture or plastic deformation, the underlying mechanisms are governed by atomic-level defects such as vacancies, dislocations, grain boundaries (GBs), and crack fronts (**Fig. 1**). These mechanisms span a wide spectrum of length and time scales, making them extremely challenging to probe by experiments alone. In this context, Modelling and Simulation methods have emerged as indispensable tools for uncovering these hidden processes. However, no single method can capture the entire micro-structural evolution across scales. This necessitate the need of multi-scale modelling framework, where atomic-scale simulations inform mesoscale and continuum-level models. Metallurgy and Materials Group (MMG) at IGCAR has been actively pursuing methods such as Density Functional Theory (DFT), Molecular Dynamics (MD), Dislocation Dynamics (DD), constitutive modelling, crystal plasticity, and finite element (FE) simulations to complement experiments and reveal mechanisms that are otherwise inaccessible.

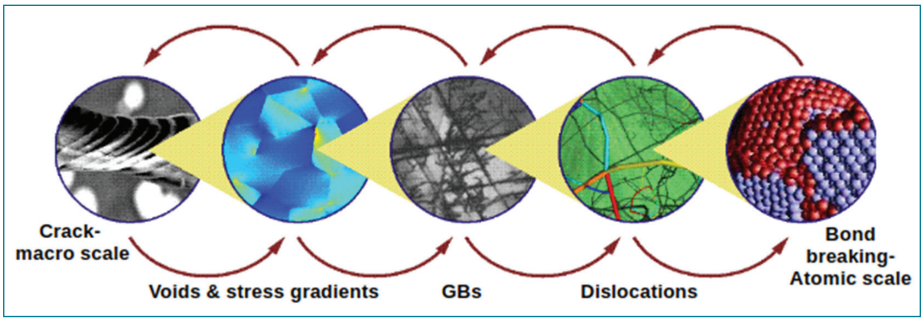


Fig. 1: Various length scale involved in material failure from bond breaking at atomic scale to crack at macroscale

This article, summarizing a recent lecture in the IGC Lecture Series, provides an overview of the crucial insights derived from atomic-scale simulations, specifically Molecular Dynamics (MD), into the fundamental mechanisms governing plastic deformation and failure in model BCC and FCC materials. Atomistic simulations employ interatomic potentials to compute atomic trajectories by integrating Newton's equations of motion, enabling a direct view into micro-structural evolution and the origins of material behavior.

Atomistic Simulations for Deformation and Failure Mechanisms in BCC Fe

Atomistic simulations performed on nanoscale BCC Fe reveal that the deformation mechanisms are strongly dependent on crystallographic orientation of the crystal, size, temperature, and the presence of defects. Under tensile loading, the orientations close to <100> axis deform mainly twinning mechanism, while orientations close to <110> axis deform by dislocation slip. On the contrary, these mechanisms get reversed under compressive loading; <100> crystal deform via slip of dislocations, while <110> crystal deform by twinning. This tension-compression asymmetry arises from the twinning-antitwinning asymmetry of 1/6<111> partial dislocations in BCC Fe. Energetically, the glide of 1/6<111> partial dislocations is allowed only in one direction (twinning) on {112} planes and the movement in opposite direction (anti-twinning) encounters high resistance. Our simulations clearly resolved the nucleation and glide of twinning partials, providing a detailed view of twin growth and dislocation multiplication mechanisms in BCC Fe.

BCC materials are known to exhibit Brittle to Ductile Transition (BDT) with temperature. To investigate the possibility of similar transition in nanoscale BCC materials, MD simulations were performed on BCC Fe at various temperatures ranging from 10 to 1000 K. The results indicate that, below 375 K, the fracture occurs in a brittle manner with negligible plastic deformation, whereas significant plastic deformation leading to ductile failure is seen above 400 K (**Fig. 2**). This transition has also been observed in defect nucleation, where crack nucleation is seen at low temperatures and dislocation nucleation is observed at higher temperatures. The reason behind this transition is the relative variation of yield and fracture strength with temperature. At low temperatures ($<$400 K), fracture stress is lower than the yield strength, leading to fracture before yielding, while at higher temperatures, the yield strength is lower than fracture strength resulting yielding before fracture. When the crystal dimensions are in nanoscale regime, size plays an important role on the deformation mechanisms. For investigating size effects, MD simulations were performed on $<100>$ and $<110>$ BCC Fe with size ranging from 1.615 to 24.7 nm. Results show that in extremely small size $<100>$ wires (d $<$ 2.5 nm), necking triggers the formation of pentagonal atomic chains, an interesting five-fold symmetry. In crystal with size in the range 2.5–11.42 nm, deformation proceed by twinning on a single twin system followed by complete reorientation and subsequent plastic deformation by slip. At higher sizes ($>$11.42 nm), twinning occurs on multiple twin systems, leading to

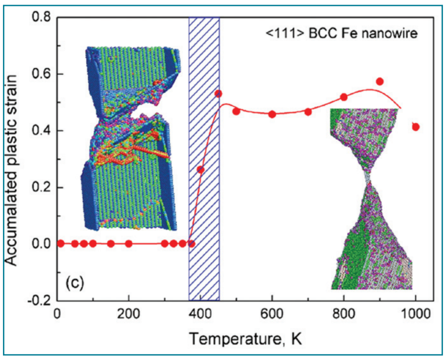


Fig. 2: Brittle to ductile transition in nanoscale BCC Fe with respect to temperature

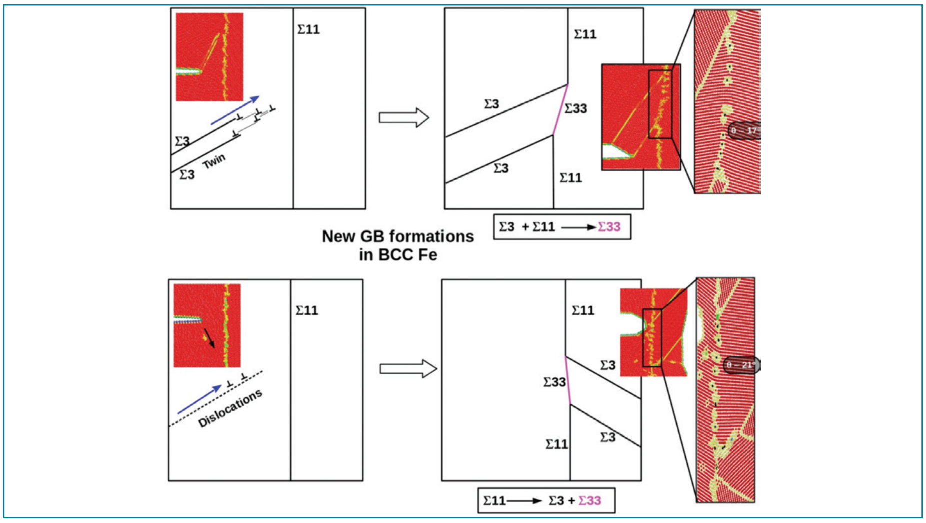


Fig. 3: Grain boundary (GB)-GB interactions in BCC Fe as revealed by atomistic simulations in BCC Fe

twin-twin interactions and brittle failure. On the contrary $<110>$ crystal, which deform primarily by dislocation slip, exhibit less pronounced size effects except higher cross-slip events in larger wires.

Grain Boundary (GB)-GB, Dislocation-GB and Crack-GB Interactions in BCC Fe

In addition to basic deformation mechanisms, MD simulations were performed to investigate the role of various Grain Boundaries (GBs), GB-GB, dislocation-GB and crack-GB interactions in BCC Fe. The results have shown that the presence of specially oriented GBs in BCC Fe can trigger complete de-twinning, involving the migration of a unique twin-twin junction. This results in the annihilation of existing GBs and significant local micro-structural changes. Further, the presence of special boundaries like $\sum3$ GBs enhanced the crack resistance of materials.

Employing atomistic simulations, a remarkable GB-GB interactions and unique GB reactions have been discovered in our study. The interaction of $\sum3$ GB with a $\sum11$ asymmetric GB produces a low angle $\sum33$ GB ($\sum3+\sum11=\sum33$) comprising an ordered array of edge dislocations (**Fig. 3**). Similarly, $\sum11$ asymmetric GB upon interaction with dislocations, dissociates into $\sum3$ and $\sum33$ boundaries through the reaction $\sum11=\sum3+\sum33$ (**Fig. 3**). Notably, symmetric $\sum11$ GBs remains stable, exhibiting no such transformations. These dynamic transformation of GBs highlight the ability of MD simulations to reveal atomistic mechanisms otherwise obscured in experiments.

Atomistic simulations were also performed to study the Twin Boundary (TB) interaction with twist GBs in BCC Fe. Results indicate that the TB can completely accommodate the dislocation network of a twist GB, revealing the intricate atomistic mechanisms. In BCC Fe, our MD simulations have revealed the three fold dissociation of screw dislocations, long predicted theoretically, but never observed experimentally.

Deformation Mechanisms and GB Interactions in FCC System

Like BCC system, MD simulations were performed to understand the deformation mechanisms and GB-GB interactions in FCC system taking Cu as a model. MD simulation results indicate that the presence of specific GB can suppress twinning by serving as nucleation sites for trailing partials, thus promoting slip. GB-GB interactions near the surface of the crystal produce five-fold twins, which are forbidden in bulk crystals (**Fig. 4**). However, local

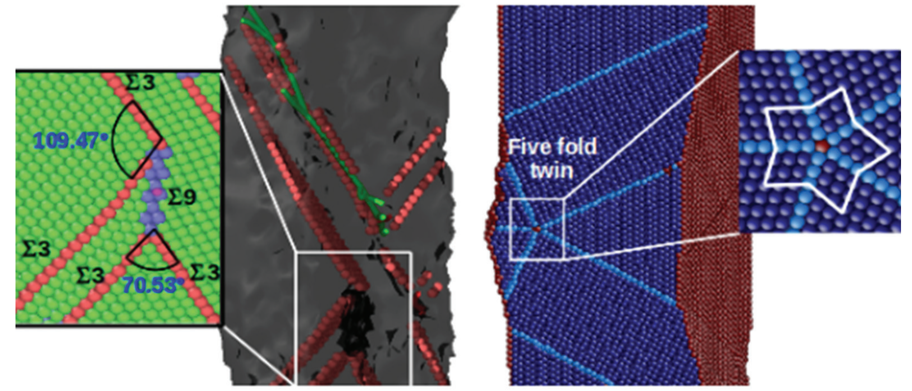


Fig. 4: Grain boundary (GB)-GB interactions leading to new GB formation and local symmetry breaking events in FCC system

stress fields and nanoscale dimensions enable such symmetry breaking events. We revealed $\sum3-\sum3$ GB interactions leading to new $\sum9$ boundary formation (**Fig. 4**) as per the reaction, $\sum3+\sum3 = \sum9$ and provided the complete atomistic detail of the underlying dislocation reactions. These kind of atomistic insights are impossible to extract experimentally.

MD simulations on FCC Cu have revealed the occurrence of double reorientation due to sequential twinning on different twin systems leading to extremely high failure strains. Another important discovery from our simulations is the continuous reflection of dislocations from the free surfaces of the crystal. Contrary to classical surface annihilation, dislocations get reflected continuously back to crystal interior due to the presence of high stresses on the surfaces. Variation of dislocation density as function of strain in Cu revealed presence of dislocation exhaustion and starvation regimes. Variation of these two regimes with respect to crystal size, temperature and strain rate has been studied in detail. Average length of dislocations in Cu has been found to be close to 2.5 nm, irrespective of crystal size and the width of the stacking fault is a strong function of thin film thickness. Increasing the thickness increasing the stacking fault width before reaching a saturation. Our simulations also revealed the conditions for various cross-slip mechanisms, like Friedel-Escaig and Fleisher mechanisms along with the detailed atomistic mechanisms involving constriction and stair-rod dislocations.

Atomistic Simulations on Polycrystalline Systems

MD simulations were performed on polycrystalline systems involving multiple grains and GBs. Polycrystalline models were prepared using Voronoi algorithm. Cyclic loading simulations performed on polycrystalline Cu revealed that, after certain cycles, GB migration dominates the fatigue deformation leading to coarsening of larger grains at the expense of smaller grains (**Fig. 5**). Further, TBs were found to be stable defects, whereas the remaining high angle GBs were highly unstable and degrade under cyclic deformation (**Fig. 5**). Among the boundaries studied, $\sum3(111)$ and $\sum9(114)$ remain stable, while $\sum3(112)$ and $\sum9(122)$ lose stability within 10 cycles. These results shed light on micro-structural stability during cyclic deformation at the nanoscale.

Conclusions and Future Directions

In conclusion, atomistic simulations have provided deep mechanistic insights into various deformation and failure mechanisms in model BCC and FCC systems. Deformation mechanisms such as twinning, twin growth, dislocation multiplication and cross-slip, failure mechanisms like brittle to ductile transition, formation of pentagonal atomic chains along with different twin-twin and GB-GB interactions, GB migration and transformations were revealed with atomistic detail. These findings offer valuable inputs for strengthening micro-structural models, designing of materials with enhanced properties, and guiding grain boundary engineering for developing materials with stable micro-structures. In near future, it is planned to extend these insights to explore more realistic polycrystalline micro-structures, exploring multi-component systems, radiation damage related studies and integrating into multi-scale modelling frameworks for predictive material design.

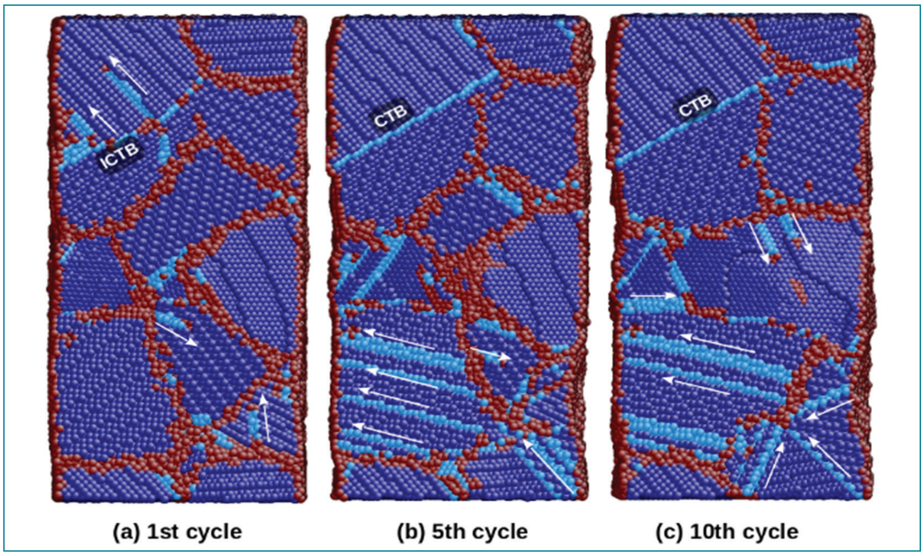


Fig. 5: Cyclic deformation in polycrystalline FCC system, revealing the grain growth mechanism and the stability of TB

Shri L. SURESH
Reactor Design Group
Indira Gandhi Centre for Atomic Research
Kalpakkam, Tamil Nadu, India

Lecture Series

Design of CSRDM, DSRDM and Hydraulically Suspended Absorber Rod for Fast Breeder Reactor

The Prototype Fast Breeder Reactor (PFBR) is equipped with two independent, fast-acting, diverse reactor shutdown systems. The Control & Safety Rods (CSR) are kept within the core under reactor shutdown conditions, and raising/lowering of CSR is carried out by their Drive Mechanisms (CSRDM) for start-up, power regulation, controlled shutdown, and emergency SCRAM. The Diverse Safety Rods (DSR) operated by Diverse Safety Rod Drive Mechanisms (DSRDM). The DSRs remain parked above the core and dropped into the active core region upon electromagnet de-energisation during SCRAM.

After a rigorous iterative process the design was validated through development and testing to meet the all functional, nuclear safety, regulatory, and mechanical/codal requirements. The qualification of CSRDM and DSRDM was completed in two stages. In the first stage, testing of critical components at the subassembly level, which includes the scram release electromagnet, hydraulic dashpot (CSRDM)/sodium dashpot (DSR), dynamic seals, and CSR/DSR components, was conducted individually under reactor-simulated conditions, along with studies on sodium vapour deposition in annular gaps. The DSRDM electromagnet design was challenging, requiring welding of magnetic soft iron with non-magnetic INCONEL-82 while ensuring leak-tightness and compliance with mechanical/thermal stress limits. It was tested in air, furnace conditions, and sodium. Tribology testing of the DSRDM magnet–armature interface showed no self-welding tendency. DSR prototypes were tested in flowing water for pressure drop and drop time. In the second stage, full-scale CSR/DSR assemblies and their respective drive mechanisms (CSRDM/DSRDM) under went integrated functional testing in air, hot argon (CSR/CSRDM only), and water (DSR/DSRDM), followed by extensive endurance testing in sodium under 30 mm misalignment(between CSR/DSR and CSRDM/DSRDM). These endurance tests in sodium accumulated to an equivalent of 1610 cycles for the CSRDM and 1150 cycles for the DSRDM at 823 K (550 °C). The campaigns successfully verified overall performance and qualified the CSR/CSRDM systems for 14 years and the DSR/DSRDM systems for 10 years of reactor operation. Later, CSRDM and DSRDM withstood Operational Basis Earthquake and Safe Shutdown Earthquake seismic loads while maintaining performance. Drop times increased under seismic loading but remained within design safety limits. After prototype testing, the 9 CSRDM and 3 DSRDM were manufactured, air-tested, installed in-pile, and commissioned in the PFBR. In-pile commissioning tests conducted in air/nitrogen at 150 °C and in sodium at 200 °C confirmed that all CSRDM and DSRDM met the acceptance limits with satisfactory results.

For future Fast Breeder Reactors, safety must be enhanced against Unprotected Transient Overpower (UTOP) and Unprotected Loss of Flow (ULOF) events. A Stroke Limiting Device (SLD) has been introduced as a mechanical add-on to the CSRDM to address an Unprotected Transient Overpower (UTOP) event. The SLD design was validated through rigorous endurance testing, and the resulting feedback was incorporated into an upgraded Mark-II configuration.

The Hydraulically Suspended Absorber Rod (HSR) is a fully passive shutdown system designed for future FBRs to address ULOF events. It should be actuated passively whenever the primary sodium flow drops below 50% of its nominal value. It shall also be released simultaneously with active control rods during normal scram for added reliability. Operated by the Hydraulically Suspended Absorber Rod Drive Mechanism (HSRDM), the ~36 kg boron carbide absorber rod in sodium is housed in a dedicated sub-assembly. The HSR comprises three parts: a head for sealing and lifting, a ~1 m cylindrical body with B_4C pellets in clad tubes within a thin sheath, and a

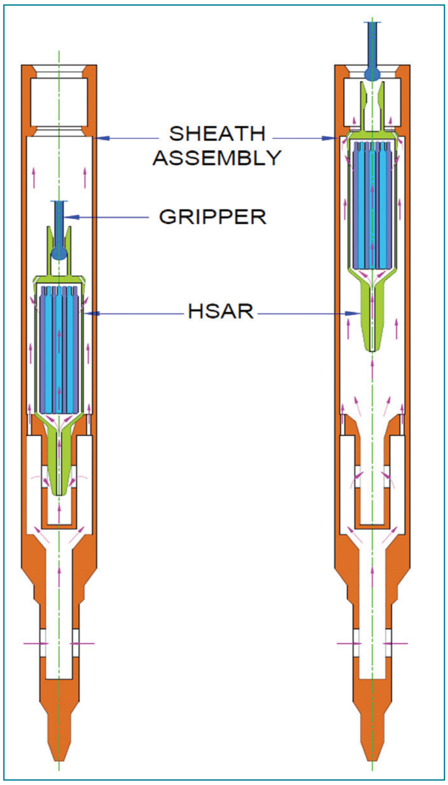


Fig. 1: HSR schematic

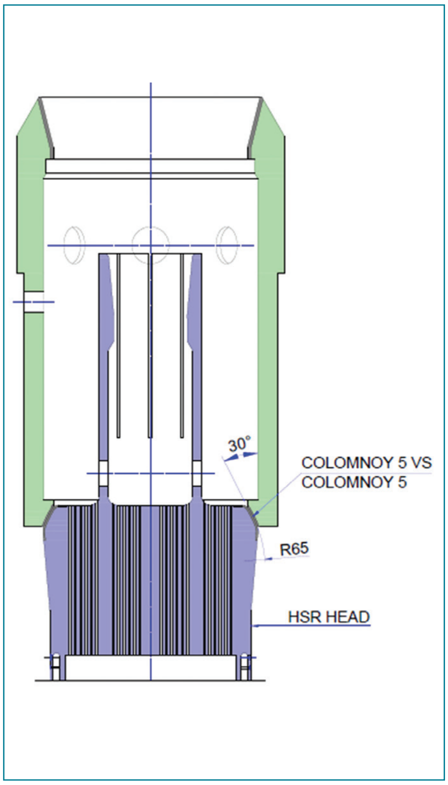


Fig. 2: HSR head seating arrangement

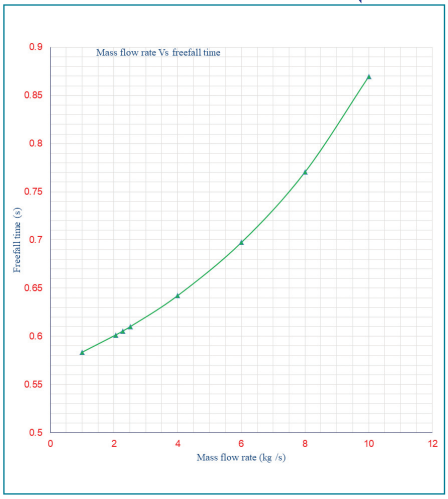


Fig. 3: Theoretical estimate of HSR free fall time

foot profiled for hydraulic braking in the sodium dashpot. The HSR subassembly features a hexagonal wrapper and foot identical to those of fuel sub-assemblies, with inlet orifices for flow control. During normal operation, the mechanism lifts the rod to its top parked position and releases the gripper. **Fig. 1** shows the schematic of HSR. The HSR then remains suspended solely by hydraulic force from upward sodium flow through a pressure-drop device in the HSR head. A spherical shoulder on the HSR head mates with a conical seat in the HSR hexagonal subassembly sheath head to form a leak-tight seal and generate the required pressure drop. Both the seating surfaces, i.e., the conical seat and the spherical shoulder, were coated with COLOMONY 5. **Fig. 2** shows the schematic of HSR head seating arrangement. Theoretical estimate of the free-fall time from the parked position to dashpot entry is 0.636 s, based on a lumped-parameter model with a 5% uncertainty margin. **Fig. 3** shows the plot of free fall time vs flow rate of HSR. Full-scale hydraulic tests were performed using water, confirming effective head sealing, suspension force, robustness against rod tilt, and reliable drop below the 50% flow threshold.

Shri Soumen Das
Materials Chemistry & Metal Fuel Cycle Group
Indira Gandhi Centre for Atomic Research
Kalpakkam, Tamil Nadu, India

Lecture Series

Development of Coating Protocols for Metal Fuel Casting and Characterizations

U-Zr alloys are melted in yttria coated graphite crucible at 1450 °C and subsequently are injection cast using yttria coated quartz tube. The coatings prevent carbon and silica ingressions during melting and casting stages, respectively. Different strategies are adopted to obtain adhesive coating on the graphite as well as quartz substrates. Deposition on curved surfaces experiences mechanical strains during deposition and annealing. It is observed that coatings on the interior surface involved growth induced wrinkles, ridges, folds, crack and tearing of adhesive films. These instabilities are ascribed to the improper wetting of the coating surfaces, drainage of the coating liquid and mechanical strains by the coated film due to the convex or concave curvatures. Chemical solution deposition method offers effective control over stoichiometry, effectiveness in covering large surface area, requirements of relatively less equipment and its economic viability. The deposition protocol can be replicated to coat a variety of protective coatings on different type of tubes, such as plastic, PVC, metal and glass, among others. This process can also be extended to coat multiple tubes simultaneously at room temperatures which offer a cost-effective advantage over other physical and chemical deposition process. We demonstrated the large area deposition of protective coating on the interior surface of multiple quartz tubes simultaneously.

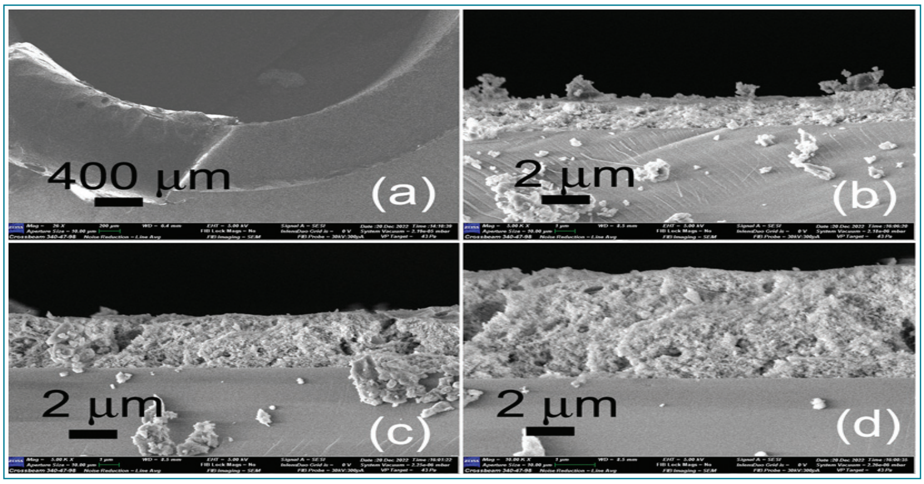


Fig. 1: View of Junction box, MHC, Earth pit and pole in the field

Given the difference in the coefficient of thermal expansion between graphite and yttria, in general, an intermediate coating, for example, SiC, or Nb, are deposited on the graphite surface to prevent the possibility of coating peeling off. Moreover, to reduce the solid waste and to reuse the graphite crucible, a modification of the deposition protocol without the requirement of intermediate coating was considered. In the present work a slurry based Y_2O_3-SiO_2-NaOH coating is developed. The role of NaOH and SiO_2 in the adhesive property is investigated by varying its relative compositions in the slurry. It is found that Y_2O_3 coating without mixture of NaOH or SiO_2 does not have proper adhesion. Y_2O_3 coating with lower concentration of NaOH (<5 M), or SiO_2 (<5 mM) can withstand a thermal cycle up to 1000 °C. In contrast, presence of a higher percentage of NaOH (>10 M) results in the coating absorbing moisture even after sintering at 1200 °C in Ar ambient. It is seen that multiple-steps annealing procedure significantly improve adhesion at 1200 °C and oxidation protection at 800 °C in O_2 ambient.

Additionally, composite oxide coating on SS316 used a guide rod in the continuous casting of U-Zr alloys at 1450 °C, barrier coating on SS430 electrodes used in electrorefining at 500 °C are being developed.

FBTR Ruby Jubilee Celebrations: 40 Years since First Criticality

On October 18, 2025, the Indira Gandhi Centre for Atomic Research (IGCAR) commemorated the Ruby Jubilee of the Fast Breeder Test Reactor (FBTR), marking 40 years of India's advancements in fast reactor technology. This milestone reflects the nation's commitment to self-reliance, innovation, and an exemplary safety record.

Since its first criticality in 1985, the FBTR has been a cornerstone of India's three-stage nuclear power programme. The 40 MWt / 13.6 MWe sodium-cooled, loop-type reactor operates with a high-performance mixed Pu-U carbide core. In addition to power generation, the FBTR serves as a leading research and development platform for irradiating structural materials and fuels, contributing significantly to the development of the Prototype Fast Breeder Reactor (PFBR) and laying the foundation for future commercial breeder reactors.

The commemorative event marking the Ruby Jubilee of the Fast Breeder Test Reactor (FBTR) was distinguished by the esteemed presence of Shri K.N. Vyas, Homi Bhabha Chair Professor and former Chairman of the Atomic Energy Commission (AEC), who served as the Chief Guest. The ceremony was graced by a distinguished assembly of senior dignitaries from the Department of Atomic Energy (DAE), including Shri Pradip Mukherjee, Chief Executive of BRIT, Shri K.V. Suresh Kumar, Chairman and Managing Director of BHAVINI, Dr. Komal Kapoor, Chairman and Chief Executive of NFC, Shri S.A. Bhardwaj, former Chairman of AERB, and Padmashri Dr. C. Ganguly, former Chief Executive of NFC. The event also honoured the legacy of the Indira Gandhi Centre for Atomic Research (IGCAR) with the presence of former Directors, Shri S.C. Chetal, Dr. P.R. Vasudeva Rao, Dr. S.A.V. Satya Murty, and Dr. B. Venkatraman.

The formal proceedings commenced with a welcome address by Shri S. Sridhar, Director of the Reactor Facilities Group, IGCAR, who paid homage to the late pioneering scientists and engineers who laid the foundation of the FBTR programme. Shri C.G. Karhadkar, Director of IGCAR, subsequently highlighted the FBTR's pivotal role in shaping and advancing India's fast reactor strategy. A commemorative coffee table book on the Fast Breeder Test Reactor was released during the event. In his keynote address, Shri K.N. Vyas lauded the milestone achievements of the FBTR and highlighted its pivotal role in showcasing India's indigenous capabilities in fast reactor technology, while significantly reinforcing the nation's pursuit of self-reliance in the nuclear sector.

A major highlight of the celebrations was the handover of the first batch of the radioisotope Phosphorus-32 (P-32), produced in FBTR, to BRIT. Generated through the irradiation of strontium sulphate pellets in FBTR, P-32 is widely used in radiopharmaceutical applications, underscoring the reactor's expanding contribution to societal welfare and healthcare.

The programme also featured reflections by pioneers closely associated with the FBTR's distinguished journey, including Shri G. Srinivasan, former Director, ROMG; Shri B. Rajendran, former Associate Director, ROMG; Dr. P. Swaminathan, former Director, EIG; and Shri C. Paramasivan Pillai, former Associate Director, BHAVINI. This was followed by the inauguration of a photo exhibition capturing four decades of technological milestones.

The celebrations concluded with a visit to the FBTR facility, during which veterans shared valuable experiences and insights.

Fig. 1: Shri S. Sridhar, Group Director, Reactor Facilities Group (RFG), IGCAR giving the welcome address to the gathering

Fig. 2: Shri C.G. Karhadkar, Director, IGCAR presenting the momento to the Chief Guest Shri K.N. Vyas, Homi Bhabha Chair Professor and former Chairman, Atomic Energy Commission and Secretary, DAE

Fig. 3: Felicitation of Padmashri Dr. C. Ganguly, former Chief Executive, NFC during the event

Fig. 4: Shri K.V. Suresh Kumar, CMD, BHAVINI and former Director, Reactor Facilities Group sharing his experience on FBTR

Fig. 5: Shri C.G. Karhadkar, highlighting various achievements of FBTR over 40 years of safe and smooth operation

Fig. 6: Release of FBTR Coffee Table Book on Operation & Maintenance experience of FBTR over the years

Fig. 7: The chief guest for the occasion, Shri K.N. Vyas, giving the keynote address

Fig. 8: Handing over P-32 Radioisotope to Shri Pradip Mukherjee, Chief Executive, BRIT by Shri C.G. Karhadkar

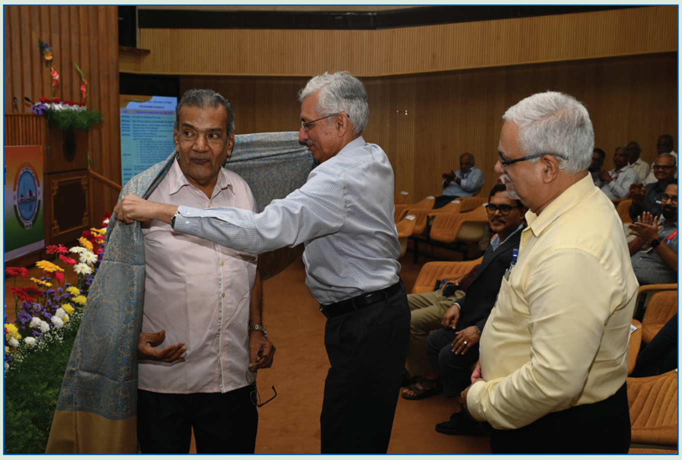


Fig. 9: Former Director Shri G. Srinivasan, ROMG being felicitated during the function by the Former Chairman AEC

Fig. 10: Former Associate Director Shri B. Rajendran, ROMG addressing the gathering

DECCAN CHRONICLE | SUNDAY | 19 OCTOBER 2025 | CHENNAI

FBR AT KALPAKKAM CELEBRATES 40 YEARS, SHOWCASES INDIA'S NUCLEAR PROWESS

Chennai, Oct 18: The Fast Breeder Test Reactor at the Indira Gandhi Centre for Atomic Research (IGCAR) near here marked its 40th anniversary on Saturday, highlighting a significant milestone in India's nuclear energy programme.

Located close to the Bay of Bengal in Chengalpattu district, the Fast Breeder Test Reactor stands as a 'shining testament' to indigenous scientific excellence and technological innovation.

"The 40th anniversary of achieving its first criticality of the Fast Breeder Test Reactor (in 1985) is a landmark achievement in India's pursuit of self-reliance in fast reactor technology," an official release said.

Designed as a test facility, the reactor has played a crucial role in advancing India's fast reactor programme by providing valuable operational experience and serving as a versatile Research and Development platform for irradiation studies on fuels and structural materials essential for future fast breeder reactors, it said.

K N Vyas, former Chairman of Atomic Energy Commission (AEC) took part in the function as the Chief Guest along with senior officials including IGCAR Director C G Karhadkar.

Vyas appreciated the dedicated teams behind the reactor's milestone achievements and emphasised its role in showcasing India's indigenous capabilities in fast reactor technology.

In his speech, IGCAR Director C G Karhadkar highlighted the Centre's achievements and underscored the Reactor's consistent record of safe and reliable operation over the last 4 decades, the release said.

A photo exhibition on the technological milestones of the reactor spanning four decades of research, commitment and technological excellence was also inaugurated by the officials. The occasion also marked the successful separation of Phosphorus-32 (P-32) - a radio isotope used for radiopharmaceutical applications and obtained from the irradiation of Strontium sulphate ($SrSO_4$) pellets in the Fast Breeder Test Reactor at the IGCAR, Kalpakkam for the first time, the release said. —PTI

THE NEW SUNDAY EXPRESS SUNDAY 19.10.2025

Kalpakkam celebrates 40 yrs of criticality of India's 1st FBTR

EXPRESS NEWS SERVICE @ Chennai

THE Indira Gandhi Centre for Atomic Research (IGCAR) in Kalpakkam celebrated completion of 40 years since the fast breeder test reactor (FBTR) first went critical on October 18, 1985. Conceived as a test bed for advanced fuels and materials, it has generated decades of operational data that informed the design of the prototype fast breeder reactor (PFBR) and future systems. The 40 MWt/13.6 MWe sodium-cooled reactor has been at the heart of India's indigenous fast breeder efforts.

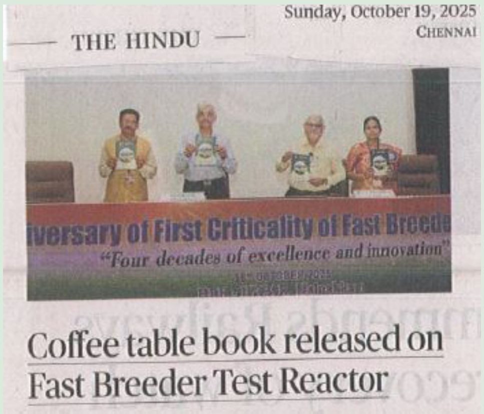
FBTR is unique in the global nuclear landscape, the only fast breeder reactor to use mixed plutonium-uranium carbide fuel. Its 70:30 plutonium carbide and uranium carbide

"FBTR's journey is synonymous with India's mastery of fast reactor technology," added S Sridhar, IGCAR director (Reactor Facilities Group).

The celebrations also marked the first successful separation of phosphorus-32, a key radioisotope used in cancer therapy, from irradiated strontium sulphate pellets. The isotope was handed over to the Board of Radiation and Isotope Technology.

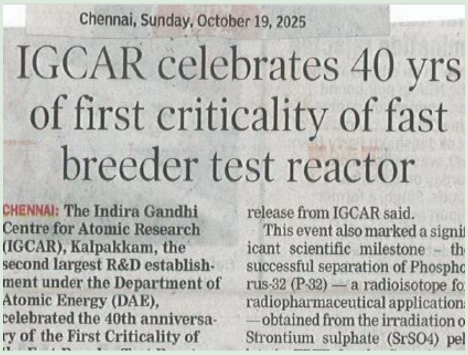
FAST BREEDERS AROUND THE WORLD

- Monju Fast Breeder Reactor in Japan was decommissioned in 2016 after a sodium leak and fire led to a prolonged shutdown.
- Rapsodie in France, a pioneering sodium-cooled reactor, operated for 15 years before being decommissioned in 1983



THE HINDU — Sunday, October 19, 2025 — CHENNAI

Coffee table book released on Fast Breeder Test Reactor



Chennai, Sunday, October 19, 2025

IGCAR celebrates 40 yrs of first criticality of fast breeder test reactor

CHENNAI: The Indira Gandhi Centre for Atomic Research (IGCAR), Kalpakkam, the second largest R&D establishment under the Department of Atomic Energy (DAE), celebrated the 40th anniversary of the First Criticality of

release from IGCAR said.

This event also marked a signif icant scientific milestone – th successful separation of Phospho rus-32 (P-32) — a radioisotope fo radiopharmaceutical application —obtained from the irradiation o Strontium sulphate ($SrSO_4$) pel

THE NEW INDIAN EXPRESS

India's first fast breeder reactor marks 40 years of critical operation

The 40 MWt/13.6 MWe sodium-cooled reactor has remained central to India's nuclear advancement, conceived as a test bed for advanced fuels and structural materials.

ANI

Government of India
Department of Atomic Energy
Indira Gandhi Centre for Atomic Research

IGCAR celebrates 40 years of fast breeder test reactor's first criticality

UNI UNITED NEWS OF INDIA

IGCAR celebrates 40 yrs of FBTR, marks significant milestone in India's Nuclear Energy Journey

Chenni, Oct 18 (UNI) The Indira Gandhi Centre for Atomic Research (IGCAR) at Kalpakkam about 70 km from here, the second largest R and D establishment under the Department of Atomic Energy (DAE), celebrated the 40th anniversary

Tags: #IGCAR celebrates 40 yrs of FBTR# **Please log in to get detailed story.** marks significant milestone in India's Nuclear Energy Journey

https://www.uniindia.com/igcar-celebrates-40-yrs-of-fbtr-marks-significant-milestone-in-india-s-nuclear-energy-journey/south/news/3615342.html

Fuel loading begins at Kalpakkam nuclear plant

Fig. 11: Newspaper clippings highlighting the 40 Year Celebrations of First Criticality at FBTR

FemTech 2025–26 at IGCAR, Kalpakkam

The Indian Society of Heating, Refrigerating and Air Conditioning Engineers (ISHRAE), Kalpakkam Chapter, in association with the Indian Women Scientists' Association (IWSA) and Indira Gandhi Centre for Atomic Research (IGCAR), successfully organized the FemTech 2025–26 on 16th December 2025 at the Sarabhai Auditorium, IGCAR, Kalpakkam. The theme of the programme was "Women in Technological Advances and Social Upliftment."

The half-day programme witnessed active participation from women professionals representing the Regional Meteorological Centre, ISHRAE National Headquarters, medical fraternity, and Department of Atomic Energy (DAE) institutions. Around 200 delegates, including women scientists, professionals, research scholars, and participants from the public domain, attended the event.

The inaugural session commenced with a welcome address by Smt. S. Rajewsari, Convener, FemTech 2025–26 and Head, MHCS, ACSD. This was followed by a presentation by Smt. N. Jayanthi, National Women Chair, ISHRAE HQ, who highlighted the role of women in ISHRAE and outlined the objectives of the FemTech initiative.

The programme was presided over by Shri C.G. Karhadkar, Distinguished Scientist and Director, IGCAR. In his presidential address, he emphasized the significant contributions of women across all spheres—from household responsibilities to advanced scientific research—and acknowledged their ability to take on challenging roles in national development.

Dr. B. Amudha, Director, Regional Meteorological Centre, Chennai, the Chief Guest, delivered an insightful talk on weather forecasting. She traced the historical evolution of the Meteorological Department since 1876, explained the mechanisms for issuing weather alerts to the public and fishermen, and highlighted the growing impacts of climate change.

The Guest of Honour, **Dr. S. Rajeswari**, Preventive Oncologist and Colposcopy Specialist, delivered a special lecture titled "Know Your Risk – Cancer Awareness." She emphasized the importance of early detection, awareness, and preventive healthcare measures.

The programme concluded with a vote of thanks proposed by Dr. Gurpreet Kaur, Treasurer, IWSA, Kalpakkam.

Overall, the FemTech National Programme fostered meaningful interactions among eminent speakers and participants and effectively promoted awareness on women empowerment across social, technical, scientific, and medical domains.

Reported by:
Marudhupandiaraja S.
President, ISHRAE Kalpakkam chapter 2025-26

Awards and Honours

Dr. Chanchal Ghosh of PMD/MCG, Metallurgy and Materials Group, has been awarded the 'Homi Bhabha Science & Technology Maanpatra' for the year 2025 in recognition of his outstanding contributions to the field of 'Materials Characterization'. The award was presented during the Founder's Day programme held at BARC on 30th October 2025.

Dr. E. Hemanth Rao, Head-SLS, SED, Fast Reactor Technology Group, has been awarded the 'Homi Bhabha Science & Technology Maanpatra' for the year 2025 in recognition of his outstanding contributions to the field of 'Experimental Thermal Hydraulics for Fast Reactor Safety Analysis'. The award was presented during the Founder's Day programme held at BARC on 30th October 2025.

Yasotha E, Madhusmita Panda, Shailesh Joshi, Annalakshmi O, EAD/SQRMG, Presented a poster in "National Conference on Luminescence and its Applications – 2025 (NCLA-2025)" during 7th to 9th December 2025 held at SSN College and received best poster award (Third Prize).

Bio-diversity @ DAE Campus, Kalpakkam

Green Bee-Eater

Green Bee-Eater is a grass-green colored bird with a long decurved beak, reddish-brown head and neck, pointed wings, and very short legs. They have a prominent narrow black necklace like the stripe on its throat. They catch their prey on the wing by making short, swift sallies like a flycatcher from an exposed perch such as treetops, branches, lamp posts, or telephone wire.

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