INDIAN INSTITUTE OF TECHNOLOGY MADRAS

DEPARTMENT OF MECHANICAL ENGINEERING |

Ph.D. Seminar Talk 1

Title of the Seminar: Graphene Platelet Exfoliation by High-Speed Jet-based Impact-induced Shearing of Graphite Particle Suspensions.

Speaker: Mr. Shahi Nabhan A K (ME23D020)

Ph.D. Research Scholar, Department of Mechanical Engineering, IIT Madras.

DATE & TIME	VENUE	ONLINE
27 November 2026, Tuesday, 03:00 PM – 04:00 PM.	Agaram Seminal Hall, Ranganathan Building, Manufacturing Engineering Section, Department of Mechanical Engineering, IIT Madras.	**Join via Google Meet:** https://meet.google.com/meet/oed-jcbj-wrf

Guide: Dr. Sathyan Subbiah, ME.

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ABSTRACT

Graphene is a two-dimensional (2D) atomically thin hexagonal arrangement of carbon atoms that exhibits exceptional electronic, thermal, and mechanical properties, making it highly promising for applications in electronics, energy storage, and composites. Depending on the number of layers and dimensions, graphene-based materials include few-layer graphene (FLG, 3–10 layers), multilayer graphene (MLG, more than 10 layers), graphene Nano sheets with lateral dimensions below 100 nm, and graphite Nano platelets (GNPs) with thicknesses up to 100 nm. Despite its broad potential, the large-scale production of high-quality graphene remains challenging. This study presents a simple and environmentally friendly mechanical exfoliation technique for producing FLG through high-speed impact-induced shearing in an aqueous medium. Graphite flakes dispersed in water containing a small amount of surfactant are pressurized and accelerated through a nozzle to impact on a hard-polycrystalline diamond (PCD) substrate. The high-velocity impact generates intense localized impact forces, shear stresses, and shear rates that promote the separation of adjacent graphite layers by overcoming their weak van der Waals interactions. The short interaction time and use of water as the processing medium provide an efficient and sustainable approach to mechanical exfoliation. The process was investigated at different impact velocities and over varying numbers of impact cycles. Characterization results confirmed shear-induced exfoliation, with higher velocities producing effective exfoliation within 10 cycles, whereas lower velocities required up to 50 cycles. At lower velocities, the additional impact cycles required for exfoliation promoted greater defect formation. In comparison, the higher-velocity condition produced graphene with a lower O/C ratio of 0.0284 and an ID/IG ratio of 0.13, compared with 0.0307 and 0.24, respectively, at lower velocity. These results demonstrate that controlled impact conditions can enhance shear-induced exfoliation while limiting excessive fragmentation and particle–surface interaction, thereby preserving graphene quality. The proposed approach provides a promising route toward high-efficiency exfoliation and improved yield under optimized impact conditions, with potential for scalable and environmentally sustainable production of FLG and GNPs for emerging applications.