INDIAN INSTITUTE OF TECHNOLOGY MADRAS

DEPARTMENT OF MECHANICAL ENGINEERING |

Ph.D. Seminar Talk 1

Title of the Seminar: Establishing the science and technology of gas-infused pulsated ultrasonic casting for A356 aluminium alloy.

Speaker: Mr. Nilesh Kumar (ME22D041)

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

DATE & TIME	VENUE	ONLINE
17 November 2026, Tuesday, 03:00 PM.	**Agaram Seminal Hall, Ranganathan Building, Manufacturing Engineering Section, Department of Mechanical Engineering, IIT Madras.**	Join via Google Meet: ----------

Guide: Dr. Sushanta Kumar Panigrahi, ME.

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ABSTRACT

A356 aluminium alloy is widely used in automotive and aerospace applications. It is commonly employed in piston cylinders, engine casings, cylinder heads, and other structural components. This is due to its low density, excellent castability, good corrosion resistance, and high strength-to-weight ratio. However, conventional gravity die casting (DC) often produces coarse dendritic α-Al grains, large and elongated eutectic silicon, intermetallic phases, and gas and shrinkage porosity. These defects affect mechanical performance, fracture resistance, and subsequent age-hardening behaviour. The present research establishes a novel casting technology, termed as Gas-Infused Pulsated Ultrasonic Casting (GIPUC). The combined effects of acoustic energy, gas injection and dynamically induced shear-strain deformation as integrated in the GIPUC, promote dendrite fragmentation, α-Al grain spheroidization, eutectic silicon refinement, and porosity reduction. The resulting microstructures after subsequent solution treatment and artificial ageing are further investigated to understand silicon dissolution and spheroidization, solute redistribution, precipitation kinetics, and strengthening mechanisms. Detailed microstructural characterization and transmission electron microscopy elucidate the underlying micro-mechanisms of microstructural refinement, phase evolution, precipitation strengthening, and deformation behaviour, establishing their relationship with the resulting mechanical properties. Compared with DC, GIPUC achieves significantly refined eutectic silicon, with large improvements in yield strength and ultimate tensile strength, respectively, and a 4-fold increase in ductility. Following T6 heat treatment, peak-aged GIPUC achieved extra ordinary strength and ductility synergy as compared to peak-aged DC. Overall, this research establishes the scientific know-how and technological framework of GIPUC as an advanced semi-solid casting process. It demonstrates its potential to produce A356 aluminium alloy with superior strength–ductility synergy and improved age-hardening efficiency for high-performance automotive and aerospace applications.