



Notice for the PhD Viva Voce Examination

Mr Nice Menachery, Registration Number: 2072702, PhD Scholar at the Department of Mechanical Engineering, School of Engineering and Technology, CHRIST (Deemed to be University) will defend his PhD thesis at the public viva-voce examination on Thursday, 14 May 2026 at 03.00 pm in CDI Conference Room, III Floor, Block V, Bangalore Kengeri Campus, Bengaluru - 560074, Karnataka,

- Title of the Thesis** : **Development and Characterization of hBN and Carbon Fiber Reinforced Precipitation Hardenable Al Alloy Hybrid Nanocomposites**
- Discipline** : **Mechanical Engineering**
- External Examiner - I** : **Dr V Anandkrishnan**
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- External Examiner - II** : **Dr B Anil Kumar**
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The members of the Research Advisory Committee of the Scholar, the faculty members of the Department and the School, interested experts and research scholars of all the branches of research are cordially invited to attend this open viva-voce examination.

Place: Bengaluru
Date: 04 May 2026

Registrar (Academics)

ABSTRACT

Materials with high specific stiffness, mechanical strength, and thermal stability are necessary for advanced engineering applications, especially in the automotive industry. Due to their favorable characteristics, aluminum alloys, particularly AA7050, are commonly employed; however, their wider applicability is limited by issues like low hardness, poor wear resistance, and high-temperature performance. To overcome these drawbacks, hybrid metal matrix composites (MMCs) have attracted significant attention, as they offer balanced improvements across multiple properties compared to single-reinforcement systems. In this study, a bimodal hybrid reinforcement approach is employed by incorporating nano hexagonal boron nitride (hBN) and carbon fiber (CF) into AA7050. Nano hBN (0–2 wt.%) is selected for its excellent solid lubricating behaviour, thermal stability, and chemical inertness, while CF (0.25 wt.%) enhances tensile strength and facilitates efficient load transfer. The composites are fabricated using spark plasma sintering (SPS), which enables rapid densification, refined grain structure, and shorter processing cycles. The hybrid composites demonstrate significant improvements in properties. Microhardness increases by 61%, compressive strength by 58%, and wear rate decreases by up to 50% under low-load conditions. Tribological performance improves due to the formation of a stable lubricating film by hBN and the frictional stability provided by CF. Further enhancement is achieved through precipitation hardening, where artificial aging results in a peak hardness increase of 124%. However, over-aging leads to precipitate coarsening and a subsequent reduction in hardness. Overall, the developed AA7050 hybrid composites exhibit superior mechanical and tribological, making them highly suitable for demanding structural applications.

Keywords: *Hybrid Nanocomposites, AlMMCs, Powder Metallurgy, Precipitation Hardening, Spark Plasma Sintering, Nano Hexagonal Boron Nitride, Carbon Fiber.*

Publications:

1. **N. Menachery**, S. Thomas, B. Deepanraj, and N. Senthilkumar, “Processing of nanoreinforced aluminium hybrid metal matrix composites and the effect of post-heat treatment: a review,” *Applied Nanoscience*, vol. 13, no. 6, pp. 4075–4099, Jun. 2023.
2. S. Thomas, **N. Menachery**, L. P. Thomas, S. N, P. Kumar G S, and G. S. Hebbar, “Influence of nano hexagonal boron nitride on the wear properties of aluminium alloy,” *Advances in Materials and Processing Technologies*, 10(3), pp. 2483-2499, 2023.
3. **N. Menachery**, S. Thomas, and B. Deepanraj, “Experimental Investigation of Nano Hexagonal Boron Nitride Reinforcement in Aluminium Alloys Through Casting Method,” *Proceedings of the 1st International Conference on Recent Advancements in Materials Science and Technology, Volume II, Springer Proceedings in Physics*, vol. 2, pp.311-318 2024, pp. 311–318.
4. **N. Menachery**, L. P. Thomas, S. Thomas, and B. Deepanraj, “Development and characterization of carbon fiber reinforcement in Aluminium metal matrix composites,” *Journal of Physics: Conference Series*, vol. 2837, no. 1, p. 012052, Oct. 2024.
5. **N. Menachery**, B. Deepanraj, and S. Thomas, “Characterization and analysis of carbon fiber and nano hBN reinforced hybrid Aluminium Metal Matrix Composites by conventional sintering,” *Turkish Journal of Engineering*, vol. 9, no. 2, pp. 378–384, Jun. 2025.