

**MICROSTRUCTURAL EVOLUTION AND
STRENGTHENING BEHAVIOUR OF IN-SITU
ALUMINIUM METAL MATRIX COMPOSITES BY
POLYMER INJECTION PYROLYSIS APPROACH**

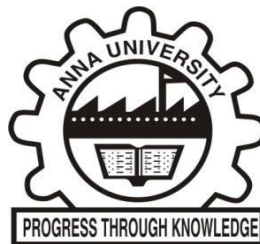
A THESIS

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ABSTRACT

Aluminium Metal Matrix Composites (Al-MMCs) grab significant attention among contemporary engineering applications as high potential, light weight alternatives of commercially used conventional metals like steel and copper due to the enhanced thermal stability and general properties like high fatigue and wear resistance. It also possess further more superior properties like hardness and toughness along with improved mechanical properties when it is incorporated with different reinforcements in to its microstructure.

The mechanical properties of MMCs that have undergone solidification processing can be weakened by particle agglomeration, severe interfacial reaction of ex-situ added particles and fluidity reduction. These problems have not yet been fully resolved. Therefore, an effort has been made to address the aforementioned difficulties in the in-situ synthesis of Al-MMC in the current work.

A new paradigm in the processing of in-situ metal matrix composites is represented by polymer derived metal matrix composites. More innovation may be sparked by the variety of polymer precursor selection and processing techniques. Melted metal can be mixed with the polymer precursor using a straightforward stir-casting method. The in-situ conversion of polymer to ceramic phases occurs by releasing volatile compounds at the temperature range of 400–1000°C within molten metal. Both oxides and non-oxide ceramics are derived from polymer precursors. The organic molecules themselves contain all the components of the ceramic phase, making the polymer precursors self-contained. Si-based polymer precursors are among the various types; they are typically non-toxic to the environment, can be stored in air, and are generally inflammable. The cross-linked polymer of polysilazane and polymethylhydrosiloxane precursor into molten Al can further simplify the casting process.

The first work falls with combination of pure aluminum with a addition of 2.5 vol.% SiCNO particles. In-situ Al-MMC were synthesized by stir-mixing, ultrasonication and squeeze casted at four different pyrolysis temperatures (675°C, 720°C, 800°C & 850°C). In order to understand the pyrolysis intensity, the wetting agent Mg is not incorporated at the pyrolysis temperature 720°C. According to microstructural data, the SiCNO particle's grain size and particle size decrease as the melt's temperature rises after the polymer is added. When fabricated composites are compared to pure aluminium, their strength properties increase by nearly 210% when fabricated at 850°C and only slightly by 17% when fabricated at 720°C. Studies using tensile fracture indicate that composites made at 675°C have a superior yield strength to ductility ratio. From the base of initial work, optimized pyrolysis temperature are chosen such as 620°C and 720°C. Al and A356 used as a matrix materials and Polysiloxane precursor used as reinforcement. Polysiloxane polymer precursor was cross-linked at room temperature with addition of catalyst DABCO -5%.

The cross-linked polymer were collected and wrapped in Al foil. The Polymer wrapped Al foil are then preheated and added gradually to Al matrix materials and ultrasonicated at 720°C and 620°C, poured in preheated mold. Similarly, A356 metal matrix composite were fabricated and ultrasonicated at both temperatures 720°C and 620°C and also compare with their base materials.

The 620°C conditions where ceramic particles evenly distributed in the matrix and enough diverse nucleation sites for α -Al in addition to the shearing action produced by the ultrasonication at semi solid state. However, composites fabricated in 720°C exhibits pores. The yield strength and tensile of the finished at 620°C composite were significantly higher than those of the parent material. The particles are segregated in grain boundaries, due to the solidification front. At 620°C SiOC incorporated A356 composites shows better time to rupture value comparing to semi solid processed base A356 alloy. Fractographic studies of stress rupture shows for ductile mode on 620°C- A356 +SiOC composites.