ABSTRACT

Electrical resistance heat assisted pressing technique can be effectively utilized as a solid-state surface modification technique for soft materials like aluminium for demanding applications in the automotive industry. The quantity of heat generated at the interface and the extent of diffusion of nanomaterials depends on the contact pressure, electrode geometry, magnitude of current and the duration for which the current is applied. In this thesis, the surface modification of Al-1100 alloy with electrical resistance heat assisted pressing technique is discussed.

The influence of various processing parameters and various carbonaceous reinforcements on the aluminium matrix has been investigated at the fundamental level. The effect of particle shape and size on the mechanical and tribological properties of aluminium matrix is also discussed. Initially, the surface alteration of Al-1100 alloy is carried out with insertion of two different sizes of graphite particles (Gr-01 & Gr-02). The detailed microstructural characterization, mechanical and tribological performance of the fabricated surface composites are critically analysed and reported. Among the two graphite particles, the surface composite with Gr-02 particles showed maximum surface hardness and wear resistance. The increased surface hardness is while attributed to the bonding between aluminium and graphite particles, the improved tribological behaviour is due to the self-lubricating behaviour of the graphite particles. The surface modification of aluminium alloy is also carried out with GNP particles and a detailed microstructural characterization, mechanical and tribological performance of the fabricated surface composites are also carried out. With GNP, the surface mechanical behaviour of the fabricated composite is noticed to be improved owing to the superior mechanical properties of the GNP particles and better bonding between aluminium and GNP particles. The improved tribological behaviour is because of the improved surface hardness and easy shearing of GNP layers which smears on the worn track avoiding direct metal-to-metal contact. The surface modification with CNT is also carried out and a detail study of the microstructure, mechanical and tribological behaviour of the surface composite is carried out. Here also improved mechanical and tribological properties are observed. The enhanced mechanical properties can be owed to the MWCNT particle‘s superior mechanical properties and better bonding between aluminium and MWCNT particles. The enhanced tribological properties is because of the improved surface mechanical properties and cylindrical structure of the MWCNT particles which rolled in between avoiding direct metal-to-metal contact. Finally, elucidating the particle shape and size effect it is observed that the

mechanical and tribological properties are drastically improved with smaller and 1D (MWCNT) structure of the particle.
Keywords: Solid-state processing, Surface modification, surface composites, graphite, GNP, MWCNT.