PREFACE

Particulate aluminium matrix composites (PAMCs) are promising materials for aerospace, marine and automobile applications in components such as cylinder blocks, pistons, brake, drums/rotors, cylinder liners, connecting rods, gears etc. due to their low density, high specific strength & elastic modulus, good high temperature properties & damping capabilities, high wear resistance, good electrical & thermal properties. These materials are replacing conventional aluminium alloys because these can be modified as per the need.

Chapter 1 presents aluminum matrix composites (AMCs), advantages of AMCs, applications, and fabrication techniques. It also embodies different types of wear and friction and their mechanisms. The objective of the present study is to develop the Al_3Zr/Al-Mg and ($Al_3Zr+ZrB_2$)/Al-Mg composites by the direct melt reaction *insitu* technique and to study the effect of different vol.% of reinforcements on morphology, mechanical and tribological properties.

Chapter 2 deals with brief introduction of equipment used for the characterization of the composites. Composites have been prepared under inert atmosphere by stir casting with bottom pouring arrangement. The formation of second phase particles in the composites was identified using X-ray diffractrometer and confirmed by energy-dispersive spectroscopy. Differential thermal analysis was used to find the reaction temperature of components. Optical emission spectrometer (OES) was used to evaluate chemical composition. Grain size, particle distribution crystal structure and dislocation studies were made by optical, scanning and transmission electron microscopes.

Theoretical and experimental densities, porosity were evaluated using standard procedures. Instron™ Universal Testing Machine, Brinell hardness testing machine and Multi-function tribometer were used for mechanical and tribological properties evaluation. SEM, EDS and 3D-profilometer were used for wear track study.

Chapter 3 deals with the fabrication of composites with different vol.% of Al_3Zr particles in the Al-Mg alloy, identification of reaction temperature was done by DTA, different phases were identified by XRD and compositional analysis by OES. Effect of vol.% of Al_3Zr particles on the mechanical and tribological properties was also studied. Morphology studies show grain refinement of Al-rich phase on incorporation of Al_3Zr particles. Mechanical test results indicate improvement in strength parameters with increase in the vol.% of Al_3Zr particles. Decreasing trend in strength is observed at higher compositions.

Presence of large Al_3Zr particles not only improves the wear resistance but also extends the working range in respect to applied load and sliding velocity. Hence, these composites can be used at higher loads/sliding velocities while being in mild wear regime, which widens their scope in different applications, especially the applications requiring low wear and high coefficient of friction.

Chapter 4 presents the synthesis of (Al_3Zr+ZrB_2)/Al-Mg hybrid composites and effect of ZrB_2 particles on morphology, mechanical and tribological properties of the composites. Presence of *insitu* formed nano size ZrB_2 particles in hybrid composites also refine Al-rich grains. UTS, YS and hardness of the hybrid composites shows remarkable improvement as compared to base alloy and even % elongation is improved. The contributing strengthening mechanisms in hybrid (ZrB_2+Al_3Zr)/Al-Mg composites are dislocation, Orowan, grain-refining & solid solution. Among these mechanisms solid-solution and Orowan are predominant strengthening mechanisms. Wear rate with load shows that load/sliding velocity range is extended in hybrid composites and these can be used at higher loads/sliding velocity while being in mild wear regime. This phenomenon is further extended with increase in vol.% of ZrB_2 particles. COF of hybrid composite increases with increasing vol.% of ZrB_2 particles.

Chapter 5 presents the effect of operating temperature (ambient temperature to 250°C) on tensile and tribological properties of base alloy and hybrid composite. Hybrid composite retains UTS almost equivalent to base alloy even at 200°C. The transition of mild to severe wear is shifted to higher temperature with incorporation of Al3Zr and ZrB2 particles in the Al-Mg alloy. Coefficient of friction increases continuously with test temperature. Mild/oxidative and severe/oxidative-metallic wear is observed at different combinations of parameters.

Chapter 6 summarizes the main conclusions on morphology, mechanical, and tribological properties of aluminium matrix composites with single and multiple reinforcement as discussed in different chapters of the thesis. In addition, tensile properties, wear and friction properties have been compared with earlier work and scope of the present work indicates its suitability in tribological applications especially in clutch and brake systems.