PREFACE

Increased demand of light weight and superior performance materials makes Particulate Aluminium Matrix Composites (PAMCs) a potential candidate for aerospace and automotive applications. PAMCs are extensively used in manufacturing of various components such as brake drums/rotors, cylinder liners, connecting rods, cylinder blocks, pistons, gears, drive shafts, suspension systems etc. These materials are replacing conventional aluminium alloys due to varied combination of properties like high wear resistance, low thermal expansion, and high strength to weight ratio, but the poor ductility is a bottleneck.

The present work has been divided into **six chapters. Chapter 1** presents a brief introduction about the origin of the work in the light of literature available. It discusses the wear process, wear mechanism, theories of wear and friction. Previous studies on microstructural, mechanical, dry sliding wear and friction properties of various aluminium matrix composites at ambient and high temperature are also presented.

To optimise wear and friction properties, AA5052 alloy having moderate strength, good corrosion resistance, low density, good weldability and formability has been chosen as matrix. ZrB_2 is an ultra-high temperature ceramic with high hardness, high melting point and high temperature strength has been chosen as reinforcement.

Chapter 2 deals with the synthesis of composites by *insitu* reaction technique. Composites have been prepared using a vertical muffle furnace with bottom pouring and stirring arrangement under controlled atmosphere of argon gas (99.99% purity). *Insitu* technique involves the production of ZrB_2 reinforcement particles on chemical reaction of inorganic salts (K_2ZrF_6 and KBF_4) with moltenAA5052 aluminium alloy at 860°C. Eight composites with different vol. % of ZrB_2 are prepared.

Different characterization techniques such as XRD, DTA, chemical extraction method for initial analysis while optical microscope, SEM, EDS, TEM are used for microstructure studies. Mechanical properties are evaluated by hardness tester and universal testing machine, and wear and friction are evaluated for different parameters by multi-function tribometer with profilometer attachment.

Chapter 3 presents physical, microstructural and mechanical properties of composites and alloy. Density increases with increase in vol.% of ZrB_2 while porosity remains within 4 to 7 %. Optical microscopy showed grain refinement with *insitu* formed ZrB_2 particles. SEM confirmed uniform distribution of ZrB_2particles. TEM studies revealed that ZrB_2 particles are mostly in nano-size with hexagonal or rectangular shape with clear interface and good bonding which contributed enhanced load bearing capacity of AMCs. Further, presence of dislocation in the matrix also contributes to hardness and strength.

With dispersion of ZrB_2 particles in base alloy, an improvement in ductility is observed which is contrary to many other composites. Contribution of Orowan, dislocation, grain-refinement and solid solution strengthening mechanisms is evaluated and it is observed that Orowan and solid solution are predominant strengthening mechanisms in these composites.

Chapter-4 presents tribological properties at room temperature. Wear and friction studies have been conducted for sliding distance, normal load, sliding velocity and composition. Worn surfaces have been studied under SEM and profilometer. Debris has been analysed by EDS. Results have been analysed and discussed with the help of morphology, surface studies and debris analysis. It is observed that at low sliding velocities and loads mild/oxidative wear mechanism prevails, while it becomes severe/oxidative-metallic at high sliding velocities and loads. With increase in ZrB_2 particles wear rate decreases and coefficient of friction increases indicating its importance in brake material.

Chapter 5 presents the tensile and tribological properties of composites at high temperature. UTS decreases with increase in temperature, whereas, % elongation improves. Composite with 9vol. % ZrB_2 retained 72% of its room temperature strength at 200°C. Wear and friction properties of composites were also carried out from ambient to 200°C temperature. It is observed that transition temperature of unreinforced alloy shifts from 100°C to 150°C with the addition of 9 vol. % ZrB_2 particles.

Chapter 6 summarizes the important findings of the present investigation and scope of future work.