

Abstract

This thesis evidences Magnesium-Boron Carbide Metal Matrix Composites as vital material for numerous tribological applications. Magnesium alloy (AZ31 Alloy) acts as matrix metal being one of the lightest structural materials. Magnesium alloy offers distinct advantages like ease of manufacturing, good machinability and lower latent heat of fusion. Consequently, AZ31 is considered as base matrix. Boron carbide (B_4C) submicron particle is chosen as reinforcement as it possesses excellent hardness ($3500\text{kg}\cdot\text{mm}^{-2}$), high melting point (2450°C), good elastic modulus (460 GPa), excellent wear resistance even at elevated temperature, justifiable thermo-chemical stability and superior thermal expansion coefficient, good wettability and viable shock absorbing capability. AZ31- B_4C composites are fabricated through ultrasonic vibration assisted stir casting technique due to its ability of effective and uniform dispersion of submicron size particles in magnesium alloy melt. Later on, synthesized cast composites are observed under optical microscopy (OM) and scanning electron microscopy (SEM) along with energy dispersive x-ray analysis (EDAX) and X-ray diffraction (XRD) study. Furthermore, micro-hardness of all submicron-composites is also investigated along with base matrix alloy.

Tribological behaviour of matrix alloy and composites is examined at various operating conditions including varied load, speed, sliding distance at ambient as well as elevated temperature. Nanoindentation and scratch tests are also performed to estimate nano hardness, elastic modulus and scratch behaviour of developed composites. Subsequently, composites and base alloy are inspected in 3.5% NaCl solution to evaluate corrosion characteristics. In addition, both SEM micrographs and EDAX spectra are analysed for worn and corroded surfaces of alloy and composites. In brief, tribological behaviour, nanoindentation response and corrosion characteristics of AZ31- B_4C composites are investigated. Characterization results validate inclusion of submicron particles (B_4C) along with good interfacial bonding between matrix phase and reinforcement phase. Hard ceramic B_4C particles improve load bearing capacity of composites and results in enhanced tribological properties at all operating conditions. Nano-hardness and elastic modulus upgrade continuously with incorporation of B_4C particles. Corrosion behaviour of AZ31 alloy enhances due to incorporation of B_4C particles. Incorporation of 1 wt.% of boron carbide particles effectively strengthen corrosion behaviour of AZ31 alloy but additional incorporation may result in deleterious consequences. It is anticipated that the results dispensed in the thesis will be beneficial to both academic and industrial community.