ABSTRACT

Aluminum matrix composites strengthened by both in-situ particle strengthening and in-situ alloying mechanisms has been studied here. Following the concept of in-situ particle strengthening and in-situ alloying, the aluminum matrix composites reinforced by Al_2O_3 particulates and alloyed with Zn and the same matrix reinforced by Al_2O_3 particulates and also alloyed with Cu and Mn have been obtained. The scanning electron microscopy shows that the in-situ Al_2O_3 particulates have a good cohesion with the matrix.

An optimum processing route to synthesis the Al/in situ Al_2O_3 composites with sound microstructure and improved physical/mechanical and electrochemical properties has been proposed. The reactive sintering process has been followed to process aluminum composites containing various weight percentages of Al_2O_3 particles. During sintering the reaction between Al and ZnO as well as Al, ZnO and CuO to form $Al_2O_{3(p)}$ dispersion in Al(Zn) and Al(Zn-Cu) matrix are confirmed by the XRD results. The densification of the composites during sintering has been investigated at 950°C/1150°C for the different sintering times. Sintering resulted in welding of pores. The hardness and density of the composite increase with the increasing sintering time and amount of reinforcement. The wear tests show that the wear resistance of the Al MMCs increases with the increase in the reinforcement weight percentages and sintering time.

Different approaches have been investigated to synthesize aluminum matrix composites by displacement reactions involving Al and metal oxide. They have been synthesized by reactive sintering, reactive milling followed by a thermal treatment and mechanical as well as thermal treatment process. Differential thermal analysis, X-ray diffraction and scanning electron microscopy have been used to study the various reaction mechanisms and transformations. Powder mixture (Al-10wt%ZnO, Al-20wt%ZnO, Al-10wt%ZnO-6wt%CuO, Al-20wt%ZnO-6wt%CuO, Al-6wt%MnO_2, Al-10wt%ZnO-6wt%MnO_2 and Al-6wt%MnO_2-6wt%CuO) have been subjected to a high-energy ball milling using tungsten balls and vial. The crystallite size and lattice strain in the powder particles have been determined using the X-ray

peak broadening techniques. TEM has been used for a direct measurement of the size distribution of the particles in sample. The milled sample has also been investigated by a differential thermal analyser (DTA) in the temperature range of 50–1000°C, with a heating rate of 10 °C min^{-1} in an argon atmosphere.

During mechanical milling there are no additional peaks besides ZnO, CuO, and MnO_2 peaks. The absence of the additional peaks indicates that no new crystalline phase has formed. Some of the CuO and MnO_2 peaks are hardly discernible in the patterns due to their low concentrations. The peak broadening indicates the crystallite size refinement and/or the introduction of lattice strains. Crystallite size of mechanically milled Al powders varies from 33 to 37nm. Each of the DTA traces shows an endothermic peak associated with the Al melting and an exothermic peak related to the reduction reaction. A high-energy ball milling of the powder modifies the reactivity of the system. A milling treatment not only reduces the reaction temperature, but can also induce a different reaction path. It is reported here that an appropriate mechanical-thermal treatment leads to the synthesis of aluminum matrix composites.

Mechanical milling process improves the distribution and homogeneity of the disperse phase in the matrix, but it also effects the morphology and matrix crystallite size to the unmilled but sintered composites. Pin on disc type apparatus has been used for determining the wear rate. It is proposed in this study that the wear resistance of the milled composites is better than that of the unmilled composites, since Al_2O_3 particle size plays the main role in bearing the external load, and there is a good interfacial cohesion between Al_2O_3 particles and the matrix. The influence of the high-energy ball milling on the corrosion behavior of aluminum matrix composites in 3.5wt%NaCl media has been investigated through electrochemical experiments. Polarization curves show that the milling procedure improves the composites corrosion resistance in the passive conditions.