Abstract

Aluminum based in-situ dual matrix composite with segregated microstructure has been synthesized from four different systems (i.e., Al-TiO_2, Al-TiO_2-B_2O_3, Al-ZrO_2 and Al- ZrO_2-B_2O_3) and subsequently characterized for the potential applications in aerospace and automobile industries. In-situ dual matrix composite consists of two distinct regions, i.e., reinforced rich area (i.e., RRA) and reinforcement lean area (i.e., RLA). The RLA is the continuous coarse-grained Al matrix and RRA consists of fine Al matrix reinforced with in-situ formed Al_2O_3 and M (where, M is Al_3Ti, TiB_2, Al_3Zr or ZrB_2). In-situ single matrix composite was synthesized by high energy ball milling of Al and TiO_2 powders for various milling times (i.e., 2, 6, 10 and 15h) followed by compaction at a pressure of 600 MPa and sintering temperature of 600 °C. The 10h milled powder gives the best combination of compressive strength and ductility for the Al-Al_2O_3-Al_3Tin composite. In order to produce in-situ dual matrix composite, the 10h milled powders were mixed with unmilled powders followed by rotor mixing for various times (10-30 mins). The hardness and compressive strength decrease, whereas the ductility and thermal conductivity increase with the increase in the mixing time. Considering all the properties, 10 h milling time and 30 min mixing time were fixed for the synthesis of dual matrix composite for the other three systems.

In an effort to improve the properties of Al-Al_2O_3-Al_3Ti composite by replacing the brittle Al_3Ti phase with TiB_2 phase, B_2O_3 was added to Al-TiO_2 powder in different mole ratios (B_2O_3/TiO_2 = 0, 0.5 and 1) and complete elimination of Al_3Ti was found at the mole ratio of 1. Hence, the B_2O_3/ZrO_2 mole ratio of 1 was also fixed to produce Al- Al_2O_3-ZrB_2 composite from Al-ZrO_2-B_2O_3 system.

The microstructure, mechanical properties (i.e., hardness and compressive strength), wear resistance and thermal conductivity of four different single (Al-Al_2O_3-Al_3Ti, Al- Al_2O_3-TiB_2, Al-Al_2O_3-Al_3Zr and Al-Al_2O_3-ZrB_2) and dual matrix composites (Al/Al- Al_2O_3-Al_3Ti, Al/Al-Al_2O_3-TiB_2, Al/Al-Al_2O_3-Al_3Zr and Al/Al-Al_2O_3-ZrB_2) were evaluated. The in-situ dual matrix composites show lower hardness and compressive strength, but higher fracture strain than those of in-situ single matrix composites. The in-situ dual matrix composites have better wear resistance than that of in-situ single matrix composites. Thermal conductivity measurements indicate that in-situ dual matrix composites have thermal conductivity which is 2-5 times higher than that of in-situ single matrix composites.