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Development of Al-5%Cu/Si_3N_4, B_4C or BN Composites for Piston Applications

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Abstract : The purpose of this research is to provide a competitive alternative to aluminum silicon alloys used in automotive applications. This alternative was created by developing three types of composites Al-5%Cu- (B_4C, BN or Si_3N_4) particulates with a low coefficient of thermal expansion. Stir casting was used to synthesis composites containing 2, 5 and 7 wt. % of B_4C, Si_3N_4 and 2, 5 of BN followed by squeeze casting. The squeeze casting process decreased the porosity of the final composites. The composites exhibited a fairly uniform particle distribution throughout the matrix alloy. The microstructure and XRD results of the composites suggested a significant reaction occurred at the interface between the particles and alloy. Increasing the aging temperature from 200 to 250°C decreased the hardness values of the matrix and the composites and decreased the time required to reach the peak. Turner model was used to calculate the expected values of thermal expansion coefficient CTE of matrix and its composites. Deviations between calculated and experimental values of CTE were not exceeded 10%. Al-5%Cu-B_4C composites experimentally showed the lowest values of CTE (17-19)·10-6 °C-1 and (19-20) ·10-6 °C-1 in the temperature range 20-100 °C and 20-200 °C respectively.

Keywords : aluminum matrix composites, coefficient of thermal expansion, X-ray diffraction, squeeze casting, electron microscopy,
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