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Corrosion behavior of extremely hard Al - Cu/Mg - SiC light metal alloy composites

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Abstract

In this study, hot-pressing technique was used to produce Al-5wt.% Cu-20vol.% SiC and Al-5wt.% Mg-20vol.% SiC particulate metal matrix composites. The powders were ball milled and the powder mixtures were hot pressed uniaxially under a pressure of 550 MPa at a temperature of 450°C in vacuum atmosphere for different holding times of 30, 60 and 120 min. A common observation was that the density of Al composites decreased slightly with increasing hot press sintering time. The Al-5wt.% Cu-20vol.% SiC samples exhibited maximum density of ~95.7% ρ_{th} (theoretical density) and Al-5wt.% Mg-20vol.% SiC composite was measured with maximum density of ~97.8 ρ_{th} after hot pressing for 30 min. The XRD and SEM characterization confirms presence of Al, SiC and $CuAl_2$ phases for Al-Cu-SiC. Whereas the microstructure of Al-Mg-SiC composite consists of $Al_{0.95}Mg_{0.05}$ solid solution phase along with SiC phase. Among all the compositions, a maximum hardness of 3.2 GPa was noted for the Al composites, which were hot pressed at 60 min. A comparison with the existing literature reveals the presently developed Al alloy composites exhibited superior hardness. Corrosion tests were carried out using potentiodynamic polarization and electrochemical impedance spectroscopy to study the corrosion behavior of both these hard composites in marine environment (3.5wt.% NaCl) at room temperature. The corrosion rate of the samples varied between 1.8 to 2.7 mpy (mils per year), particularly, Al-5wt.% Cu-20vol.% SiC composite showed better corrosion resistance. Further impedance spectroscopy analysis revealed that Al-Cu-SiC has relatively larger semi-circular diameter when compared to Al-Mg-SiC. These observations indicate that Al-Cu-SiC exhibits high polarization resistance than Al-Mg-SiC composite.

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