ABSTRACT

Microstructure, Mechanical and Electrical Properties and Fracture of Squeeze Cast Eutectic Al-1.8Fe Alloy

Y. Zheng1, A. Hu2, W. Shen3, S. Liu4, Z. Zhou5, J. Li6, H. Hu7, *
Department of Mechanical, Automotive and Materials Engineering
University of Windsor, Windsor, Ontario Canada N9B3P4
email: 1zheng1q@uwindsor.ca, 2 hu14l@uwindsor.ca , 3shen12a@uwindsor.ca ,4liu1114z@uwindsor.ca , 5zhou18m@uwindsor.ca, 6lijiaru@uwindsor.ca, 7, *email: huh@uwindsor.ca

As a light alloy, the eutectic Al-1.8Fe alloy prepared by conventional permanent steel mold casting (PSMC) was demonstrated its potential for electric motor application in battery-powered electric vehicles due to its high specific strength and electrical conductivity. But, the PSMC Al-1.8 alloy provided inadequate mechanical properties to cast parts with heavy cross sections due to the high level of gas and shrinkage porosity. In this research, the Al-1.8 alloy with a cross-sectional thickness of 20 mm was squeeze cast (SC) under an applied pressure of 90 MPa. For comparison purpose, a counterpart was made by the PSMC. The porosity of the SC and PSMC Al-1.8 specimens was evaluated by the image analyses and density measurements. The SC Al-1.8 alloy contained only 1.74%, whereas the counterpart had a porosity of 5.17%. The microstructure of the as-cast specimens was analyzed by the scanning electron microscopy (SEM) and energy dispersive spectroscopy (EDS). The microstructure analyses indicated that the cast Al-1.8Fe alloy consisted of the primary Al phase, eutectic Al phase, micron-sized eutectic Al-Fe phase, and nano-sized eutectic Al-Fe phase. The results of the tensile testing and electrical conductivity measurements showed that the mechanical properties includes ultimate tensile strength (UTS), yield strength (YS), elongation (ef), modulus, toughness, resilience, and electrical conductivity increased to 121.77 MPa, 41.67 MPa, 21%, 68.3 GPa, 17.2 MJ/m3, 12.71 kJ/m3, 51.49 %IACS from 85.99 MPa, 28.33 MPa, 15%, 63 GPa, 8.58 MJ/m3, 6.37 kJ/m3, 48.44 %IACS, as the casting process changed to the SC from the PSMC, respectively. The strain-hardening rate of the SC Al-1.8Fe alloy during plastic deformation was higher than that of the PSMC specimen. The fine microstructure and low porosity level should be responsible for the high mechanical properties and electrical conductivities of the SC sample. The observation via SEM fractography illustrated that the fracture behavior of the cast Al-1.8Fe was influenced by the casting process.

Key Words: Al-Fe alloy, Squeeze casting, Microstructure, Mechanical Properties, Electrical Properties