Thermal Residual Stresses in SiCw/Al Composite

Liu Qiuyun

(School of Materials Science and Technology, Harbin Institute of Technology, Harbin 150001)

Abstract The SiCw/6061Al composites were fabricated by squeeze casting method. Variations of thermal residual stresses with quenching temperature, cooling manner, aging time and the thermal-cold cycle process in thin specimens, and the distributions of thermal residual stresses along the distances from the surface and changes with heating temperatures in thick specimens were studied by means of X-ray diffraction(XRD). The effects of residual stresses on the microstructure, dimensional stability and age-hardening behavior were studied by SEM, TEM observations, and tensile test.

The results showed that there existed macrostress, microstress and thermal mismatch stress in SiCw/Al compo-site, and the presence of microstress and thermal mismatch stress has no influence on the measurement of macrostress, but the macrostress can affect the measured value of thermal mismatch stress.

Thermal residual stress induced during the composite fabrication process, will be further increased when the composite were subjected to the extruded, solution treatment and aged procedures. Thermal mismatch stress can be decreased by thermal-cold cycling treatment at the suitable upper and lower limit temperatures of thermal-cold cycle, but it can not be eliminated completely.

In thick specimens, the true thermal mismatch strain was equal to that of the measure value minus the strain caused by macrostress[which is $-\upsilon(\sigma_1+\sigma_2)/E$]. Compared to the thin specimens, the changing tendency of thermal mismatch stresses with quenching temperature in thick specimens were quite different, which might be caused by the effect of sub-layer and the macrostress on the relaxation behavior of thermal mismatch residual stress at the surface.

The value of residual compressive macrostress in thick specimens decreased with the distance from the surface increasing, and gradually turned into the residual tensile stress, the tensile stress enhanced continuously. Thermal mismatch stress and microstress reduced only nearby the surface, then with the distance from the surface increasing, they exhibited no considerable change.

The results of TEM observation showed that the dislocation density was very high in matrix of SiCw/Al compo-site, which were 10-100 times greater than that in unreinforced alloys.

Compared to the unreinforced alloy, the aging process of SiCw/Al composite was accelerated. TEM observations indicated that in the matrix of SiCw/Al composite, the quantities of precipitations were less than that in unreinforced alloy aged at the situation, and the sizes of precipitations were larger in the matrix of the composite. The reasons were the existence of higher dislocation density in the matrix of SiCw/Al composite, which can suppress the nucleation and promote the growth of precipitations.

Key words SiC whisker, aluminum matrix composite, X-ray diffraction, thermal residual stresses

导师:赵连城 姚忠凯 费维栋

联系人:刘秋云,博士后,中国科学院力学研究所 LNM 室,北京 100080

© 1994-2010 China Academic Journal Electronic Publishing House. All rights reserved. http://www.cnki.net