

ABSTRACT

This work investigates the ageing heat treatment effects on structural and mechanical properties of Al-Mg-Si alloy (Al-6061) at various ageing temperatures and time. The samples of Al-6061 were initially given solution heat treatment (SHT) at 500 °C for 2 h. The solution treated samples were then artificially aged at 140 °C, 160 °C, 180 °C, 200 °C and 220 °C for 4 hours and were rapidly quenched in water. Another set of samples was also given ageing heat treatment at 200 °C for 1h, 4h and 7h. The structural properties of Al-6061 before and after ageing treatment were studied by x-ray diffraction (XRD) technique. The surface morphology of the heat-treated samples was visualized by the scanning electron microscope (SEM). The hardness measurements were made through the Vickers hardness tester whereas the tensile properties were investigated by using universal testing machine (UTM). The XRD results showed Mg_2Si diffraction peaks that appeared due to the ageing heat treatment of the samples. The Mg_2Si precipitates peaks became more significant with increase of the ageing temperature up to 200 °C. The crystallite size of Mg_2Si precipitates was increased with increase of the ageing temperature. The SEM results also validated the formation of precipitates particles in the aged samples. The Vickers hardness of Al-6061 was increased with increase of the ageing temperature to 200 °C, however the hardness was decreased as the ageing temperature was increased up to 220 °C. Similarly, the values of yield stress and ultimate tensile stress were found to be maximum at 200 °C/4h, followed by a decrease in the percentage elongation of the samples. At 220 °C/4h, the hardness and strength of Al-6061 were decreased. Similarly, the hardness and tensile measurements of Al-6061 aged at 200 °C for different durations revealed their maximum values at 4h ageing time. As the ageing time was increased to 7h, the hardness and strength of the material were decreased. The increase of the Al-6061 strength and hardness after ageing heat treatment was ascribed to an increase in the resistance offered by the Mg_2Si precipitates to the dislocation motion during deformation that became more effective as the ageing temperature was increased up to 200 °C. However, as the ageing temperature was increased to 220 °C, both the hardness and strength of the alloy were decreased due to coarsening of the Mg_2Si precipitates. Similarly, the over-ageing of the samples aged at 200 °C for 7h was responsible for a decrease in the strength of the material.

The SEM fractographs indicated uniform dimples that were changed to a flat surface with increasing the ageing temperature above 180 °C.