ABSTRACT

A majority of aluminium scrap have differences in chemical composition. Consequently, this makes the quality of recycled cast aluminium alloys to be questionable due to difficulty in chemistry control. This subsequently affects the microstructure and the general mechanical properties of these resulting products. Therefore, during aluminium recycling, it is vital to look for means of maximising the chemistry control of the alloy so as to improve the process efficiency.

The aim of this project was to contribute towards efficient aluminium recycling through the development of a model recycle friendly alloy for cylinder applications utilising direct recycling of automotive aluminium wheels. Four alloys were developed as a result of four ingots (obtained from recycled automotive wheels) being alloyed with strontium, titanium, zirconium, vanadium and copper in different proportions. The effect of these elements individually and in various combinations on the formation of intermetallic compounds was evaluated using microstructure analysis (optical, and SEM) and mechanical tests (tensile test, and fatigue tests).

The tensile tests at room temperature showed that alloy additions increased the ultimate tensile strength by as much as 31 % (from 218 MPa in alloy 356 to 285 Mpa in alloy 356+3.5Cu+X) while the fatigue strength increased by 37 % (from 71.35 MPa in alloy 356 to 98.05 MPa in alloy 356+0.5Cu+X). The alloying elements added formed compounds like (AlSi)xTiVZr, with rod/blocky morphology which precipitated into very fine precipitates after heat treatment that impeded the movements of dislocations thereby increasing the strength of the alloys.

With increasing the testing temperature from 25 °C to 237 °C, tensile strength drastically decreased by up to 30 % from 218 MPa in alloy 356 at room temperature to 152 MPa realised when the same alloy was tested at 237 °C. However, all is not lost since the addition of Cu, Ti, V, Zr and Cr improved the high temperature strength of the base alloy (alloy 356) from 152 MPa to 198 MPa in alloy 356+3.5Cu+X.

Fractographic analysis after fatigue and tensile testing was done to investigate the crack initiation and propagation mechanisms. The fractographic studies revealed that the fracture characteristics were similar for all alloys. Some intermetallics and eutectic silicon particles were deboned from the matrix which was accompanied by secondary cracks between dendrites, and tear ridges. This suggests that there was a strong interaction between the dislocations and the eutectic silicon particles especially at grain boundaries leading to a contribution to inter-granular cracking.