Precipitation observation of Al-1.0mass%Mg_2Ge alloys with different elements

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The Al-Mg-Ge alloy is one of the age-hardening aluminum alloy after solution heat treatment. And alloys are treated as Al-Mg_2Ge quasi-binary like Al-Mg_2Si alloys. The precipitates are Matsuda et al. reported that needle and shape precipitation has been observed in Al-Mg-Ge alloy, and Ge could be good substitutional or better element for Si in Al-Mg-Si alloy. In Al-Mg-Ge alloy, it showed a better age-hardenability at the high aging temperatures and a different precipitation sequence when it compares to Al-Mg-Si alloy[1)]. It is worth to research the effect of alloying element to precipitation sequence and mechanical properties for use of industrial purpose, however, only few reports are available. The aim of this research is to understand the effect of alloying elements on age-hardening behavior and mechanical property variation of Al-Mg-Ge alloy.

The chemical compositions of the alloys are Al-0.43%Mg-0.20%Ge (at. %) alloy (base alloy). And 7kinds of alloys with alloying elements of Ag, Cu, Cr, Si were prepared in this research. Alloys were fabricated using casting, then, they were subjected to homogenization treatment at 673K for 21.6ks before extrusion. During extrusion, alloys were deformed from 30mm of bar to 1.5mm thickness of plate. Solution treatment was conducted at 873K for 3.6ks. Aging treatment was carried out at the temperatures of 473K using oil bath. Vickers microhardness measurement was conducted to estimate the mechanical properties of alloys using Mitutoyo HM-101(load: 0.98N, holding time 15s). The hardness for each condition is given as an average of 10 indentations. To observe microstructure, TEM was used. TEM samples were prepared electron-polishing using 10% $HClO_4$ and 90% ethanol solution at 253K. TEM observation was conducted using Topcon, EM-002B with accelerated voltage of 120k

The hardness in the 8 alloys during the aging at 473K up to peak hardness shows that every alloy with Cu containing, maximum hardness increased compared to base alloy. With Ag addition, hardness increased quickly at the initial stage of aging. In the case of Ag-Cu-Cr-Si added alloy shows the highest hardness values. The microstructure observation aged at 473K for peak aging, needle or rod-like precipitation that along <100>Al was observed. In Cu-added alloy, the cross section of some needle or rod-like shape precipitation was elongated. All alloys of Ag-Cu-Cr-Si added alloy showed the higher density of precipitation than base.

1) K. Matsuda, T. Munekata, T. Kawabata, Y. Uetani and S. Ikeno: Journal of J. Inst. Light Metals, 56, 680-684, 11 (2004).