Microstructure observation in Al-Zn-Mg-(Cu) alloys with high Zn concentration

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Al-Zn-Mg alloys (7xxx series alloys) are known as the strongest aluminum alloy and, have been traditionally strengthened by dispersed fine precipitates through aging treatment. The precipitation sequence is reported like: S.S.S.S. -> G.P.zone -> Φ#183;' -> Φ#183;($MgZn_2$) . The Φ#183;' phase has been referred as the main hardening phase in Al-Zn-Mg alloys. Lee et.al have investigated Al - Zn - Mg alloys with different ratios of Zn/Mg to understand the inuence of the Zn/Mg ratios on age-hardening, microstructures and precipitates. They concluded that alloys containing higher ratios of Zn to Mg revealed higher peak hardness, ultimate tensile strengths, 0.2% proof stresses and higher number densities of precipitates per unit area. Also, Watanabe et.al reported that Cu addition in Al-Mg-Zn-Si alloy can increase the hardness at the initial stage of aging and peak aging.

In this work, It was investigated that Al - Zn - Mg alloys with different Cu concentration to understand the effect of Cu addition on Al-Zn-Mg alloy of using transmission electron microscopy and to estimate the mechanical properties.

All samples have the ratio of Zn/Mg is 2.0 with different Cu concentration were prepared by casting. Solution heat treatment was conducted at 748K for 3.6ks, and then quenched in cold water. The alloys were subjected to articial aging at 423K using oil bath. Micro-vickers hardness was measured using Mitutoyo HM-101 (load: 0.98 N, holding time 15s). Tensile test was performed using peak-aged samples with the strain rate of 1.0 X $10^{-3}s^{-1}$ at room temperature using Instron type tensile machine. Fractured surfaces were observed by scanning electron microscopy (SEM, HITACHI S-3500). Transmission electron microscopy (TEM, Topcon EM-002B) observation was conducted under the accelerated voltage of 120kV.

Result of tensile tests Micro-vickers hardness tests, with increase of Cu addition, not only hardness increasing rate becomes faster at the initial stage of aging, but also maximum hardness level increases. Result of tensile tests, Ultimate tensile strength and yield strength increased with increasing concentration of Cu. While, elongation decreased with increasing concentration of Cu. In SEM observation, all alloy's fracture mode show mainly transgranular fracture and a part of fractured specimen were intregranular fracture.

Close inspection of TEM bright field images from peak-aged alloys at 423K, fine precipitates were well dispersed on grain inside in all alloys. The shape of precipitates was granular and elongated. The precipitates of Cu addition alloys were finer than that of Cu free alloy. In grain boundary, grain boundary precipitates and precipitate free zone was observed in all alloys. The grain boundary precipitates were coarser than precipitate of grain inside.