

TEM observation of Al-2.5mass%Li(-2.0mass%Cu) alloys deformed by HPT (high pressure torsion)

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Severe plastic deformation (SPD) processes attracted attention in recent years as a method of grain refinement. High-pressure torsion (HPT) process can introduce the large amount of strain continuously compared to other SPD processes. Al-Li alloys has low density and are strengthened by dispersed fine precipitates through an aging treatment, traditionally. They have been used as aircraft materials. It is known that the addition of Cu to the Al-Li alloy precipitates the $T_1(Al_2LiCu)$ phase. The intension of this research is to investigate the effect of Cu on Al-Li alloys on grain refinement using HPT process and aging behavior using aging treatment.

In this research, two kinds of alloys (Al-2.5%Li, Al-2.5%Li-2.0%Cu alloy in wt. %) were prepared by casting. Alloys were subjected to homogenization treatment at 808K for 12h, then, they were undergone hot-rolling to the thickness of 1.2mm. Disks with 10mm diameter were cut from the sheets using electrical discharge machine (EDM). The discs were solution treated at 833K for 3.6ks at Ar atmosphere, then quenched into ice water. The solution treated discs were subjected to HPT process under an applied pressure of 6GPa for 5 revolutions with a rotation speed of 1 rpm at room temperature. Aging treatments were conducted on the HPT-processed alloys at 423K for a total time period of up to 600ks.

The Micro Vickers hardness measurement was conducted on mechanically polished surface of the disks. Each hardness measurement was performed by using a load of 100g for 15s. After HPT process, hardness increased significantly compared to as-quenched (asQ). During aging treatment, Al-Li-Cu alloy reached peak aging at 0.48 ks (8 min), however, Al-Li alloy did not change the hardness level at the initial stage of aging, then hardness started to decrease.

The microstructures of the disks were observed using a TOPCON EM-002B transmission electron microscope (TEM) operating at 120kV. The samples were thin disks electrochemically polished with a solution of 75vol.% methanol and 25vol.% nitric acid. In asHPT sample, i.e. no aging treatment, δ' (Al_3Li) phase was observed. With increase of aging time, it was possible to observe the coarsened δ' phase in both alloy and T_1 phase in Cu added alloy.