Al-Mg-Si alloys are known as the age-hardening alloy. Addition of transition elements and thermo-mechanical treatments have been reported as methods to improve the mechanical properties of these alloys[1]. Ultrafine-grained (UFG) materials produced by SPD have attracted considerable attention over the last decade because of their superior mechanical and physical properties. HPT is an attractive processing route because there is good evidence that it leads to a greater refinement of the microstructure and to a higher incidence of high-angle boundaries. The HPT samples, in the form of disks with diameters in the range of ~10 mm, are held between anvils and subjected concurrently to a high pressure and torsional straining [2]. The aim of this study, to study the effect of HPT on aging behavior and microstructure in Cu-added excess Mg-type Al-Mg-Si alloys by means of hardness tests and TEM.

The Al-1.1%Mg-0.4%Mg alloys (at.%) including Cu were obtained by the laboratory casting. The specimens were solution heat treated at 848K for 3.6ks in an air furnace, quenched in chilled water and subsequently HPT processed or rolled, followed by an aging treatment at 343 and 373K for different periods. The specimens were processed by HPT using imposed pressures of 6.0GPa for 5 rotations at a rotation speed of 1 rpm. The Micro vickers hardness was measured using Mitutoyo HM-101 hardness tester. After the aging treatment, samples were polished by using electrolytic solution (perchloric acid: ethanol=1:9) for making thin films for TEM observation. The microstructure was observed using TEM(TOPCON EM-002B) operated at 120kV.

Fig. 1 shows the age-hardening ability (ΔHV) of HPT processed ex.Mg-type alloys aged at 373K. ΔHV is the difference between each point of the value of hardness and the hardness of as HPT. ΔHV increases in aging treatment at 373K in Fig. 1. ΔHV is high in order of ex.Mg, ex.Mg-0.2%Cu and ex.Mg-0.7%Cu alloy. This is regarded as influence of amounts of the additional element. These results were same as the result on aging treatment at 343K.

Fig. 2 shows the bright field images of HPT-processed ex.Mg-0.7%Cu alloy aged at 373K for 6000 ks. Some fine-grains were observed, and a few dislocations in the crystal grain were observed. The typical needle-shaped precipitates of Al-Mg-Si alloys were not observed in the matrix. But precipitates were observed on grain boundary. β, S and Q phase were observed from the analysis of SAED ring pattern.

References
Fig. 1: Age-hardening ability of HPT-processed ex. Mg-type alloys aged at 373K.

Fig. 2: The bright field image of HPT-processed ex. Mg-0.7%Cu alloy aged at 373K for 6000 ks.