## Investigation of deformation mechanism in ultra-fine grained metals by In-situ XRD

Hiroki Adachi : Univ. of Hyogo, Yoji Miyajima : Tokyo Inst. of Tech., Masugu Sato : JASRI

Recently, it has been reported that the strength of ultra-fine grained (UFG) aluminum is several times higher than that of coarse-grained (CG) aluminum and that UFG aluminum exhibits unique mechanical phenomena in pure aluminum etc., under tensile deformation. This implies that dislocation behavior in UFG aluminum differs from that in CG aluminum. In this research, change in dislocation density during tensile deformation and the effect of grain size were investigated by in-situ X-ray diffraction using SPring-8 synchrotron facility. 99% purity aluminum was severely deformed by accumulative rolling-bonding and the sheets with grain size of 500nm were fabricated. The samples were annealed to change the grain size. For these samples, dislocation density change during tensile deformation was investigated by In-situ XRD measurement at BL19B2 or BL46XU in SPring-8 with time resolution of 2 s. As a result, the dislocation density changed in four stages with increase in tensile strain. The first stage was the elastic deformation region and the dislocation density hardly changed. When the stress reached $\sigma_I$, the region shifted to region II and the dislocation density rapidly increased and the plastic deformation started. This stage was the elastic-plastic deformation region. When the stress and the dislocation density reached to $\sigma_{II}$ and $\rho_{II}$, respectively, the region shifted to region III and the dislocation density change became moderately. In this region, tensile strain was mainly produced by plastic deformation. In the last region, by the unloading with the fracture, the dislocation density rapidly decreased. This implies that in UFG metals, it is difficult to reveal the origin of unique mechanical properties by ex-situ microscopy observations because the dislocation density during deformation is significantly differed from that after unloading. In CG aluminum with the grain size of 20μm, dislocation density changed in four stages shown in Fig.1. Though, in CG aluminum, $\sigma_I$ was close to $\sigma_{II}$ and region II was quite narrow. This is because the dislocation density necessary for the progress of elastic deformation is quite lower than that in UFG aluminum.

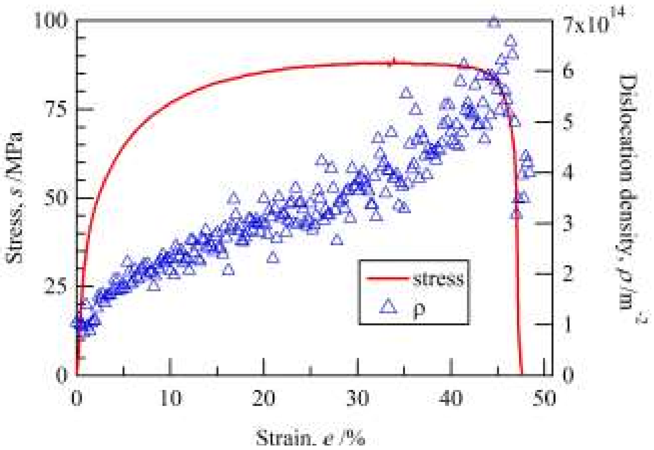


Fig.1 Dislocation density change in coarse-grained Aluminum during

**Bibliography**

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