Deformation induced nanoscale structural inhomogeneity in bulk metallic glass

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Bulk metallic glasses (BMGs) show no plastic elongation under tensile stress. This mechanical behavior strictly limits the application field of BMG. Recently, we found that the severely deformed Zr50Cu40Al10 (at%) BMG using HPT process shows tensile plastic elongation. We also found that this mechanical property improvement is closely related to the β-relaxation induced by the severe plastic deformation.

In order to understand such phenomenon, we have to understand the structure of the BMG. Recently, we found that the microstructural evolution can be observed as the increase in small scattering intensity, and the variation of scattering intensity upon annealing correlated with β relaxation behavior. Furthermore, by comparing the scattering intensities obtained by using two different probe (i.e., X-ray and neutron), it is suggested that deformation induced microstructure have lower density and higher Cu content compared with matrix. However, the information about the size or number density of such microstructure could not be determined owing to the limited Q range. Furthermore, thermal behavior of deformation-induced microstructure is still unknown. The aim of this experiment is to evaluate the size of deformation induced microstructure in the BMG upon annealing by measuring low-Q SANS profiles.

All measurements were performed at room temperature. The disk-shaped Zr50Cu40Al10 samples were HPT processed with a revolution number of 50 under an applied pressure of 5 GPa. To investigate the thermal behavior of deformation-induced microstructure, we also measured the samples annealed after HPT process at annealing temperature of 473 K for various time (3h and 14 days).

Figure shows SANS profiles of samples before and after the HPT process. The as-cast sample is a non- deformed sample prepared by casting process. Annealing treatment of as-cast sample (as-relaxed) caused no change in scattering intensity, indicating that as-cast sample has no nanostructure which detectable by SANS technique. The increase in scattering intensity after the HPT process indicates a development of deformation induced nanostructure in the BMG. Scattering intensity decreased upon annealing at 473 K. This result shows that the nanostructure formed by plastic deformation annihilated during annealing. Furthermore, it can be seen that slope of profile changed after annealing. By analyzing these profiles detail, information of nanostructure formed by severe plastic deformation will be obtained.

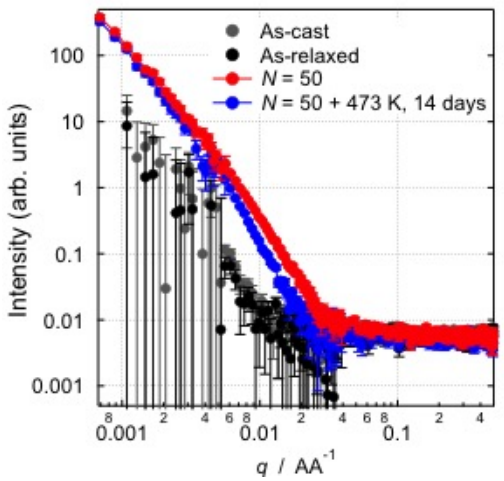

Fig. 1. SANS profiles of Zr50Cu40Al10 before and after severe plastic deformation.