Nanoscale Structure-Controlled Alloys Fabricated by Stabilization of Supercooled Liquid

Akihisa Inoue
Institute for Materials Research, Tohoku University, Sendai 980-8577, Japan

Since the finding of a dramatic increase in the stability of supercooled liquid against crystallization for metal-metal type alloys without metalloid in 1988, a large number of bulk glassy alloys have been fabricated by use of the stabilization phenomenon. The novel stabilization phenomenon of supercooled liquid has been recognized to occur in special alloys with compositional features of multi-component more than three elements, significant atomic size ratios above 12% and negative heats of mixing. In addition, the stabilization has been presented to result from the formation of a novel disordered structure with the features of highly dense random packed atomic configurations, new local atomic configurations and long-range homogeneity with attractive interaction. The control and use of the novel short-range ordered atomic configurations are thought to be important for future development of advanced materials with useful properties. Based on the above-described concept, we have fabricated various kinds of novel metallic materials such as bulk glassy single phase alloys, porous bulk glassy alloys, bulk glassy alloys with dispersed nanocrystalline, nanoquasicrystalline or dendritic crystalline phase, nanocrystal base alloys and nanoquasicrystal base alloys and reported that these novel metallic alloys exhibit various functional properties which cannot be obtained for any kinds of crystalline alloys. This paper intends to present the fabrication, characteristics and applications of these novel bulk metallic materials and to investigate the future prospect of material developments on the basis of the new alloy design concept.