Phase separation can occur when there is at least one atom pair with positive enthalpy of mixing or there is a large difference in enthalpy of mixing between the atom pairs in metallic glass forming systems. By selecting a proper pseudo-binary section of the miscibility gap in the multi-component system, droplet-type microstructure formed by nucleation and growth mechanism or interconnected-type microstructure formed by spinodal decomposition can be obtained in the as-solidified microstructure. Thermodynamic calculation of miscibility gap allows the formation of full spectrum of the microstructure from interconnected type to droplet type microstructure. Phase separation phenomena can provide some advantages in utilizing metallic glasses, for example, introduction of complex shape forming by using the two-step glass transition phenomena or synthesis of porous glass by leaching out one of the two separated amorphous phases. In the present study, we have investigated the microstructural evolution in phase separating Al-based amorphous alloys. The double halo rings in the electron diffraction pattern and nm scale interconnected STEM image obtained from the as-melt-spun alloys indicate that two different amorphous phases form during solidification. With heat treatment below the glass transition temperature, the scale of phase separation increases. Detailed investigation on the crystallization behavior reveals that a metastable single crystalline phase forms at early stage of crystallization. However, at later stage, equilibrium phases replace the metastable phase.

Acknowledgement: This work was supported by the Global Research Laboratory Program of the Korean Ministry of Education, Science and Technology.
Fig. 1: STEM image and diffraction pattern showing phase separation in Al-Mn-Ge amorphous alloy