Alloy phase formation in isolated nanometer-sized particles

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Understanding the structure (or phase) stability of nanometer-sized condensed matter is one of the key issues in current materials science, and dramatic progress in the understanding has been achieved, in recent years, by virtue of the rapidly advancing techniques of transmission electron microscopy (TEM). In the present work, alloy phase formation in isolated, nm-sized particles has been studied by in situ TEM.

The finite size effect on the eutectic point, Teu, in binary alloy systems is so strong that in nm-sized alloy particles Teu can be lowered down to a temperature even below the glass transition temperature, Tg. This is a situation ascribed to the large suppression of Teu across Tg, induced by the size reduction. As a result of this, in a particular system of the Au-Sn system where room temperature (RT) at which observations were carried out, lies in such an order as Tg>RT> Teu, a crystalline-to-amorphous, solid-to-solid transition has been observed by simply adding Sn atoms onto nm-sized crystalline particles of pure Au, whereas in the Sn-In system where RT lies in such an order as RT>Tg>Teu, a crystalline-to-liquid transition has been observed by simply adding In atoms onto nm-sized crystalline particles of pure Sn. It should be noted here that both the amorphous phase in the former system and the liquid phase in the latter system can be present at RT as phases more stable than crystalline counterparts only when the size of the system is in the nanometer range. [Reference : Lee, Mori, and Yasuda, Phys. Rev. B65 (2002) 132106]