The Science of the Small: Understanding the Coalescence of Nanoparticles by Advanced Transmission Electron Microscopy

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Nanoparticles possess many unique properties that are distinct from that of bulk materials, which allows them to be used in applications such as in catalysis and in optical, magnetic and electronic devices. Among these properties, the coalescence behavior of nanoparticles is expected to be quite different from that of bulk materials, especially if the particles experience elevated temperatures. In this work, *in-situ* heating experiments were performed in a transmission electron microscope (TEM) to monitor the thermal stability of silver nanoparticles. For nominally isothermal experiments, the observed sublimation temperatures generally decreased with decreasing particle size, in agreement with the predictions from the Kelvin equation. However, sublimation of smaller nanoparticles was often observed to occur in discrete steps, which led to faceting of the nanoparticles. In addition, due to their large surface area-to-volume ratio, nanoparticles have a strong tendency to coalesce and sinter during processing or usage over short time scales. Hence, *in-situ* TEM heating was used to investigate the effects of particle size, temperature and carbon capping layers on sintering in silver and platinum nanoparticles. For the first time, we make direct and real-time measurements of nanoparticle size, neck growth, dihedral angle and grain boundary motion during sintering, which are then used to calculate fundamental material transport parameters such as surface diffusivity and grain boundary mobility [1-3].

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