Microscale Synthesis of Fusible Alloys and Low-Melting-Point Metallic Nanoparticles

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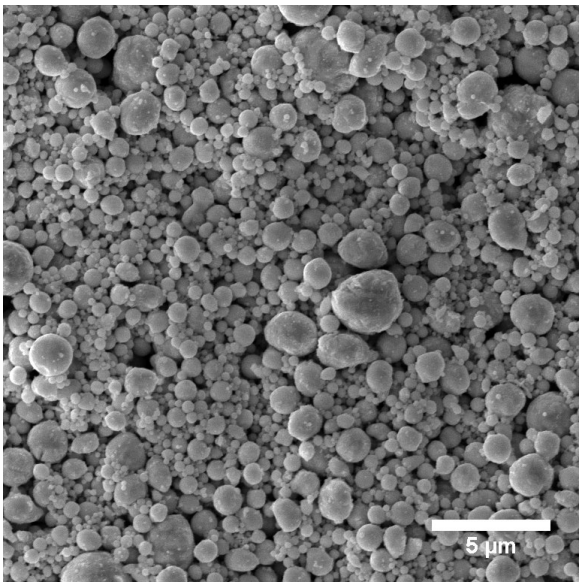
Abstract

Fusible alloys melt at a low temperature and typically consist of metals such as indium, gallium, bismuth tin, and zinc. These alloys can be used in applications such as electrical solder, thermal fuses, liquid metal coolants, die casting, and rapid prototyping. Additional metals such as mercury, lead, cadmium, and even thallium could also be used but are more restricted in their potential applications due to high toxicity. Some of these metals, such as indium and gallium, are relatively expensive making it advantageous to conduct microscale research of new fusible alloy compositions on a small scale. Such syntheses are challenging due to the comparatively high surface area to volume ratio of microscale samples leading to significant oxide formation when being mixed in the melt phase. A method has been developed to prepare alloy samples of various compositions at a 500 mg scale using a rosin-based flux to protect the molten surface and promote mixing without the need for a vacuum furnace or inert atmosphere. The resulting alloy samples were characterized by dynamic scanning calorimetry (DSC) and optical microscopy and were found to have the expected melting points and microstructure when compared with known phase diagrams found in the literature. Fusible alloy samples were then converted to low-melt-point metallic nanoparticles using an ultrasonic nanoemulsion method. Samples of the selected alloy were pre-heated and sonicated in mineral oil using a probe sonicator. The resulting high shear converted droplets of molten metal into particles ranging in size from tens of nanometers to a few microns depending on the intensity and duration of the applied sonication. Particle size and distribution were characterized by optical and scanning electron microscopy. The methods used to prepare and characterize fusible alloy samples and nanoparticles will be discussed.

Zinc–Tin Alloy Microstructure
(**75** wt% Zn, **25** wt% Sn)



Bismuth–Tin Alloy Metallic Nanoparticles
(**47** wt% Bi, **53** wt% Sn)