Tuning of Indium Antimony nanoparticles generated with spark discharge

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Introduction

Indium antimonide (InSb) is one of the III-V semiconductor materials which show great promise for the future of downscaled electrical and optoelectronic components. InSb has a small band gap and inherent high electron mobility which makes it a good candidate material for infrared detectors and high speed electronics.

The processing and production of antimonides are among the most challenging materials systems. This makes them not as well studied as other material systems.

Generation of nano-sized semiconductor compound aerosol particles is a challenging task, but can provide a good way of continuous production if successful. Previous work has focused on silicon particles and some III-V materials . Many of the III-V compounds are not suitable for generation with spark discharge due to their toxicity, stability in air, and stability at elevated temperatures, but InSb combines the requirement of only being moderately hazardous and having stable electrodes, in addition to the scientific interest in the properties of the nanoparticles. Some areas in particular are the optical properties and how they change with the particle diameter and generation parameters, and the use of aerosol generated III-V nanoparticles as seed particles for nanowires, which would be possible to study of a stable method of production was developed.

Methods

In the process of optimizing the generation, the sintering behaviour of the produced agglomerates was investigated. Bulk InSb have a melting temperature of 527ºC which would suggest that the compaction of the agglomerates would occur around 500º C if the particles are pure InSb. In Fig 1 the sintering in different carrier gas is shown. It was clear that no compaction occurred and the agglomerates were still intact at 525ºC in N_2 which could indicate the formation of oxides, something that antimonides are known to easily form. With an addition of 5 vol% H_2 to the carrier gas and a sintering temperature of 500ºC it was possible to generate compacted spherical particles, example of a 40 nm (d_m) can be seen in Fig. 2.

Conclusions

This method of InSb particle generation could be an alternative for production of III-V particles as the initial tests shows full compaction of agglomerates and the compacted particles show good crystalline quality.

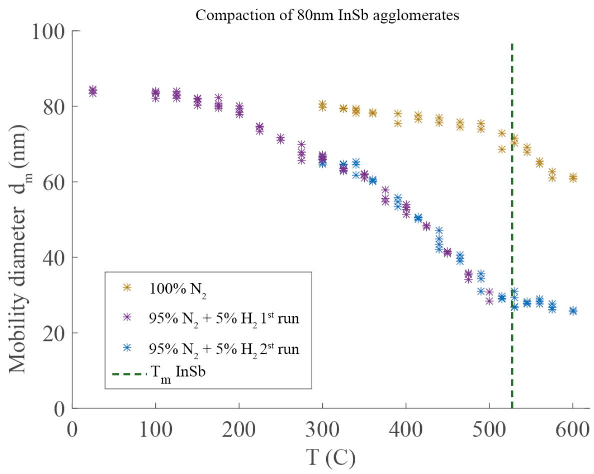

Figure 1. Sintering of InSb in different atmospheres

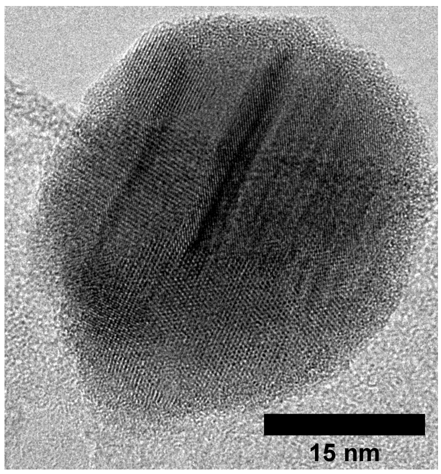

Figure 2. TEM micrograph of a compacted d_m=40nm InSb particle

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