Abstract

Our understanding of materials interfaces has seen significant improvement in recent times. Focus on smaller length scale design of materials has further increased the need for understanding grain boundary behaviour. Development in experimental and computational tools allow us to study these grain boundaries in far more detail.

Since the theoretical prediction of grain boundary wetting transition phenomenon, several computational and experimental investigations have reported this transition in various metals and alloy. In this work we study polycrystalline Al-Sn system as candidate for the grain boundary wetting transition. For this purpose, alloys of various composition were prepared using electric arc melting unit followed by optimum heat-treatment routine to obtain wetting transition at the grain boundary. The transitions which typically occur at higher temperature were quenched to room temperature and the samples thus produced were studied for grain boundary segregation, grain boundary phase identification and its distribution using various characterisation techniques. These include optical and scanning electron microscopy for structural characterization and energy dispersive spectroscopy and X-ray diffraction techniques for analytical studies. This was further combined with differential scanning calorimetry in order to estimate the transition temperature and compare with direct observation from imaging.

We successfully demonstrated the phase and structural changes at the grain boundaries in Al-Sn binary system. The wetting transition behaviour was studies with respect to annealing temperature and alloy composition. The approach was further validated by fabricating and studying some of the relatively well studied alloys such as In-Sn, Cu-In, and Zn-Al and comparing our results with the published literature. Analytical investigation showed up to 2-3 times of solute concentration at the grain boundary. Differential scanning calorimetry provided distinctive signature of grain boundary solidus temperature in case of some of the alloy compositions.

Keywords : Grain boundary, Complexion, Segregation, Wetting Transition, Triple Junction Al-Sn alloy