Morphology and Magneto-Transport Properties of Mn_3Sn Films Deposited on High-Temperature Si/SiO_2 Substrates without Post-annealing

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Despite being an antiferromagnet, the Weyl semimetal Mn_3Sn [0] exhibits ferromagnetic-like responses such as the Anomalous Hall and Nernst Effects (AHE/ANE) [1][2] and has attracted much attention in recent years. These phenomena stem from the topological band structure of Mn_3Sn, which yields nontrivial Berry curvature near the Fermi energy. Recently, Mn_3Sn thin films in particular have been of great interest owing to their potential application in spintronics [3,4], and studies of submicron Mn_3Sn particles on substrates could further expand the material's usefulness in nanotechnology. Mn_3Sn thin films are typically annealed for a fixed amount of time after being deposited on substrates at varying temperatures ("post-annealing") to achieve the Kagome crystal structure that gives rise to their topological properties [5].

In this work, Mn_3Sn films were fabricated by DC magnetron sputtering on Si/SiO_2 substrates heated at 500℃ ($SiO_2/Mn_3Sn(t)/Al(2)$) without any post-annealing. The surface morphology of these films, investigated with an atomic force microscope (AFM), was found to be qualitatively different from that of post-annealed films: crystal structures on the order of μm can be seen in post-annealed films, while films deposited at high temperature seem to be amalgamations of formations with submicron sizes. AFM images reveal that in films with $t \leqq 20$ nm, local islands were evenly distributed throughout the substrates. As films comprised of such islands were all found to be insulating, the islands are implied to be electrically isolated from each other. Depending on the nominal thickness of the film, the size of these islands varies on the order of several tens to hundreds of nanometers. Hall resistivity measurements were conducted to probe the magneto-transport properties of the Mn_3Sn islands covered by a conducting layer, the details of which will be discussed in the presentation. Our observation of the AHE signal suggests that even submicron Mn_3Sn particles possess non-zero Berry curvature in momentum space, which could further cement the material's role in spintronics.

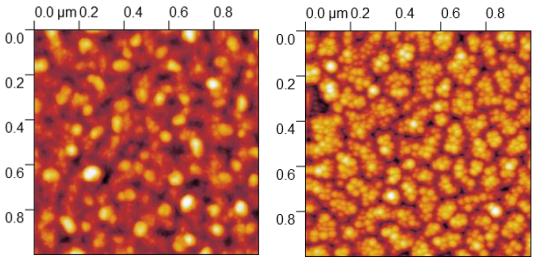

Fig 1: AFM image of Mn_3Sn films deposited at 500℃ with t=40 nm (left) and t=20 nm (right)

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