



INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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SHORT ABSTRACT

This thesis has described the successful synthesis of stoichiometric Co_2FeSn , off-stoichiometric Co-Fe-Sn, stoichiometric Fe_2CoSn , and Co-Fe-Cr-Sn quaternary Heusler alloys in single phase without any impurity phase in thin film form using a non-equilibrium electrodeposition technique. The significance of this work is apparent since it is difficult to prepare these alloys in pure single phase using conventional alloy preparation techniques like arc-melting. The single-phase polycrystalline alloy films with excellent control on their composition were deposited on polycrystalline Cu substrates using this cost-effective technique. The as-deposited films, which exhibited poor crystallinity, were heat treated at $550\text{ }^\circ\text{C}$ for 1 hour under vacuum ($\sim 10^{-3}\text{ Pa}$) to achieve well-crystallized and ordered Heusler alloy structure. The formation of highly ordered $L2_1$ or X-type Heusler alloy structure was confirmed by structural analysis involving powder X-ray and electron diffraction data and Rietveld refinement technique. *Ab initio* calculations have been extensively used to predict the atomic configurations in these alloys, validate the structural data and infer the role of atomic defects in these alloys with a complex crystal structure. Energy dispersive spectroscopy data confirmed that the composition of the films closely matched the target compositions, while morphological studies revealed a granular morphology across all the films. To explore the half-metallic character in Co and Fe based Heusler alloys, the nature of the minority spin gap near Fermi level were investigated by *ab initio* calculations. Isothermal magnetic measurements revealed the soft ferromagnetic behaviour in all the electrodeposited films. The dependence of saturation magnetization, coercivity, Curie temperature, and effective magnetic anisotropy constant on the alloy composition and film thickness has been systematically examined in Co-Fe-Sn alloy films. Additionally, the itinerant and half-metallic ferromagnetic nature of the synthesized alloy film samples were validated by calculating the Rhodes-Wohlfarth ratio using temperature dependent magnetic data. To further support the theoretical predictions of half-metallicity, temperature-dependent DC electrical resistivity measurements have also been conducted.