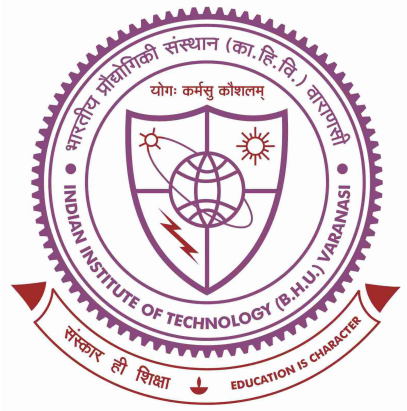
Study of Magnetic and Magnetotransport Properties of Some Heusler Alloys



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Chapter 7

Summary and Future prospective

In this chapter, a concise overview of the key findings and future suggestions from the current study is presented.

7.1 Summary

The focus of this thesis was the examination of polycrystalline samples, prepared through standard arc-melting furnace procedures followed by vacuum annealing. Utilizing various experimental methods, including laboratory-based X-ray diffraction (XRD), scanning electron microscopy, and a range of magnetic and transport measurements (dc magnetization, ac-susceptibility, and anomalous transport), conducted within in-house facilities, yielded significant insights. The essential findings of this study are as follows:

Chapter 1 involves the study of Co-substituted $Mn_{1.5}Co_{0.5}FeAl$ alloy confirmed a $\beta - Mn$ crystal structure with space group $P4_132$, characterized by two inequivalent manganese sites. This led to frustrated structures and irreversibility in dc magnetization between zero-field cooled warming and field cooled warming curves. The presence of a spin glass phase was supported by frequency-dependent ac susceptibility measurements and empirical models. The study also observed sluggish relaxation and memory effects

in both protocols, and a shifted hysteresis loop, indicating a cluster spin glass. The study explores the thermal and electrical properties of Co-substituted Mn_2FeAl, revealing an initial increase in Seebeck coefficient and power factor up to 150 K. The power factor and ZT peak at approximately 4×10^{-3}. Lattice thermal conductivity and electronic thermal conductivity show crossover behavior around 150 K. Electronic Raman spectra are attributed to crystal field splitting, confirmed by X-ray absorption spectroscopy. Electrical resistivity shows a dual nature of semiconductor and metallic behavior, with a narrow band gap of around 9 meV. These findings provide insights into the complex thermoelectric behavior of Co-substituted Mn_2FeAl and its potential applications. The chapter 5 explores Ni-based systems using the substitution method on the Z-site. It presents a $Ni_2MnSn_{0.5}Al_{0.5}$ system with potential properties like Spin Valve and Anomalous Hall effect up to room temperature. The system's magnetization confirms spin vlave, and its resistivity changes during phase transition from austenitic to martensitic. The study also analyzes AHE NMSA, revealing extrinsic skew scattering as the dominant mechanism in AHE, opening up new applications like magnetic sensors and shape memory effect. In chapter 6, involves the investigation of quaternary Heusler alloys. The study investigates the impact of ansite disorder on the magnetic and transport properties of the quarternary Heusler alloy $CoFeMnSn$. XRD analysis reveals a type I configuration with partial disorder between atoms. The magnetization study confirms the room temperature ferromagnetic nature of the system, making it suitable for applications. The anomalous Hall effect, with a conductivity of 83.5 S/cm.

7.2 Future Perspectives

The current research explores many systems that exhibit intriguing and versatile behavior. In order to further investigate this matter in future research, as indicated in chapter 5, the use of temperature dependent X-ray diffraction (XRD) will provide a more precise

determination of the presence of an asymmetric magnetoresistance in the system, as shown by the martensitic and austenite phases. It will provide new opportunities for investigating these characteristics. The occurrence of anomalous Hall effect in the $CoFeMnSn$ Heusler alloy, even at ambient temperature, makes it very favorable for practical applications. The primary mechanism responsible for the observation of the Anomalous Hall effect in the system is the intrinsic processes, which may be confirmed by theoretical calculations as well. Furthermore, the 2-D system has great potential for practical applications. Moreover, bulk Heusler alloys have multifunctional behavior, making them suitable for the fabrication of spin transfer torque devices. Perform a comprehensive examination of the thermoelectric characteristics of the Heusler system, since it exhibits a significant anomalous Nerst effect that has been recently reported in Heusler compounds.