INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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Thesis Title: **Investigations on selected cobalt-based quaternary Heusler alloys for spintronic applications**

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SHORT ABSTRACT

Systematic experimental and theoretical investigations have been conducted to explore the structural, magnetic, and electronic properties of bulk $Co_{2-x}MnV_xAl$ (x = 0.0, 0.25, and 0.5) and $Co_{2-x}FeTi_xAl$ (x = 0.00, 0.25, 0.50, 0.75, and 1.00) Heusler alloys. These investigations explored the impact of V and Ti substitution for Co in $Co_{2-x}MnV_xAl$ and $Co_{2-x}FeTi_xAl$ Heusler alloys, respectively. These studies demonstrated a viable approach to attain 100% spin polarization (P) by tuning the minority spin bandgap at Fermi level (E_F) while retaining the ferromagnetic character. After achieving high P, the next step was to comprehend impact of P on Gilbert damping constant (α) to ascertain the efficiency of the free ferromagnetic layer in magnetoresistance devices. In this regard, off-stoichiometric compositions of the promising $Co_2FeGa_{0.5}Ge_{0.5}$ Heusler alloy was considered. Off-stoichiometric $Co_{1.77}Fe_{1.23}Ga_{0.56}Ge_{0.44}$ Heusler alloy thin film was heat treated at different annealing temperature (T_{an}) to improve its atomic ordering. Effect of improvement in atomic ordering on intrinsic contribution to α and its correlation with P was then analysed. This investigation revealed remarkably low α in the $Co_{1.77}Fe_{1.23}Ga_{0.56}Ge_{0.44}$ film annealed at T_{an} = 600 °C. It also clarified that atomic disorder significantly influences α, and α decreases with increasing P resulting from improved atomic ordering. To assess the potential of the spin-orbit torque mechanism for achieving energy-efficient switching of the magnetization in the free ferromagnetic layer, spin mixing conductance ($g_{\mathrm{eff}}^{\uparrow\downarrow}$) across the interface of $Co_{2.06}Fe_{0.99}Ga_{0.53}Ge_{0.42}$/Pt bilayers was evaluated. Furthermore, a detailed investigation was carried out to assess the effect of ultrathin Cu, Ni, Ru, Ta, and Cr insertion layers on $g_{\mathrm{eff}}^{\uparrow\downarrow}$ of $Co_{2.06}Fe_{0.99}Ga_{0.53}Ge_{0.42}$/Pt bilayer film after ensuring that there are no insertion-layer-induced changes in the atomic structure of the Pt layer.