



Theoretical Research Framework on Magnetism and its Impact on Structural and Magnetic Properties of Co-Fe

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Abstract

Cobalt–iron (Co–Fe) alloys are important magnetic materials because of their high saturation magnetization, significant magnetic anisotropy, and potential applications in magnetic storage, sensors, spintronic devices, transformers, and electromagnetic technologies. This theoretical research framework aims to examine the relationship between magnetism and the structural and magnetic properties of Co–Fe alloys using established concepts of solid-state physics and magnetism. The study will focus on how crystal structure, atomic arrangement, composition, lattice parameters, electronic structure, and interatomic interactions influence magnetic behaviour. Particular attention will be given to exchange interactions, magnetic moments, saturation magnetization, coercivity, magnetic anisotropy, and Curie temperature. The proposed framework will consider theoretical and computational approaches, including density functional theory and atomistic or micromagnetic modelling, to investigate the relationship between composition, structural stability, electronic states, and magnetic properties. Variations in cobalt-to-iron concentration and structural configuration will be analysed to understand their effects on magnetic ordering and material performance. The research will also examine how structural defects, strain, interfaces, and changes in atomic coordination may modify the magnetic response of Co–Fe systems. The proposed study is expected to provide a systematic theoretical understanding of the structure–magnetism relationship in Co–Fe alloys and identify parameters that can be controlled to optimize their magnetic properties. Such knowledge may support the development of Co–Fe-based materials for advanced magnetic and spintronic applications.

Keywords: Co–Fe alloys, magnetism, magnetic properties, crystal structure, exchange interaction, magnetic anisotropy, saturation magnetization, density functional theory, electronic structure, spintronics.

