

Digital framework on magnetism and its impact on structural and magnetic properties of Co-Fe

Sukrita Das Samanta, Research Scholar, Dept of Physics, CMJ University, Jorabat, Meghalaya, India

Abstract

Cobalt–iron (Co–Fe) alloys are technologically important magnetic materials because of their high saturation magnetization, favourable magnetic properties, and potential applications in data storage, sensors, spintronic devices, transformers, and electromagnetic systems. This study presents a digital framework for investigating magnetism and its influence on the structural and magnetic properties of Co–Fe materials. Digital computational techniques, data-driven analysis, and materials modelling can provide valuable insights into the relationship between composition, crystal structure, electronic configuration, and magnetic behaviour. Parameters such as lattice structure, atomic arrangement, grain size, defects, composition, magnetic anisotropy, coercivity, saturation magnetization, and Curie temperature can significantly influence the performance of Co–Fe alloys. Computational approaches, including density functional theory, atomistic simulations, numerical modelling, and machine-learning methods, can be used to predict electronic and magnetic characteristics and identify structure–property relationships. Digital analysis of experimental data obtained through techniques such as X-ray diffraction, magnetometry, and electron microscopy can further improve the understanding of phase formation and magnetic response. The integration of computational modelling with experimental observations may reduce material-development time and support the design of Co–Fe compositions with optimized magnetic performance. Such a framework can also facilitate systematic comparison of materials under different compositions, processing conditions, and external magnetic fields. The study highlights the potential of digital materials science to advance the understanding of Co–Fe alloys and support the development of high-performance magnetic materials for emerging technological applications.

Keywords: Co–Fe Alloys, Magnetism, Digital Framework, Structural Properties, Magnetic Properties, Density Functional Theory, Machine Learning, Magnetic Anisotropy, Saturation Magnetization, Materials Modelling.

