METAMAGNETISM, PHASE CO-EXISTENCE AND METASTABILITY IN FUNCTIONAL MAGNETIC MATERIALS

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Materials in which the electronic and structural degrees of freedom are intimately interdependent open up numerous opportunities for the emergence of novel and potentially highly nonlinear effects across phase instability regions. Regardless of chemical makeup, nearly all such systems exhibit phase separation and other characteristic non-equilibrium thermodynamic features, *e.g.*, structural and magnetic glassiness, and anisotropic spin clustering. These phenomena are inescapable features of real materials, but their origin, scale, and lifetimes, as well as their role in controlling the properties of a material, have yet to be thoroughly examined, modelled and understood. Our ability to manipulate these effects, however, is critical because even if the electronic and spin-based phenomena are nearly 100% efficient, the events occurring in real materials may not be. Yet, efficiency is the key when energy supplies become limited.

Magnetic field induced (metamagnetic) transitions play an important role in the functionality of various classes of magnetic materials. Rare-earth manganites showing colossal magnetoresistance and $Gd_5(Ge_{1-x}Si_x)_4$ alloys showing giant magnetocaloric effect are typical examples of such functional materials. The key features of this metamagnetic transition are phase-coexistence and metastability. The generality will be highlighted by concentrating on some of the features found in the $R_5(Ge_{1-x}Si_x)_4$ compounds and by drawing parallels known from the science of magnetic oxides. We show that a framework of disorder influenced first order phase transition is useful to understand the interesting experimental results which not only span across different materials systems, but have considerable bearing on the functionality of the concerned materials.