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Variety and complexity of magnetic structures of rare earth-based nano-lamellar i-MAX phases

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Abstract

MAX phases (where M is an early transition metal, A is an element of groups 13 to 16 and X is either C or N) make up a large family of nano-lamellar and quasi two-dimensional compounds, many of which remain to be discovered and understood. One of the most notable advances in the recent years has been the prediction and the synthesis of the magnetic (Mo2/3RE1/3)2AC series, called i-MAX phases, through partial substitution of Mo atoms by rare-earth (RE) elements [1-4]. The first interest of these phases is based on their layered structure in which bilayers of quasi-2D magnetic skewed triangular lattice overlay a Mo honeycomb arrangement and an A Kagomé lattice. The second interest is related to the fact that these phases display a wide range of magnetic characteristics. This results from intra and inter-planes exchanges caused by Ruderman-Kittel-Kasuya-Yosida indirect coupling mechanism of localized inner 4f-shell electron spins though the conduction electrons [2,5]. The interaction of the aspherical 4f orbitals with the CEF results in magneto-crystalline anisotropy and magnetization measurements performed on i-MAX single crystals revealed a strong anisotropy and interesting magnetic behaviours strongly dependent of the nature of the RE element included in the structure [5-6]. The confluence of oscillating RKKY couplings of 4f magnetic moments, competing interactions and CEF can then induce a complicated magnetic behaviour, including incommensurability and metamagnetism.

We have determined the magnetic structures of several i-MAX phases with different rare earths by powder and single crystal neutron diffraction under magnetic field [6]. In this talk, I will present different cases, illustrating the wide variety of magnetic structures ranging from simple commensurate to rather complicated doubly modulated incommensurate magnetic structures that can be described in (3+2)D superspace group.

References

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