Mo4Ce4Al7C3: A nanolamellar ferromagnetic Kondo lattice

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The study of Rare-Earth (RE) based compounds has been at the forefront of condensed matter physics for decades, due to the variety of magnetic and electronic ground states that they display. Recently, rare-earth-based nanolaminates have attracted attention because of their rich magnetism and their potential as precursors for strongly correlated two-dimensional materials, opening the door to exciting fundamental science as well as technological applications. We report on the $Mo_4Ce_4Al_7C_3$ phase, which belongs to a recently discovered family of nanolaminates with a $Mo_4RE_4Al_7C_3$ stoichiometry in which the RE order within planes, and featuring 2 nonequivalent lattice sites for the RE to sit on [1]. Single crystals of this compound were grown using high temperature solution growth. Bulk magnetisation revealed a transition to a ferromagnetic (FM) order below T_C=10.5K, with the easy magnetisation axis in the out-of-plane direction. X-ray absorption near edge structure (XANES) performed at the Ce L_3-edge revealed that Ce is in a mixed-valence state [1]. X-ray Circular Magnetic Dichroism (XMCD) carried out at the edges of the Mo, Al and C elements of the compound allowed us to conclude that one of the 2 nonequivalent Ce sites is in a $4f^1$ configuration and is responsible for the FM, while the other one is in a mixed-valence state and does not participate to the FM [1,2]. We were also able to establish which of the 2 Ce lattice sites is FM, and which one is in a mixed-valence state. High-pressure XANES showed an evolution of the initially mixed-valent Ce site, up to a fully $4f^0$ configuration at around 20GPa. This measurement, together with high pressure magnetoresistance measurements across the ferromagnetic transition unveiled a clear Kondo behaviour. Angle-Resolved photemission spectroscopy coupled with density functional theory highlight a delocalisation of conduction electrons in the out-of-plane direction. [2]

References:

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