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Low Temperature Nuclear Orientation Studies of the Magnetic Structures of RNiAl₄ in Applied Magnetic Fields

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The family of metamagnetic compounds RNiAl₄ (R = rare earth) exhibits a range of interesting magnetic behaviours. There are multiple magnetic phases, and crystal field driven differences in anisotropy and behaviour when different rare earth ions (R) are present in the compound. TbNiAl₄ is one illustrative example. It has two phase transitions (three phases) as a function of temperature in low applied magnetic field, and also at least three phases as a function of applied magnetic field at low temperature [1]. Aligned with the first of these field driven transitions is a large inverse magneto-caloric effect (MCE) [2]. Recent neutron diffraction studies carried out on single crystal TbNiAl₄, in applied magnetic fields, show the onset of an incommensurate anti-ferromagnetic ordered phase above the first field induced phase transition [3]. This observation vindicates the existence of the higher entropy state at higher applied field that is required for an inverse MCE but contradicts the predictions of other authors who suggest a spin flop transition [4]. Low Temperature Nuclear Orientation (LTNO) can also be usefully applied to TbNiAl₄ and other RNiAl₄ compounds to investigate magnetic structure. In the case of the Tb compound, neutron activation is used to create in situ ¹⁶⁰Tb LTNO probes. However, as we found recently, TbNiAl₄ crystals must be annealed after thermal neutron irradiation in order to remove damage and restore full gamma-ray anisotropy [5]. In this paper, we present new LTNO results for annealed TbNiAl₄, in applied fields extending to 9 tesla. These results support the model of magnetic structure revealed by the earlier neutron diffraction studies. LTNO is also applied to crystals of compounds with R = Nd and Pr. These additional studies magnetic fields sufficient to traverse the respective first metamagnetic transitions were also used and behaviours similar to the TbNiAl₄ case were observed.

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no

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poster

Summary

References

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