

Magnetic behavior of the nanophase of YbNi₂ alloys

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Abstract

© 2017, Pleiades Publishing, Ltd. Variations in magnetic properties of the heavy-fermion YbNi₂ alloy when milled in a high energy ball milling system have been investigated. The ferromagnetic transition ($T_C = 10.4$ K) in the initial sample almost vanishes after milling, which leads to the appearance of a magnetic transition at $T^* = 3.2$ K in nanocrystallites. Before milling, processes of spin-lattice relaxation of the Orbach-Aminov type with the participation of the first excited Stark sublevel of the Yb³⁺ ion located at 75 K are dominating in the electron spin dynamics in the paramagnetic phase of the alloy. A comparative study of the temperature dependence of the magnetic properties and spectra of electron paramagnetic resonance in poly- and nanocrystalline samples indicates the existence of a magnetic inhomogeneity of the compound arising upon milling.

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Keywords

electron paramagnetic resonance, heavy fermions, magnetic susceptibility, nanocrystallites

References

- [1] D. P. Rojas, L. Fernández Barquín, J. I. Espeso, J. Rodríguez Fernández, and J. Chaboy, "Reduction of the Yb valence in YbAl₃ nanoparticles," *Phys. Rev. B: Condens. Matter Mater. Phys.* 78, 094412 (2008).
- [2] A. V. Chadwick, I. J. F. Poplett, D. T. S. Maitland, and M. E. Smith, "Oxygen speciation in nanophase MgO from solid-state ¹⁷O NMR," *Chem. Mater.* 10, 864-870 (1998).
- [3] G. Singh and S. V. Bhat, "Effect of size reduction on magnetic ordering in Bi_{0.2}Sr_{0.8}MnO₃," *J. Appl. Phys.* 115, 17E130 (2014).
- [4] K. Baberschke, "From local moment EPR in superconductors to nanoscale ferromagnets," *J. Supercond. Nov. Magn.* 19, 77-84 (2006).
- [5] E. M. Gataullin, V. A. Ivanshin, D. P. Rojas, and L. Fernández-Barquín, "Electron spin resonance of the ferromagnetic YbNi₂ alloy," *JPS Conf. Proc.* 3, 012028 (2014).
- [6] D. P. Rojas, L. Fernández Barquín, J. Rodríguez Fernández, J. I. Espeso, and J. C. Gómez Sal, "Size effects in the magnetic behaviour of TbAl₂ milled alloys," *J. Phys.: Condens. Matter* 19, 186214 (2007).
- [7] D. P. Rojas, L. Fernández Barquín, J. Rodríguez Fernández, J. I. Espeso, and J. C. Gómez Sal, "Magnetization and specific heat of nanocrystalline rareearth TbAl, TbCu and GdAl alloys," *J. Phys.: Conf. Ser.* 200, 072080 (2010).
- [8] D. P. Rojas, L. Fernández Barquín, C. Echevarria-Bonet, and J. Rodríguez Fernández, "YbNi: A heavy fermion ferromagnet," *Solid State Commun.* 152, 1834-1837 (2012).
- [9] G. K. Williamson and W. H. Hall, "X-ray line broadening from filed aluminum and wolfram," *Acta Metall.* 1, 22-31 (1953).
- [10] V. A. Ivanshin, J. Deisenhofer, H.-A. Krug von Nidda, A. Loidl, A. A. Mukhin, A. M. Balbashov, and M. V. Eremin, "ESR study in lightly doped La(1 - x)SrMnO," *Phys. Rev. B: Condens. Matter Mater. Phys.* 61, 6213-6219 (2000).

- [11] P. Schlottmann, "Electron spin resonance in heavyfermion systems," *Phys. Rev. B: Condens. Matter Mater. Phys.* 79, 045104 (2009).
- [12] E. Abrahams and P. Wölfle, "Electron spin resonance in Kondo systems," *Phys. Rev. B: Condens. Matter Mater. Phys.* 78, 104423 (2008).
- [13] A. Ramirez and P. Coleman, "Theory of the electron spin resonance in the heavy fermion metal β -YbAlB₄," *Phys. Rev. Lett.* 112, 116405 (2014).
- [14] D. S. Rodbell, "Ferromagnetic resonance absorption linewidth of nickel metal. Evidence for Landau-Lifshitz damping," *Phys. Rev. Lett.* 13, 471-474 (1964).
- [15] M. Domke, C. Laubschat, E. V. Sampathkumaran, M. Prietsch, T. Mandel, G. Kaind, and H. U. Middelman, "Bulk and surface valence in YbPdx compounds," *Phys. Rev. B: Condens. Matter* 32, 8002-8006 (1985).