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Growth routes for synthesizing the YbCd1-xSb2 intermetallic compounds.

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Abstract
In this work we report the growth and characterization of single crystals of the intermetallic compound YbCd1-xSb2. This compound was synthesized with different Cd concentrations, using the Sb self-flux technique. Magnetic susceptibility as a function of temperature and applied field, electrical resistivity, specific heat and x-ray powder diffraction measurements were performed to characterize the physical properties of our single crystals. The results suggest an AFM phase with Tn ~ 3 K and heavy-fermion behavior. In order to understand the role of the CEF effects in the properties of this system, we have also performed preliminary studies of CEF effects. Finally, we discuss the magnetism and other physical properties of the YbCdSb2 compound based in the Cd stoichiometry dependency and CEF effects.

Key words:
CEF effects, heavy fermion, antiferromagnetism

Introduction

Previous results in the family of heavy-fermion intermetallics $RTBi_2$ (R = Ce, Pr, Nd, Sm, Gd; T = Cu, Au) and $CeCd_{0,7}Sb_2$ compounds show that the crystalline electrical field (CEF) effects play a crucial role in the strong competition between ferromagnetic (FM) and antiferromagnetic (AFM) interactions[1,2]. Moreover, the magnetic phases of these compounds appear to be highly influenced by the dimensionality of the system[1,2]. These Ce-based compounds display highly localized Ce^{3+} ions, which have one electron in their ground state ($^2F_{5/2}$). The strong localization of Ce 4f electrons in those systems may reduce the chance of tuning their ground states towards unconventional superconductivity. As such, perhaps a more reliable path to search for superconductivity in these families would trying to find analogues with stronger hybridization between the 4f and conduction electrons, possibly the less explored Yb-based analogues.

Results and Discussion

Using Sb-flux growth, Cd-deficient single crystals of $YbCdSb_2$ were synthesized, and through resistivity, specific heat and magnetic susceptibility measurements we were able to characterize macroscopically the samples.

Image 1. Magnetic susceptibility measurement showing low temperature magnetic ordering.

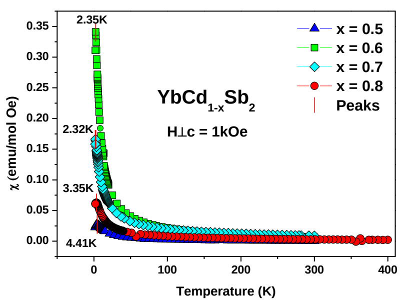
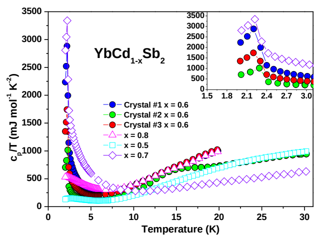
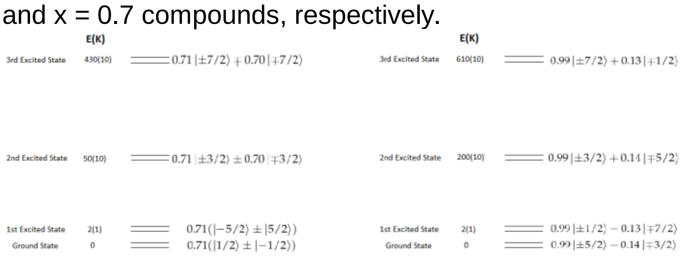


Image 2. Specific heat measurements displaying heavy fermion behavior.



Our results indicate that the compound shows a heavy fermion behavior (γ~1200 mJ/mol K^2) and a magnetic ordering at T ~ 3 K, which we believe to be AFM.
We also performed preliminary CEF effect studies to better understand the magnetism of this compound, and how the Yb - based samples differ from the Ce – based family, obtaining the states below.

Image 3. Energy levels and wave functions for the x = 0.6 and x = 0.7 compounds, respectively.



Conclusions

We were successfully able to synthesize the compound, and even though it's desirable to increase the Cd concentration and quality of the crystals, we already can investigate and begin to understand the physics behind the magnetism of the $YbCd_{1-x}Sb_2$ compounds.

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