

Shallow-muonium state interaction with native donors in CdS

JM Gil, HV Alberto, RC Vilão, J Piroto Duarte, N Ayres de Campos

CEMDRX, Department of Physics, University of Coimbra, P-3004-516 Coimbra, Portugal

SFJ Cox

ISIS Facility, Rutherford Appleton Laboratory, Chilton, Oxon OX11 0QX, United Kingdom

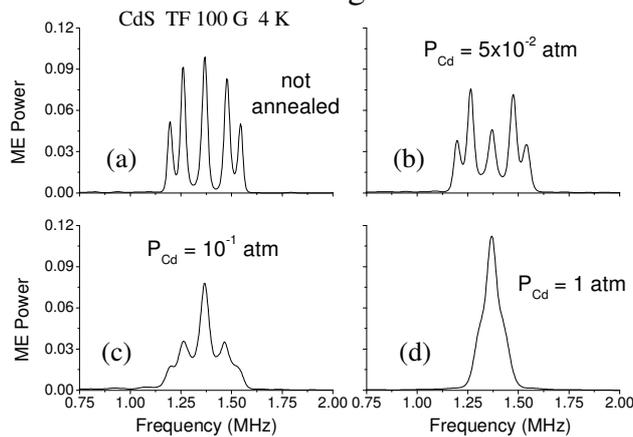
In early spectroscopic measurements of the shallow-level muonium state in n-type CdS and CdTe, the presence of a sample-dependent additional signal was noticed at temperatures below the ionisation of shallow donors, reasonably modelled by a broad gaussian line, its width being of the same order of magnitude of the hyperfine constant of the shallow-muonium state [1-3]. This signal has been interpreted as belonging to the same muonium state undergoing an interaction with the electron wave functions of other shallow-donors (native V_S in the case of undoped CdS) through an impurity conduction mechanism [4,5].

To confirm this interpretation, the present experiment aimed at proving a correlation between the amplitude, shape and temperature behaviour of this signal and the concentration of other shallow-donors present in the sample. Three undoped CdS Eagle Picher single crystals were annealed for 7 days at 900°C in different Cd vapour pressures of 5×10^{-2} , 1×10^{-1} , and 1 atm, in order to achieve the final V_S concentrations of 3×10^{16} , 5×10^{16} and 1×10^{17} cm⁻³, respectively [6].

μ SR measurements were in a transverse magnetic field of 100 G (high-field limit for the shallow-muonium state), with the c-axis of the single crystals parallel to the external field (hence the two pairs of satellites). Figure 1 shows the maximum entropy frequency distributions obtained from the time spectra at 4 K. The development of a broad frequency distribution is seen as the V_S concentration increases, gradually substituting the clean lines of the undoped sample.

The changes with V_S concentration and temperature of the amplitudes and shapes of the various signals will be discussed in the frame of the dynamics of impurity conduction at low temperatures.

Fig. 1



References

- [1] JM Gil et al., Phys. Rev. Lett. 83 (1999) 5294
- [2] JM Gil et al., Phys. Rev. B 64 (2001) 075205
- [3] V. Corregidor et al., Europhys. Lett. 67 (2004) 247
- [4] EA Davis, W Dale Compton, Phys. Rev. 140 (1965) A2183
- [5] K Morimoto, M. Kitagawa, J. Phys. Soc. Japan 54 (1985) 4271
- [6] V Kumar, FA Kröger, J. Solid State Chem. 3 (1971) 387

Muon study of magnetic ordering and critical behaviour in molecular magnets

Piotr Konieczny and Tadeusz Wasiutynski

Institute of Nuclear Physics Polish Academy of Sciences, Krakow, Poland

Abstract:

The molecular magnets exhibits many novel properties which are not present in traditional magnetic materials. The nature of the magnetic ordering is often hidden in the critical behaviour at the magnetic phase transition. The muon spectroscopy happens to be the unique technique to study above properties. We will present the results of the study performed at ARGUS and MuSR spectrometers in ISIS facility. The subject of the study were octacyanometallates of transition metals with different network dimensionality that exhibit magnetic anisotropy of XY and Heisenberg types.

It has been previously demonstrated that there is a missing fraction present when muons are used to investigate a sample of biologically reduced palladium [1]. Given that this material possessed a non-linear component when analysed using a SQUID magnetometer it was asserted that the missing fraction was present due to the ferromagnetic component. This would be in agreement with results obtained using chemically reduced palladium nanoparticles [2]. However, due to the large biological component present, 80% of sample size, there remained the possibility that the missing fraction was the result of muonium formation. To probe this relationship, this work took a sample with a greater biological component proportion for investigation at the Paul Scherrer Institut with a goal to investigate the early implantation behaviour, and determine the cause of the missing fraction.

1. Creamer, N., et al., Local magnetism in palladium bionanomaterials probed by muon spectroscopy. *Biotechnology Letters*, 2011: p. 1-8.
2. Seehra, M.S., et al., Core-shell model for the magnetic properties of Pd nanoparticles. *Materials Letters*, 2012. 68(0): p. 347-349.

Jack Wright

Of all the Fe-based superconductors currently known, LiFeAs remains one of the most intriguing. Unlike other compounds, such as BaFe₂As₂ or NaFeAs, superconductivity is observed and optimised in the stoichiometric compound such that T_c is reduced on substituting Fe for Co, and no long-range ordered magnetic state or structural transition has yet been observed. Interest in this compound has intensified as more theoretical attempts have been made to understand these differences; one prediction of particular note is that LiFeAs in fact exhibits triplet pairing [PRB 83 060501 (2011)]. Additionally it is suggested that Li-deficient samples may show an induced magnetic phase, as this chemical change may constitute an effective "hole-doping" that drives the system towards magnetism. Previous work by our group [JACS 132 10467 (2010)] has highlighted the intriguing chemical possibility that Fe can be accommodated on the Li site, creating Li(1-y)Fe(1+y)As. We have previously shown the dramatic effects this has on superconductivity and now we have performed zero-field μ SR experiments on a very well-characterised series of such samples and found a static, disordered magnetic phase is induced upon such a substitution. We suggest that even tiny concentrations of Fe on the Li site, which can occur during certain synthesis routes, may account for the reports of magnetic signatures in supposedly stoichiometric LiFeAs. We also find no evidence in our data for the time-reversal symmetry breaking that would accompany triplet pairing.