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Summary

Electric quadrupole interactions in nano-structured SnO2 as measured with PAC spectroscopy

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The search for diluted magnetic semiconductors with ferromagnetic ordering at room temperature has attracted a great deal of interest in the last years. In this search several wide band-gap semiconductor oxides such as ZnO, TiO2, and SnO2 have been doped with transition metals in an attempt to create magnetic properties without significantly affecting the physical properties of the host. Among these materials, SnO2 is a good candidate to successfully exhibit intrinsic magnetic ordering when doped with transition metal because of native oxygen vacancies occurrence, once it has been reported that such vacancies play an important role in the ferromagnetic order of semiconductor oxides.
In the present work electric quadrupole interactions in Tin dioxide (SnO2) samples have been measured with perturbed gamma-gamma angular correlation (PAC) spectroscopy using 111In (111Cd) as a nuclear probe. Single phase nanocrystalline powder samples of SnO2 were produced by the sol-gel Pechini method. At the sol step, the solution was separated in two parts. Probe nuclei were introduced in one of these parts which along with the other one were annealed at different temperatures under nitrogen atmosphere. The samples without 111In were characterized by Scanning Electron Microscopy (SEM) measurements as well as X-ray Diffraction. The results showed nanometric particles homogeneously distributed, with particle diameter in the range of 15 – 60 nm.
PAC measurements were carried out in the temperature range from 10 k to 1123 K and the results show that the temperature dependence of the electric quadrupole frequency depends on the annealing temperature. In all measurements it was observed two different electric quadrupole interactions. One of them with νQ ~ 115 MHz, ⊠ ~ 0.1, and ⊠ ~ 12 %, which changes very little with temperature has been assigned to 111Cd at Sn sites in SnO structure. The second interaction is characterized by a wider distributed frequency that changes with temperature with values in the range of 120-160 MHz and asymmetry parameter varying from 0.4 to 1. This interaction was associated with 111Cd probes tapped in defects near the surface of the nanoparticles.

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