

Diffusion of ^{111}Cd probes in Ga_7Pt_3 studied by nuclear quadrupole relaxation

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Ga_7Pt_3 has the cubic Sn_7Ir_3 structure, with 40 atoms per unit cell, including one Pt-site and two inequivalent, noncubic Ga-sites, designated Ga(3) and Ga(4) according to the number of sites per formula unit. Using the method of perturbed angular correlation of gamma rays, $^{111}\text{In}/\text{Cd}$ probes were found to occupy both Ga-sites. The temperature dependence of the ratio of site-fractions for probes on Ga(3) and Ga(4) sites yielded a difference in site energies of the probe on the two sublattices $E[\text{Ga}(4)]-E[\text{Ga}(3)]=+0.10$ eV, similar to what had been previously observed in Ga_7Pd_3 [1].

Nuclear relaxation was observed at high temperature that is attributed to diffusional jumps of probe atoms [2], as a consequence of changes in orientation and/or magnitude of the electric field gradient. The sum of quadrupole perturbation functions for probes on Ga(3) and Ga(4) sites could be fitted with products of static functions and exponential attenuation factors $\exp(-\lambda t)$. Relaxation frequencies λ are proportional to jump frequencies w . Although the phase appears as a line compound in the binary Ga-Pt phase diagram, it has been observed that w can be highly sensitive to composition in narrow phase fields [3]. Accordingly, samples were studied having mean concentrations of 27 and 31 at. % Pt, so that major volume fractions of the samples were of Ga_7Pt_3 at the more Ga-rich and Ga-poor boundary compositions. Arrhenius plots of relaxation frequencies for the Ga(3) site yielded jump-frequency activation enthalpies and prefactors that were equal for both samples: 0.85(7) eV and 8×10^{11} Hz. At the same time, relaxation frequencies for probes on Ga(4) sites were about a factor of three greater than on Ga(3) sites, just as observed for Ga_7Pd_3 . The equality of values of w for Ga(3) sites at opposing boundary compositions suggests that the width of the phase field is very small, much less than one atomic percent. The present values can be compared with 0.49(2) eV and 2×10^{11} Hz obtained for the Ga(3) site in Ga_7Pd_3 [1]. Qualitatively, jump frequencies of Cd probes in Ga_7Pt_3 are 10-100 times lower than in Ga_7Pd_3 . Reasons for such large differences in jump frequency in chemically similar compounds will be discussed.

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