Simultaneous measurement of tracer jump frequencies on different sublattices*

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Recently, we showed how the method of perturbed angular correlation of gamma rays (PAC) can be used to measure jump frequencies of probe atoms through relaxation of the nuclear quadrupole interaction [1, 2, 3]. In this paper, the method is extended to Ga_7Pd_3, a cubic phase having 40 atoms per unit cell and two inequivalent sublattices of Ga-sites having 3 and 4 atoms per formula unit. Samples were made by arc-melting high-purity metals with carrier-free ^{111}In radioactive PAC probes. At left below are shown PAC perturbation functions $G_2(t)$ measured at the indicated temperatures. Additional measurements demonstrate that the signals having 25-ns and 115-ns periods belong to probe atoms on Ga(3) and Ga(4) sublattices, respectively. As can be seen, each signal becomes more damped with increasing temperature. Empirical fits were made to the form $G_2(t) = G_2^{static} \exp(-\lambda t)$, in which G_2^{static} is the static quadrupole interaction perturbation function and λ is a relaxation frequency that is of the order of the jump frequency of the probe (inverse of the residence time on a site). At right is an Arrhenius plot of the two relaxation frequencies, yielding activation enthalpies of 0.49(2) eV and 0.44(4) eV, respectively, for probes starting on Ga(3) and Ga(4) sublattices. It will be shown that the two observed relaxation frequencies can arise from jumps of probes between Ga(3)-Ga(3) sites, between Ga(4)-Ga(4) sites, and inter-sublattice jumps between Ga(3)-Ga(4) sites. Possible scenarios to explain the results will be presented.

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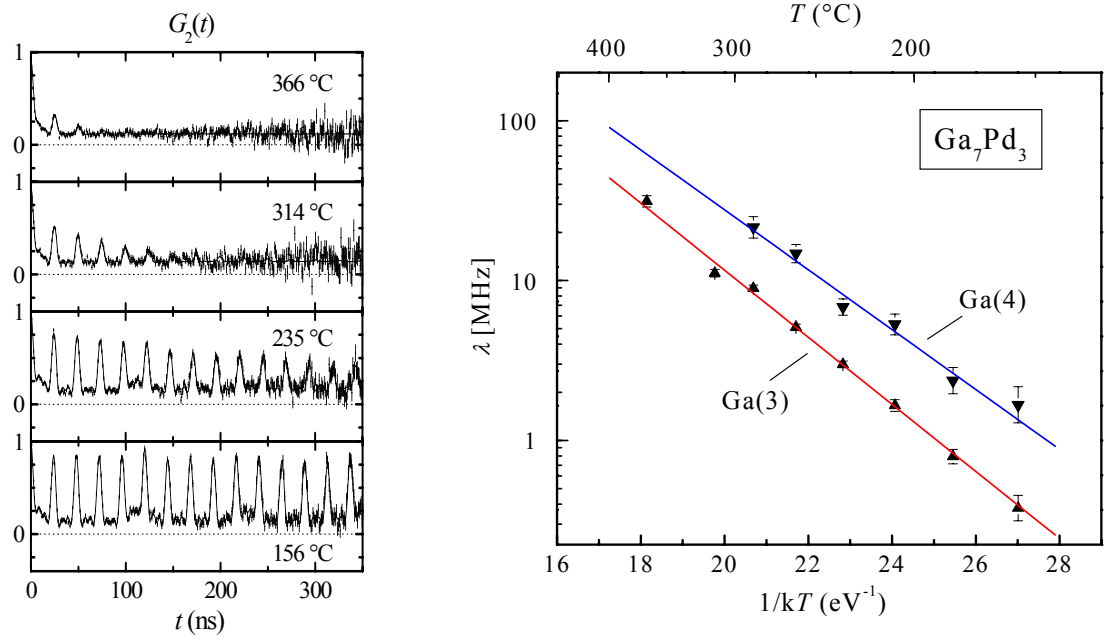

1. Matthew O. Zacate, Aurélie Favrot and Gary S. Collins, Physical Review Letters 92, 225901 (2004).
2. G.S. Collins, A. Favrot, L. Kang, D. Solodovnikov and M.O. Zacate, Defect and Diffusion Forum 237-240, 195-200 (2005).
3. Gary S. Collins, Aurélie Favrot, Li Kang, Egbert Rein Nieuwenhuis, Denys Solodovnikov, Jipeng Wang and Matthew O. Zacate, Hyperfine Interactions (Springer, available Feb. 2006).