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The effect of substitution of Ge for Si on the magnetic properties of $LaMn_2Si_2$ investigated by PAC spectroscopy with ^{111}Cd probe nuclei

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The effect of Ge substitution for Si in $LaMn_2Si_2$ compound on the magnetic hyperfine field (B_{hf}) properties has been investigate by perturbed γ-γ angular correlation (PAC) spectroscopy using ^{111}Cd as probe nuclei at Mn sites. The magnetic properties of $LaMn_2X_2$ (X = Si, Ge) compounds are associated with the magnetic ordering of Mn ions, which form a magnetic subsystem ordering at relatively high temperatures. The ferromagnetic transition when Ge gradually substitutes Si with concentrations of 10%, 20%, 40%, 80% and 100% will be discussed in this work. Samples of $LaMn_2Si_2(Ge_2)$ (La = 99.9%, Mn = 99.999%, Si = 99.999%, and Ge = 99.9999% purity) were prepared by arc-melting the constituent elements in stoichiometric proportions. The compounds were characterized by X-ray diffraction and the results analyzed with Rietveld method. Results show that all samples crystallize in the expected tetragonal structure with single phase containing Si and Ge ions on the same crystallographic site. Carrier-free ^{111}In (^{111}Cd) probe nuclei were added to the compounds having by thermal diffusion. PAC measurements were carried out in the temperature range of 10 K to 325 K. PAC results show that the dependence of B_{hf} with temperature follows the expected behaviour for the host magnetization, and can be fitted by Brillouin function for J_{Mn} = 5/2. Results also show a transition from antiferromagntic ordering with T_N= 480 K and T_N= 415 K followed by a ferromagnetic ordering with T_C= 308.5 K and T_C= 323.6 K, respectively for $LaMn_2Si_2$ and $LaMn_2Ge_2$. However, when Ge concentration increases T_N decreases while the Curie temperature increases.