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Magnetic clusters on the verge of long range ferromagnetism in Lu(Fe_{0.75}Al_{0.25})₂ and Lu(Fe_{0.50}Al_{0.50})₂ alloys

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Abstract

Lu(Fe_{0.75}Al_{0.25})₂ and Lu(Fe_{0.50}Al_{0.50})₂ alloys have been produced by arc-melting. DC and AC magnetization, Mössbauer spectroscopy, specific heat and neutron diffraction experiments have been performed to determine their magnetic ground state. DC magnetization curves measured at low fields ($H < 1$ kOe) evidence two peaks, at T_{SRO} and T_f , and magnetic irreversibility. The peak at T_{SRO} vanishes and the one at T_f smears out when high fields ($H \geq 1$ kOe) are applied. The thermal variation of AC susceptibility shows that both transitions at T_{SRO} and T_f are frequency dependent. Neither magnetic splitting nor broadening is observed in the Mössbauer spectra of both compounds in the $T_f < T < T_{SRO}$ thermal range. A magnetically split spectrum is only observed in Lu(Fe_{0.75}Al_{0.25})₂ for $T < T_f$. The absence of long range ferromagnetic order in both alloys is confirmed by specific heat and neutron diffraction measurements. The overall interpretation points to a clustered magnetic environment due to the random positions of Fe atoms in the crystallographic cell. At T_{SRO} a short range ferromagnetic order takes place within the clusters, which become frustrated at T_f , when the random anisotropy of the clusters enables their freezing.

Keywords: Intermetallic compounds; Laves phases; Magnetic measurements; Mössbauer spectroscopy; Cluster spin-glass behavior; Short-range ferromagnetic order.

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