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Critical phenomena and estimation of the spontaneous magnetization by a magnetic entropy analysis in $Mn_{0.96}Nb_{0.04}CoGe$ alloy

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Magnetic and magnetocaloric properties of the alloy $Mn_{0.96}Nb_{0.04}CoGe$ have been investigated. According to the mean-field theory prediction, the relationship between $\Delta S_M \propto (H/T_C)^{2/3}$ has been confirmed in the temperature region near T_C for that system. To investigate the nature of the magnetic phase transition, a detailed critical exponent study has been performed. The critical components, γ, β, and δ determined using the Kouvel-Fisher method, the modified Arrott plot, as well as the critical isotherm analysis agree well. Moreover, these critical exponents are confirmed by the Widom scaling law and the validity of the calculated critical exponents was also confirmed by the scaling theory. The values deduced for the critical exponents are close to the theoretical prediction of the mean-field model values, thus indicating that long range interactions dominate the critical behavior in the $Mn_{0.96}Nb_{0.04}CoGe$ system. It is also speculated that the competition between the localized Mn-Mn magnetic interactions should be responsible for the critical behavior in this system. Moreover, an excellent agreement is found between the spontaneous magnetization determined from the entropy change ($-\Delta S_M$ vs. M^2) and the classical extrapolation from the Arrott curves (H/M vs. M^2), thus confirming that the magnetic entropy change is a valid approach to estimate the spontaneous magnetization in this system.
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