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Magnetotransport properties of inverse-spinel $Cr_xFe_{3-x}O_4$ thin films

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Magnetotransport properties of $Cr_xFe_{3-x}O_4$ ($x \leq 0.95$) thin films prepared using a sol-gel method were measured and analyzed in comparison with their magnetic properties. The samples were polycrystalline and exhibited a slight decrease in lattice constant as the Cr composition (x) increases. The observed decreasing trend in the saturation magnetization (M_s) of $Cr_xFe_{3-x}O_4$ with increasing x can be explained in terms of the decrease in net spin magnetic moment due to the substitution of $Cr^{3+}(3\ \mu_B)$ for octahedral $Fe^{3+}(5\ \mu_B)$. The magnetoresistance (MR) of the $Cr_xFe_{3-x}O_4$ films was found to increase in a linear manner with increasing external field ($H \leq 5$ kOe) while the observed magnetization of the samples started to saturate near $H=2$ kOe. For a given H, MR decreases with increasing x. The observed increase in MR with increasing H in $Cr_xFe_{3-x}O_4$ is mainly attributable to the reduction in tunneling resistance of spin-polarized carriers through grain boundaries (GBs). Transition layers of magnetization formed around magnetic defects in the GBs are likely to be connected to the spin-dependent tunneling. The decrease in MR with increasing x is attributable to the disorder-induced scattering.
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