Modeling the Role of the Buildup of Magnetic Charges in Low Anisotropy Polycrystalline Materials

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Abstract

A Stoner-Wohlfarth-type model is used to demonstrate the effect of the buildup of magnetic charges near the grain boundaries of low anisotropy polycrystalline materials, revealed by measuring the magnetization during positive-field warming after negative-field cooling. The remnant magnetization after negative-field cooling has two different contributions. The temperature-dependent component is modeled as an assembly of particles with thermal relaxation. The temperature-independent component is modeled as an assembly of particles overcoming variable phenomenological energy barriers corresponding to the change in susceptibility when the anisotropy constant changes its sign. The model is applicable to soft-magnetic materials where the buildup of the magnetic charges near the grain boundaries creates demagnetizing fields opposing, and comparable in magnitude to, the anisotropy field. The results of the model are in qualitative agreement with published data revealing the magneto-thermal characteristics of polycrystalline gadolinium.

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Magnetic Remanence Resiliency Compositionality Internet of Things cyber physical systems Anisotropic magnetoresistance anisotropy field composability demagnetisation gadolinium grain boundaries low anisotropy polycrystalline materials Magnetic anisotropy magnetic charges magnetic susceptibility Magnetization magneto-thermal characteristics magnetocaloric effects Magnetometers negative-field cooling Perpendicular magnetic anisotropy phenomenological energy barriers polycrystalline gadolinium polymer structure positive-field warming pubcrawl remanence remnant magnetization Soft magnetic materials soft-magnetic materials Stoner-Wohlfarth-type model Stoner?Wohlfarth model susceptibility Temperature measurement thermal relaxation