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Low-temperature magnetic properties of single-domain and two-domain partially-oxidized magnetite

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Magnetite, Fe_3O_4, oxidizes readily in ambient atmosphere to a less stoichiometric form. The oxidation is often incomplete and the resulting product likely has a gradient of stoichiometry. We present new low-temperature results for partially-oxidized and stoichiometric single-domain and two-domain magnetite. Results from the temperature-cycling of a room-temperature saturation remanent magnetization demonstrate clearly that while the amount of remanence lost at 300K before and after such temperature cycling scales with grain size for stoichiometric samples, the same does not hold for partially-oxidized samples. A saturation magnetization imparted at low-temperature ($\sim$5K) monitored on warming depends critically on the field treatment during cooling from 300K to $\sim$5K. We will present results for two types of cooling treatments, one with varying field strength and the other with restricted temperature window of applied field, and explain how they deviate from our current understanding of the role an applied field has in controlling the selection of one of the [100] in the cubic phase to be the new magnetocrystalline easy axis as magnetite cools below the Verwey transition. To understand further the low-temperature behavior of partially-oxidized magnetite and to gather evidences for surface spin disorder induced effects, we measured and found shifts in the irreversible component of hysteresis loop at low temperature, cooling-treatment dependent AC susceptibility measured on warming, and waiting-time dependent DC susceptibility measured on warming.