Size effect on magnetic properties of $LiFePO_4$ particles

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Fine tuning of the $LiFePO_4$ structure and/or of valance of iron ions can change significantly magnetic properties of $LiFePO_4$, a candidate material for electrodes in rechargeable Li-ions batteries. It is known that partial lithium extraction from $LiFePO_4$ affects its intrinsic magnetic properties, leading to an increase of the Néel temperature from 50 K to 125 K (A. Ait-Salah et al., Z. Anorg. Allg. Chem. 632 (2006) 1598). We found for the particles of $LiFePO_4$ the appearance of an additional antiferromagnetic transition at 125 K as well as the presence of a minor phase showing a spontaneous magnetization with T_C above room temperature along with the presence of a main antiferromagnetic phase, characteristic of a bulk $LiFePO_4$ with T_N of about 50 K. Importantly, the transition at 125 K can be suppressed by relatively small magnetic field of the order of 0.3 T. We attribute the observed behavior to the electronic and/or structural differences between the outer layers and the interior of the $LiFePO_4$ particles.