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Different magnetic behaviors of Mg and Zn doped Fe_3O_4 nanoparticles estimated in terms of crystal domain size, universal dielectric response and application to anodes for lithium ion batteries

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Magnesium (Mg) doped Fe_3O_4 nanoparticles representing as $MgxFe_3$-xO_4 ($0<x\leq1$) was analyzed in comparison with zinc (Zn) doped Fe_3O_4, $ZnxFe_3$-xO_4. Magnetization vs. applied magnetic field for $MgxFe_3$-xO_4 particles provided the maximum saturation magnetization (Ms) with 69.4 emu/g at x=0.1 as super-paramagnetism, while the Ms by Zn-doping was 80.9 emu/g at x=0.2. The crystal unit volume (Vc) by Mg-doping at ($x\leq0.5$) were constant but the crystal size decreased with increasing x. Further doping beyond x=0.6 provided small amorphous power aggregates which offer universal dielectric response implying highly disordered system. In contrast, the Vc by Zn-doping expanded up to x=0.4 as the acceptable limit, which was attributed to the large difference between doping ion radius and replaced Fe^{3+} ion radius. On the other hand, the $ZnxFe_3$-xO_4 ($0\leq x\leq1$) and $MgxFe_3$-xO_4 ($0\leq x\leq0.6$) formed by a crystal domain were analyzed by a three-circuit model with one normal parallel circuit and two circuits with resistance and constant phase element (CPE). The stability of capacity as anode of lithium ion batteries was investigated for the composites prepared by adhering Mg^{2+}, Fe^{2+} and Fe^{3+} on sidewalls of as-modified multiwall carbon nanotubes (MWCNT), in which poly(vinylalcohol) (PVA) was used as a hydrogen bond functionalizing agent to modify MWCNTs. Among the ferrite composites, $Zn_{0.2}Fe_{2.8}O_4$ provided the highest capacity with good stability under discharge and charge cycles. The reason is due to the highest crystal unit volume of $Zn_{0.2}Fe_{2.8}O_4$ to accept lithium ions.

Biography

Masaru Matsuo has completed his PhD at Kyoto University in Japan and he was a professor of Nara Women's University. After his retirement, he becomes a professor of Dalian University of Technology in China. He has published about 200 papers in refereed journal articles. He is one of IUPAC fellows and he received Paul Flory Polymer Research Prize on April 2009.

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