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Dramatic Enhancement of the Saturation Magnetization of a Sol-Gel Synthesized $Y_3Fe_5O_{12}$ by a Mechanical Pressing Process

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Abstract

We fabricated polycrystalline yttrium-iron-garnet ($Y_3Fe_5O_{12}$, YIG) samples using the sol-gel synthesis method to develop an energy harvesting material based on the spin Seebeck effect. We confirmed that crystallization occurred during calcination at 850 °C and that only the polycrystalline YIG structure was formed. We found that a sintering process at 1400 °C not only increased the size of the YIG particles and the densification of their microstructure but also enhanced their saturation magnetization (M_s) and dramatically reduced their coercivity (H_c). A mechanical pressing process was carried out between the calcination and sintering treatments to prepare a free-standing YIG fillet sample. We found that M_s was enhanced by almost three times without an associated reduction in H_c. We found that mechanical pressing assists the oxidation reaction during the subsequent sintering process by increasing the surface energy and densification before the heat treatment.

Keywords: Sol-gel processes; Oxidation; Thermoelectric materials; Microstructure; Magnetic measurements