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Bulk Anisotropic Nd-Fe-B/α-Fe Nanocomposite Permanent Mangets Prepared by Sonochemistry and Spark Plasma Sintering

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Nanocomposite permanent magnets have attracted much attention due to their potential magnetic properties[1]. In recent years, many efforts have been put into the preparation of bulk nanocomposite permanent magnets. The importance of preparation is to make two-phase grain coupled well and to obtain high densities anisotropic magnets without excessive grain growth. In present study, we applied Sonochemistry and spark plasma sintering (SPS) technique to prepare full dense anisotropic NdFeB/α-Fe nanocomposite magnets. Magnetic properties and microstructure of the magnets were also studied.

The two-phase nanocomposite powders were obtained by sonochemistry method using decomposing carbonyl iron as the α-Fe source. NdFeB particles in several micrometers were coating by the iron nanoparticles, the nominal Fe content can be controlled accurately. Then the composite powders were densified and deformed by SPS.

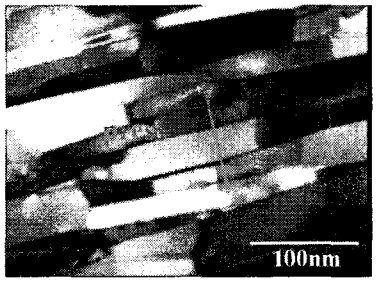

Fig. 1. TEM image of anisotropic NdFeB/α-Fe magnet after hot deformation

After coating process, the NdFeB powders were coated with nano-sized Fe particles well and homogeneously. Average size of iron particles was about 10 nm. Bulk compact NdFeB/α-Fe nanocomposite magnets with full dense were obtained by SPS process. An obvious remanence enhancement was observed in the isotropic magnets, in detail, value of B_r reached to 0.96T when α-Fe content was 5 vol.%. It is also worth noting that a little addition of amorphous boron powders will increase the coercivity of the magnets. After hot deformation, the magnets gained anisotropy, and displayed desired grain alignment as showed in Fig. 1. The magnetic properties of the anisotropic magnet were B_r=1.39 T, $_iH_c$=712 kA/m, and $(BH)_{max}$=327.44 kJ/m^3.

In conclusion, nano-sized α-Fe coating NdFeB two-phase powders were obtained by sonochemistry method, the two phases mixed homogeneously and quantificationally. Bulk NdFeB/α-Fe nanocomposite magnets with nearly full density were created successfully by hot pressing in SPS. Anisotropic magnets were fabricated by subsequent hot deformation.

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Surfactant-assisted sol-gel auto-combustion synthesis of Sr-hexaferrite nanopowder using different fuels and basic agents

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Magnetic ceramic powder of Sr-hexaferrite is generally prepared through a solid-state route. However, the other Sr-hexaferrite synthesis methods leading to highly homogeneous powders with finer particle size and better sinterability have attracted considerable attention in recent years. It is well known that low-temperature sintering can be achieved by using active ultra fine powders synthesized by wet-chemical methods. Several chemical processing techniques, such as hydrothermal, salt melt, co-precipitation and sol-gel auto-combustion have been investigated to prepare ultra fine Sr-hexaferrite powder. Among these techniques, sol-gel auto-combustion synthesis has been approved as a simple and economic way to prepare nanoscale powders. In this technique, an auto-ignition reaction of a dried gel, which has been formed from a solution of metal nitrates and an organic fuel, takes place [1]. Addition of surfactant into precursor solution results in formation of reverse micelles in the gel. Placing the aqueous ions inside these micelles can be effective in controlling the nucleation and growth of the particles [2, 3].

In this research Sr-hexaferrite powders synthesized by a sol-gel auto-combustion process using sodium dodecyl sulfate (SDS) as an anionic surfactant were studied for the first time. The influence of the amount of the surfactant on the synthesis process and physical properties of the powders were investigated by scanning electron microscopy (SEM), Fourier transform infrared (FTIR) spectroscopy and X-ray diffraction (XRD) techniques. With addition of this surfactant in the molar ratio of surfactant/strontium: 0.4, the combustion intensity increases significantly and single phase Sr-hexaferrite forms by calcination at 800 °C, with crystallite size of 26.7 nm.

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