Microstructure and magnetic properties of nanocomposite permanent magnetic materials

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It is well known that nanoscale magnetic materials can exhibit significantly different magnetic properties than the corresponding bulk materials. In present work, we summarized the preparation, microstructure, Mössbauer study and magnetic properties of nanocomposites. It was found that both grain size and the amount of magnetically soft phase α-Fe play a very important role in determining the magnetic properties. Due to very broad diffraction peaks from very fine crystallites, it is difficult to determine quantitatively the amount of different phases present or, in some cases, to even identify these phases, by x-ray diffraction technique. Mössbauer spectroscopy, however, is very powerful technique for investigating the nearest neighbor environment of resonant nuclei and gaining additional information about the phase composition that cannot be resolved by x-ray diffraction. Furthermore, Mössbauer experiments can obtain reliable absorption intensities of subspectra, which are proportional to the site occupancies of Fe atoms, and consequently can determine the quantity of each phase. Our work demonstrated that nanocomposite permanent magnets composed of magnetically hard and magnetically soft phases show a significant enhancement of remanence when the grain sizes of both phases are comparable with the exchange length (several nanometers). The origin of "exchange-spring" coupling and remenance enhancement has been discussed.