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Abstract George Hadjipanayis:

Development of ThMn 12-type compounds for permanent magnets

Interest on the ThMn12-type hard magnetic materials has increased markedly in recent years motivated in part by the fact that the Nd-Fe-B energy product limit has been reached and in part by the desire to decrease the reliance of permanent magnets on critical elements. New approaches, such as high-throughput screening and mechanochemical synthesis enriched the arsenal of techniques that are currently being utilized in the development of the ThMn12-type functional materials. The maximized concentration of Fe in NdFe12Nx films, which was stabilized by epitaxy, resulted in fundamental hard magnetic characteristics superior to those of the Nd2Fe14B. Other-than-epitaxy approaches which are more appropriate for bulk materials are also being sought. The relatively abundant cerium has been considered as the principal rare earth element in lower-cost medium-grade ThMn12-type magnets; the Si-stabilized compounds with Ce were found to be of particular interest because of their anomalously high Curie temperatures. A new rare-earth-free uniaxially anisotropic ZrFe10Si2 compound has been discovered, and R1-xZrxFe10Si2 compounds with R = Ce, Sm were proposed for the development of magnets that are minimally reliant on the rare earth elements. The newly employed mechanochemistry proved to be an attractive synthesis technique having produced in particular a submicron Sm0.7Zr0.3Fe10Si2 powder with a coercivity of 10.8 kOe and a calculated maximum energy product of 13.8 MGOe. At the same time, little progress has been made in the fabrication of fully dense ThMn12-type magnets because of the inherent instability of the nitrides and the unfavourable phase equilibria involving the more stable compounds. The work was supported by U.S. Department of Energy and University of Delaware Energy Institute.