Controlling the parameters of Pressure-less Spark Plasma Sintering of Sr-ferrite magnets

Aleksander Učakar[1,2,3], **Andraž Kocjan**[2,3] **and Petra Jenuš**[2,3]

[1]Center for Microscopy and Microanalysis, Jožef Stefan Institute, 1000 Ljubljana, Slovenia
[2]Department for Nanostructured Materials, Jožef Stefan Institute, 1000 Ljubljana, Slovenia
[3]Jožef Stefan International Postgraduate School, 1000 Ljubljana, Slovenia

Permanent magnets (PM) are very important in current enabling technologies and modern devices. They allow storing, delivering, and converting energy. [1] If we are comparing production quantities Sr and Ba Ferrites are one of the world's most-produced permanent magnetic materials [2]. Although ferrite magnets are inferior in performance to rare-earth magnets, the harmful environmental impact of rare-earth magnet production, uneven distribution, and increasingly questionable supply due to geopolitical fluctuations force us to look for substitutes. One such substitute is coming from the group of hexagonal ferrites [3]. Much attention has been devoted in recent years to the development of various methods of consolidation of this strategically important material, and Pressure-less Spark Plasma Sintering (PSPS) offers rapid consolidation of products with complex geometries.

In this study we were researching PSPS of Sr hexaferrite. With this method, we want to prepare a magnet with a fine microstructure that would exhibit magnetic properties comparable to commercially available magnets. Tailoring of experimental parameters played an important role in this research. We controlled preparation of green pellets (sample dimensions, uniaxial compression, isostatic compression, particles' magnetic orientation) as well as sintering process itself. In sintering we focused mainly on heating rate, sintering temperature and retention time. The experiments have been done in SPS device with a modified graphite die that enabled isolated radiation sintering. Graphite die heats up by Joule effect and energy is transferred to the sample via thermal radiation effect. Once the energy reaches the sample it is then transferred through it via conduction. The advantage of the PSPS method is that it enables rapid sintering, which allows us to consolidate the material and preserve smaller crystal grains. The key objective of this research was to produce a magnetic sample with fine microstructure exhibiting comparable magnetic properties to the commercially available ones. Fine microstructure is important because we want to make a material with the highest possible coercivity, which is affected by the particles size. Samples magnetic properties were tested with a vibrating magnetometer, their chemical composition was analysed by XRD and an in-depth SEM analysis was performed.

Key words: Sr hexaferrite, magnets, sintering, SEM, EDS

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