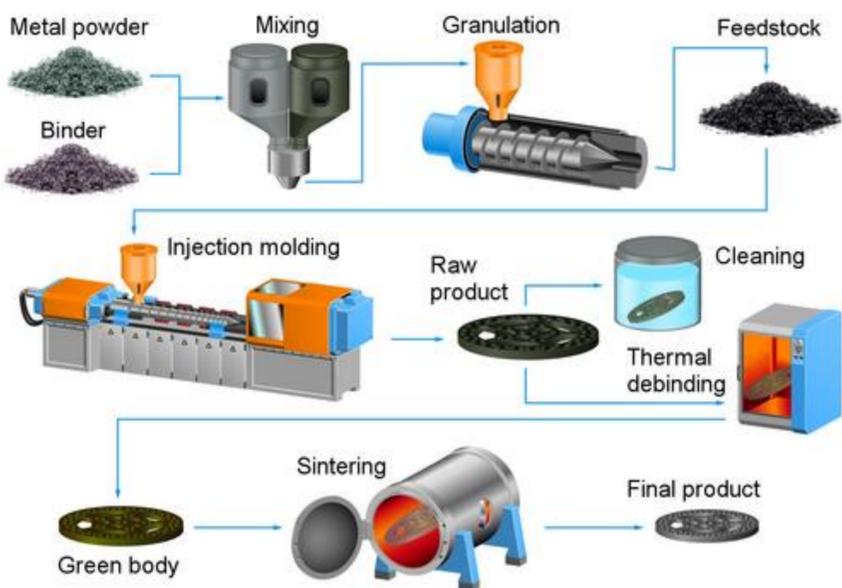


# FABRICATION OF Sm-Co-Fe-Cu-Zr AND SrFe<sub>12</sub>O<sub>19</sub> BASED PERMANENT MAGNETS BY PIM-TECHNOLOGY AND STEREOLITHOGRAPHY METHODS

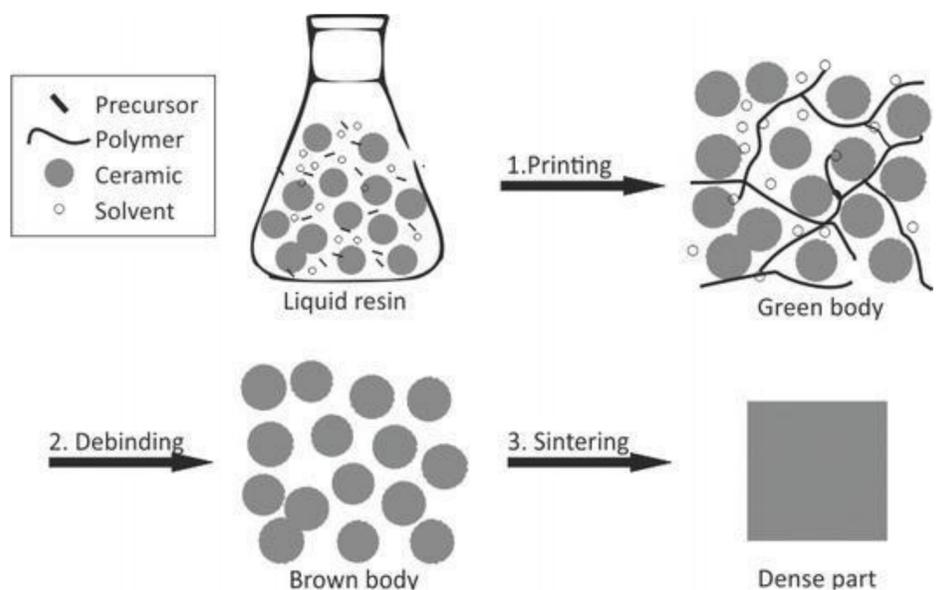
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**Abstract:** Additive manufacturing and powder injection molding (PIM) technologies promise much for the production of permanent magnets. PIM-technology has been successfully used for fabrication of Fe-Cr-Co permanent magnets with clear structure and high magnetic properties in comparison with investment casting technology. And SLM technology applied for building of one layer from Nd-Fe-B powder. This work dedicated to study possibility of making ceramic magnets based on cheap strontium hexaferrite SrFe<sub>12</sub>O<sub>19</sub> and anisotropic Sm-Co-Fe-Cu-Zr magnets by PIM-technology and application of fine ferrite powders for fabrication of photopolymers and their usage for making complex shape samples by SLA method

## Scheme of permanent magnet production by PIM-technology



## Scheme of permanent magnet production by SLA-technology



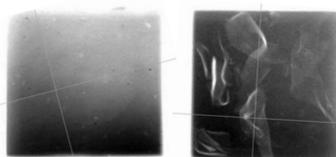
### 1. Feedstock preparation



Sm-Co powders with chemical composition (wt. %) 25.1 Sm, 48.8 Co, 18.1 Fe, 5.4 Cu, 2.6 Zr and strontium hexaferrite with average particle size was 22 μm were mixed with organic binder to prepare granulate for PIM method

Granulate was compacted in an injection molding machine at the temperature close to melting temperature of organic binder to obtain «green body». Feedstock filled with SrFe<sub>12</sub>O<sub>19</sub> powder were pressed without application magnetic field while Sm-Co powders were aligned inside «green bodies» by external magnetic field of 2 T

### 2. Green body fabrication



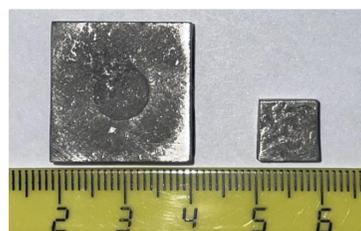
Tomography of SrFe<sub>12</sub>O<sub>19</sub> «green bodies» with and without defects

### 3. Brown body fabrication

They were obtained by solvent debinding: «green bodies» were kept in acetone, heptane and perchloroethylene at different temperatures. The largest amount of binder (6.5 wt. %) was removed using acetone at 40 °C

### 4. Sintering

Sintering of «brown bodies» filled with Sm-Co-Fe-Cu-Zr and ferrite powders was performed in vacuum furnace in argon and in muffle furnace in an oxidizing atmosphere respectively. Density of Sm-Co and ferrite magnets was 8.2 and 4.8 g/cm<sup>3</sup> respectively

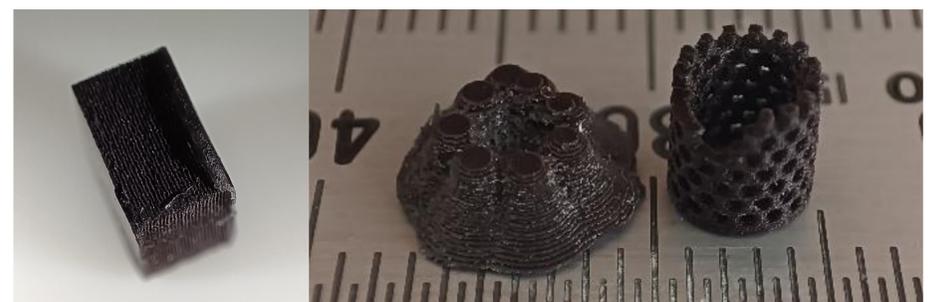


Anisotropic and isotropic Sm-Co magnets obtained by PIM-technology

3D printing by stereolithography was possible with a maximum filling of photopolymers by 19 wt. % of strontium hexaferrite powder with average particle size of 5 μm. Increase of the ferrite powder amount made polarization impossible even with powerful UV source. Research will be continued with usage of finer powders with particle sizes < 1 μm obtained by the sol-gel method



Autodesk Ember



SrFe<sub>12</sub>O<sub>19</sub> «green bodies» with different geometry obtained by SLA

### Magnetic properties

Magnetic properties of isotropic strontium hexaferrite permanent magnets obtained by PIM-technology were about 70 % of theoretical values: H<sub>CB</sub> = 71.1 kA/m, B<sub>r</sub> = 0.09 T. It occurred because of the low density of the samples and the presence of defects (cracks and pores). Combination of high density of Sm-Co-Fe-Cu-Zr permanent magnet and heat treatment allowed to achieve magnetic properties close to requirements of technical documentation on anisotropic magnets: H<sub>CB</sub> = 743.8 kA/m, B<sub>r</sub> = 0.97 T, (BH)<sub>max</sub> = 219.5 kJ/m<sup>3</sup>

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