Novel and Sustainable Manufacturing of Nanocrystalline Ferrite Permanent Magnets through Recycling and Additive Manufacturing

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Permanent magnets (PMs) based on ferrites are the most used due to their availability and low cost, being an alternative to PMs based on critical rare-earths in new applications such as electromobility [1]. This study will show the possibility of fabricating objects by 3D-printing using nanostructured Sr-ferrite powder obtained through recycling of the residue generated from the fabrication of commercial ferrite magnets. Tuning the morphology and structure of the residue by post-processing made possible to obtain Sr-ferrite nanocrystalline powder with PM properties superior, not only to the residue precursor, but to those of the brand-new commercial powder (3.5 fold increase in coercivity and a 25% increase in remanence) [2].

The recycled Sr-ferrite was used as starting material for the synthesis of composites by solution casting [3], and extruding filaments (Fig. 1a) for advanced manufacturing of magnets (with a particle content up to 65 wt%) by Fused Filament Fabrication technology. Scanning Electron Microscopy (SEM) analysis showed a homogeneous distribution of the particles in the polymer matrix. The magnetic characterization of the composites, filaments and printed objects by Vibrating Sample Magnetometer (VSM) showed that the magnetization scales to the content of ferrite particles (Fig. 1b) and that there is no deterioration of the PM properties of the starting particles along the processing (Fig. 1c) [4]. This work has shown an efficient route for developing new and alternative PMs by the combination of recycling and 3D-printing.

References

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Figures

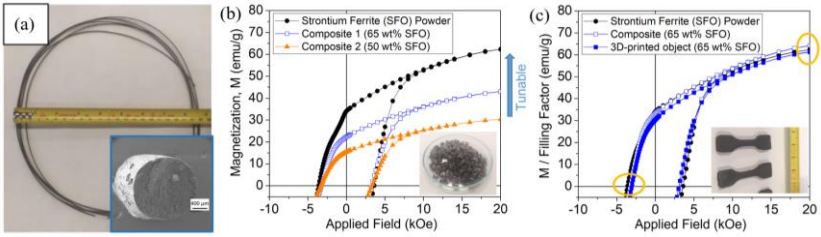

Figure 1: (a) Extruded filament (65 wt% of SFO) and SEM image showing its circular cross section; (b) first and second quadrants of the hysteresis loops of starting powder and composites (image in inset) with different content of ferrite; and (c) normalized hysteresis loops of the starting powder, composite and 3D-printed object. Inset shows 3D-printed pieces for tensile tests based on ferrite particles.

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