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Hysteresis Design of Magnetic Materials for Efficient Energy Conversion

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Advances in the fabrication of rare earth-free permanent magnets by thermally controlled additive manufacturing: case study of gas-atomized MnAlC alloy

Multi-material additive manufacturing (AM) is attracting much interest in many high-tech sectors (e.g., transport, energy, aerospace, medicine) as it allows the fabrication of complex high-performance objects with tuned properties [1]. For permanent magnet (PM) applications, the fabrication of magnets with no geometrical constrictions and no deterioration of their magnetic properties is a relevant point and a present challenge [2], together with finding alternatives to rare earth-based magnets [3]. Improved ferrites and the promising MnAlC-based alloys are expected to partially cover the gap between conventional ferrites and NdFeB, provided successful development of adequate PM properties [3].

Along this talk the process for developing rare earth-free magnets by AM will be explained, going from the synthesis of composites (PM particles/polymer) to the 3D-printing of magnets. Different alternative PM materials (gas-atomized τ-MnAlC, ferrite and, by comparison, hybrids –ferrite/NdFeB) have been studied in collaboration with the companies Höganäs AB (Sweden) and IMA (Spain). The effect of particle size, polymer and fabrication parameters on the properties of the final products was analysed, showing that they are key factors to be considered and optimized for obtaining flexible and continuous filaments with a high filling factor and non-deteriorated magnetic properties [4]. Optimized MnAlC-based filament (with a high MnAlC content of 80 wt.%) was used for 3D-printing objects, proving that alternative PM materials can be efficiently synthesized and processed for developing novel PMs by AM [4].

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