Doctoral Dissertation
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(35.th cycle)

Feasibility study of components manufactured using additive technology for the electrical sector

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Summary

This research work addresses the application of Additive Manufacturing (AM) technologies for the production of ferromagnetic components. The design freedom offered by AM allow to realize component with complex geometry, so new geometries can be made for the most common applications such as the electric motors. The thesis explore the possibility offered by AM to improve ferromagnetic objects for lightweight and high performance point of view, with potential in several industrial sectors. First of all, the printing technique that best lends itself to the production of these components was investigated. From the studies carried out, it appears that the optimal technique is the Laser Powder Bed Fusion (LPBF). After the technique was identified, the printing parameters that influence the microstructural properties and consequently the mechanical, electrical and magnetic properties were characterized. Subsequently, post-processing heat-treatments were analyzed to undestand its influence on the magnetic properties. The results of this research show that, by means of LPBF, silicon steel parts with permeability ($\simeq$ 3000) and hysteresis loss ($\simeq$ 85.6 A/m) can be produced. Two new applications, compared to the technical literature, are presented. A plug of an electromagnet and an electromagnetic shield. The results of the first application made it possible to understand some limitations of the printing technology. For example, the creation of small axial-symmetric objects involves a tolerance with respect to the axis of revolution to be taken into consideration. The application of the electromagnetic screen is completely innovative as there are no applications of this kind in scientific literature. The results show good shielding properties for this kind of material, especially after annealing.Finally, we propose that further research should be aimed at expanding the range of applicability of this printed material , as well as at the adapting of the alloy's chemistry for improved ductility to avoid the risk of in-process cracking.

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