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ID:307-Thermal management from the build platform for laser powder bed fusion of Fe-Si alloys

ABSTRACT. In the process of actuator design, the limitations imposed by conventional manufacturing processes can be very restrictive. This is particularly true for certain types of actuators such as axial flux machines, where the lamination of the magnetic circuit, necessary to limit the occurrence of induced currents, is very complex. Additive manufacturing techniques, and in particular laser powder bed fusion (LPBF) of soft magnetic Fe-Si alloys, are likely to provide an answer to these limitations. To reach good magnetic properties, both in terms of magnetic permeability and iron losses, high silicon content Fe-based alloys have potential. However, at the desired contents, these alloys become very brittle, leading to numerous defects when used with LPBF, in particular the appearance of cracks and porosities. Babuska et al [1] showed that it is possible to enhance the ductility of Fe-50Co, and thus reduce the appearance of defects on brittle magnetic alloys, by regulating heat flows during the print. Inspired by their work, the present study aims to investigate how heat fluxes towards the building platform influence the formation of defect in the printed component. The effect of various support topologies is investigated by studying thermal dynamics using print-specific thermal curves. Dynamic finite element method (FEM) simulations are used to understand and manage heat fluxes. Finally, the validity of the thermal simulations is assessed by comparison with thermal measurements, and an evaluation is carried out on a complete print to reinforce the impact of heat flow management.

[1] Tomas F. Babuska et al., An additive manufacturing design approach to achieving high strength and ductility in traditionally brittle alloys via laser powder bed fusion, Additive Manufacturing, Volume 34, 2020, 101187, ISSN 2214-8604, https://doi.org/10.1016/j.addma.2020.101187