

# ADDITIVE MANUFACTURING OF SOFT MAGNETIC ALLOYS

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While there has been substantial effort focused on additive manufacturing (AM) of structural alloys over the past couple of decades, there have been rather limited efforts on AM of functional alloys, such as magnetic materials. The present study will focus on laser additive processing of magnetic alloys using the laser engineered shaping (LENS) process that falls under the category of directed energy deposition (DED) processes. Examples will be presented both from alloys using a feedstock consisting of a blend of elemental powders as well as pre-alloyed powders. Soft and semi-hard magnetic alloys of different types have been processed using LENS. These include those of the permalloy type, based on Fe-Ni, Ni-Fe-V and Ni-Fe-Mo compositions, as well as compositions based on Finemet,  $\text{Fe}_{73.5}\text{Si}_{13.5}\text{B}_9\text{Nb}_3\text{Cu}_1$ . Systematic changes in the laser-power and the travel speed have been correlated to the phase stability in the deposits of these soft magnetic alloys, and the consequent magnetic properties. The LENS technique can be effectively used to process compositionally-graded alloys by systematically varying the flow rates from individual powder hoppers that comprise the feedstock for this AM process. Influence of Fe/Co ratio on the microstructure and magnetic properties of Hiperco type soft magnetic alloys will also be discussed in this presentation. This work shows the feasibility of AM processing of soft magnetic materials.