3D-printing of magneto active elastomers: a topology optimization, printing parameters investigation, and rheological approach

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Magnetoactive elastomers (MAEs) have garnered significant interest as a versatile soft robotics candidate capable of actuation, sensing, energy storage, and energy harvesting. A design framework for a general actuation case can be realized through simultaneous shape, mechanical property, and magnetic property optimization. Topology optimization has been conducted to determine the optimal shape for different actuation cases, but 3D printing is also required to fabricate these shapes. Understanding the rheological behavior of MAE and the effect of printing parameters is vital to process and print an MAE. The goal of this research is to both topology optimize MAE actuators using coupled multiphysics, and fabricate the optimized shapes considering the rheology of PDMS with iron oxide ink and printing parameters using direct ink-writing. First, we conducted a comprehensive study on the rheological behavior of PDMS dispersions loaded with surface treated iron oxide to identify the optimum inks in terms of yield stress capability and shear thinning behavior. Second, we assessed the effect of printing parameters to define a standard for MAE 3D-printing, using those standards to find the optimum printing parameters. And finally, we conducted topology optimization of MAE actuators using coupled multiphysics.