
Surface morphing in 3D-printed magneto-active elastomers.

Vignesh Selvam^{*†1}, Laurence Bodelot¹, and Kostas Danas¹

¹Laboratoire de Mécanique des Solides (LMS) – Laboratoire de Mécanique des Solides, CNRS, Ecole Polytechnique, Institut Polytechnique de Paris – France

Abstract

This study investigates the controlled morphing of surfaces through the harnessing of magnetically-induced instabilities in heterogeneous magneto-rheological elastomer (MRE) layers bonded to non-magnetic soft substrates. The interplay between magnetic fields and elastic deformations is indeed utilized to actively control surface morphologies, where shape transformations are influenced by the material properties and the geometrical design of the active layer.

Herein, the Direct Ink Writing (DIW) printing technique is employed to print heterogeneously-structured MRE films bonded to a non-magnetic soft substrate. A rheologically-optimized MRE ink is developed, exhibiting the shear-thinning and yield-stress behaviors crucial for effective extrusion and deposition. Magneto-mechanical experiments then demonstrate how the geometrical design of the heterogeneous MRE layer influences surface morphing.

In parallel, a full-field 3D finite element numerical code capable of performing under large strains and magnetic fields is introduced and validated by experiments. It permits investigating a much wider breadth of material properties and geometrical designs, thereby opening up the path towards efficient programming of magnetically induced surface morphing.

*Speaker

†Corresponding author: vignesh.selvam@polytechnique.edu