Magneto-Rheological Elastomers: experiments and modeling

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Résumé

Magneto-Rheological Elastomers (MREs) are composite materials made of magnetizable metallic particles embedded in an elastomeric matrix. They belong to the class of smart materials since some of their properties, in particular their stiffness, can be modified by the application of an external stimulus, a magnetic field in their case. In the presence of a magnetic field, they can also exhibit large deformations. Hence they stand as promising candidates for a large number of engineering applications linked to tunable damping or non-contact actuation. The simplest form of MRE samples are isotropic due to a homogeneous dispersion of magnetizable spherical particles in their matrix but curing these composites under magnetic fields can impart them with anisotropic properties through the creation of particle chains in the direction of the curing field.

To our knowledge, there exists no precise and complete characterization of the fully- coupled magneto-mechanical response of MREs, which hinders the further design of MRE- based devices and the validation of magneto-mechanical models. The purpose of the present work is to develop a coupled experimental/numerical methodology for characterizing and modeling the coupled magneto-mechanical behavior of isotropic soft MREs that can sustain large deformations.

The first part of the presentation will introduce sample fabrication, including the question of interfacial adhesion between the magnetizable particles and their host elastomeric matrix. In the second part, the experimental setup developed to characterize the behavior of MREs under coupled magneto-mechanical mechanical loadings will be presented along with experimental results. Finally, a continuum phenomenological model of isotropic MREs will be introduced and it will be shown that an additional 3D finite-element model is necessary to identify the parameters of the model from the experimental data previously acquired.

Mots-Clés: Elastomères magnétorhéologiques, matériaux actifs

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