Characterization of Morphing Nanocomposites under a Quasi-Static and Impulsive Magnetic Field

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Abstract.

Designing composites with a specific set of mechanical and magnetic properties is of great interest to improve performance in a number of industrial fields. There is a large amount of literature on magnetic materials and on iron oxides but there is a general lack of information on the mechanical and magnetic characterization of composites, oriented towards macroscopic applications.

This paper deals with the realization of magnetic nanocomposites and their morphing capability with respect of their morphology. The study focuses on the influence of the magnetite content and size on the mechanical response when the nanocomposite is embedded in a quasi-static and dynamic magnetic field. This work lays down the foundation for the design of advanced morphing materials.

Introduction

Morphing materials are acquiring ever increasing interest and are considered the most promising materials for structural/devices performance enhancement. A structure that morphs should change shape statically or dynamically in an ultra-wide range of deformations. Conventional active control of the shape of a structure, with actuators (e.g. PZTs), has: (a) limited degree of morphing due to the structural rigidity; and (b) limited morphing capability in view of a small number of controllable devices. Making structures/devices out of a morphing material can in principle encounter these issues but the key challenge is the actual lack of shape-changing materials that can provide at the same time: large scale deformations and load-bearing capability with controllable actuation speed (static or dynamic). Magnetic elastomers [1-2] are investigated in this paper for their potential in solving the above issues. The work focuses on the material characterization and morphing capability as a function of its composition, morphology and actuation speed.

Results and Discussion

This work focuses on magnetite nano/micro-composites which exploit the flexibility of a polymer matrix and the load-bearing capability acquired through the interaction between a magnetic field and the embedded particles. It is found that the mechanical and mechano-magnetic material properties are highly influenced by the particle size. As expected, the load-bearing capability is non-linearly related to the position of the field source with respect to the sample. Quasi-static and dynamic actuations performed on 2D and 3D structural elements, were successfully achieved and quantified.

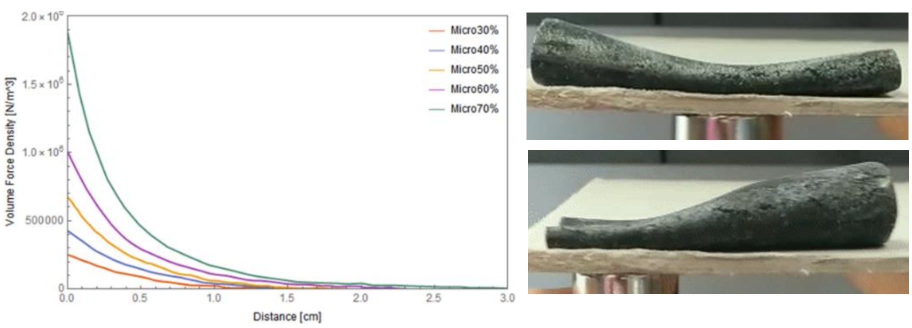

Figure 1 – (Left) Response of micro-composites with increasing source distance. (Right) Example of a 3D nanocomposite while morphing.

References

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