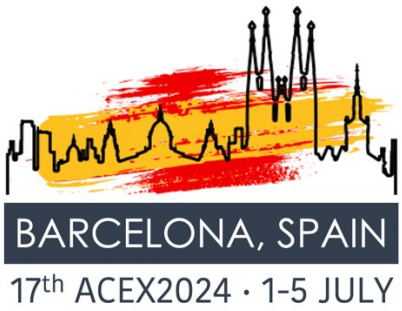

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ABSTRACT:

Design of magnetorheological elastomers based on hard magnetic particles

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The mechanical and rheological properties of the smart magnetorheological elastomers (MREs) with soft magnetic particles of carbonyl iron can be controlled rapidly and reversibly by applying an external magnetic field. The controllable stiffness and damping properties predetermine MREs use in structural elements for vibration control of mechanical and structural systems. A new generation of MREs with hard magnetic particles aligned in an electromagnetic field has various applications in biomedical engineering, soft robotics, and smart materials and systems design. MRE mixture was fabricated by the dispersion of hard magnetic NdFeB microparticles in the two-component silicon rubber ZA13 with different particle volume percentages. The silicone rubber acts as the matrix, contributing to the low stiffness and flexibility, and the embedded hard magnetic particles produce the MR effect. The mixture of silicone rubber and non-magnetized particles is carefully degassed in a high vacuum chamber, cast into plastic molds, and then cured at ambient temperature. The resulting samples of MRE are in the form of strips or thin beams. The individual parts of the cured sample are exposed to the strong external magnetic field of different directions in order to create the regions with desired directions of particle magnetization. The samples with different magnetization profiles alter their shapes and geometries in response to an external magnetic field. A simple MRE grip with four flexible fingers was designed, and the fingers were suitably magnetized. The movement of the grip was actuated by an external magnetic field when the fingers were subjected to magnetic forces and torques, which enables the gripping and releasing of cargo and excellent cargo gripping capability. The ability to grip and transport the cargo was experimentally verified and compared to the finite element simulation.