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Experimental Research and Numerical Simulation of Magneto-Sensitive Composites

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Magneto-sensitive composites (MSCs) are smart materials which change their properties under the influence of an external magnetic field. They consist of magnetically permeable particles, generally of micron size, dispersed in non-magnetic elastomeric matrix. The magnetic particles can be randomly distributed in the matrix resulting in the isotropic behaviour of the composite. Another option is that the magnetic field is applied to the composite during matrix cross-linking so that chainlike columnar particle structures can be formed and fixed in the matrix after curing. This procedure leads to the anisotropic response of MSCs. Thanks to the rapid and reversible change of the stiffness and of viscoelastic properties MSCs have found a wide range of applications as adaptive tuned vibration absorbers, mounts of tuned stiffness and automobile suspensions.
The dependence of dynamical moduli and loss factor of MSCs on the external magnetic field intensity and on the frequency and amplitude of applied cyclic shear deformation is presented. Samples of MSCs were made of the silicon rubber matrix filled by carbonyl iron micro-particles. The magnetic field was applied in course of cyclic loading of double-shear samples of MSCs under controlled shear strain. The dynamical mechanical behaviour of MSCs in the magnetic field was simulated based on Chen and Jerrams [1] rheological model. The model comprises the viscoelasticity of the elastomeric composite, the interaction between the elastomeric matrix and iron particles and the influence of the magnetic field. The simulations were compared to the experimental dynamical response of MSCs to the simultaneous action of the mechanical loading and the magnetic field.

[1] Chen, L., Jerrams, S.: A Rheological Model of the Dynamic Behaviour of Magnetorheological Elastomers. Journal of Applied Physics, 110, 013513 (2011); doi:10.1063/1.3603052.