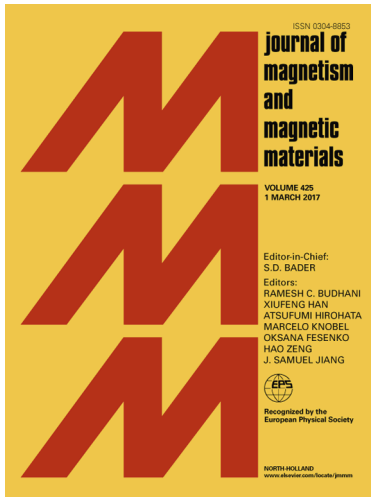

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Magnetomechanical properties of composites and fibers made from thermoplastic elastomers (TPE) and carbonyl iron powder (CIP)

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Keywords: soft magnetic composite; magnetoactive elastomer; magnetoelastic fiber; magnetic fiber bending, thermoplastic elastomer

Abstract

Magnetoactive elastomers (MAE) made from composites of five thermoplastic elastomers **(**TPE) of different stiffness with carbonyl iron powder (CIP) as magnetic component were investigated. The composites were produced by melt blending of the magnetic particles with the TPEs in a twin-screw extruder. The resulting materials were characterized by ac permeability testing, stress-strain measurements with and without external magnetic field and magnetically controlled bending of long cylindrical rods in a homogenous magnetic field. The magnetic field necessary for deflection of the rods decreases with decreasing modulus and increasing iron particle content. This effect can be used e.g. for magnetically controlled actuation. Some highly filled MAE show a magnetic field induced increase of Young´s modulus. Filaments could be spun from some of the composites.

Introduction

Magnetorheological or magnetoactive elastomers are known to change their mechanical properties or shape when exposed to an external magnetic field [1]. They consist of magnetic particles dispersed in an elastomer matrix like hydrogels, silicones or rubber. Due to magnetic dipole-dipole interactions, the particles in the elastomer matrix form chains along the direction of the applied field, which results in a mechanically anisotropic composite [2, 3]. This rearrangement of magnetic particles under the action of a magnetic field can cause a deformation of the composite body, commonly denoted as magnetostrictive behavior [4] or a stiffening of the material known as magnetorheological effect [1-3, 5, 6]. The effect of deformation can also be used for magnetically controlled actuation. For example Zimmermann et al. realized a worm-like locomotion of a cylindrical elastic rod in a tube [7, 8] and an amoeboid movement [9].

The group of R. Superfine intensively investigated the bending of cylindrical elastic rods containing superparamagnetic particles for the application as artificial cilia arrays [10].