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Editorial corner – a personal view

When polymers meet metals: The changing shape of magnetostrictive polymer composites

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The property of some materials to change their shape or dimensions in presence of a magnetic field was first identified in 1842 by the English physicist, mathematician (and brewer) James Prescott Joule who was able to magnetize an iron sample and measure its change in length. Since then, a wide spectrum of metallic ferromagnetic alloys with magnetostrictive response have been developed, such as Terfenol-D ($Tb_{0.3}Dy_{0.7}Fe_2$) and Galfenol ($Fe_{81.6}Ga_{18.4}$) alloys, cobalt ferrites (FeCo) and carbonyl iron https://doi.org/10.1002/0471216275.esm051. Depending on the composition, the magnetostrictive response can reach up to 1% strain.

Magnetostrictive metals in form of particles, flakes or fibers, can be embedded in polymeric matrices to obtain magnetostrictive polymer composites (MPCs), a class of functional materials with the ability to simultaneously change dimensions, elastic and/or electromagnetic properties under the stimulus of a magnetic field https://doi.org/10.1016/j.pmatsci.2018.02.005. Their advantages over magnetostrictive metals are primarily represented by a lower weight, easier formability, higher resistivity, extended frequency response, and improved mechanical properties. In particular, large (giant) magnetostrictive deformations higher than 9% has been reported when ferromagnetic particles are dispersed in soft matrices such as elastomers https://doi.org/10.1016/j.jmmm.2010.06.020. The potential applications of MPCs touch several fields including, transducers, actuators, sensors and devices for the conversion of energy between the magnetic and the mechanical forms. An interesting progress towards the development of magnetostrictive materials lighter that metallic ones have been recently made with the fabrication of magnetically functionalized polycarbonate-urethanes nanofibers, incorporating nickel nanoparticles https://doi.org/10.3144/expresspolymlett.2018.28. This magnetic nanofibers have been then used to prepare composite polymer tubes by electrospinning and characterized by a smart reversible response (over 50% increase in eccentricity of the tube cross-section) when a low magnetic field intensity (≈30 mT) is applied https://doi.org/10.3144/expresspolymlett.2020.53. These devices could be potentially applied in biomedical devices when a controlled transverse contraction is needed to resolve occlusive phenomena in blood vessels substitutes of small or medium caliber as for example to avoid periscope approach in vascular prosthesis or to solve obstruction problems in cardiology. Interestingly enough, the possibility to use biopolymers, in particularly cellulose, to prepare magnetostrictive composites has been also successfully explored https://doi.org/10.1038/s41467-017-00034-4. So, why not further investigate this fortunate meeting between polymers and metals ?

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