98

Improving filler dispersion in magnetoactive elastomers via DBSA surface modification of hexaferrites

Author: Lucija Drempetić[1]

Co-authors: Darja Lisjak[1]; Darko Makovec[1]; Stanislav Gorb[3]

[1] *Jožef Stefan Institute*

[3] *Christian Albrechts University (CAU)*

Magnetoactive elastomers (MAEs) are smart composite materials composed of magnetic particles embedded in elastomer matrices, capable of rapidly and reversibly tuning their mechanical and surface properties under external magnetic fields [1,2]. Their development, however, is limited by an incomplete understanding of processing–structure–property relationships, as well as challenges in achieving uniform filler distribution within the elastomer matrix. In particular, aggregation of particles reduces reproducibility, mechanical performance, and actuation reliability. These limitations largely stem from poor interfacial compatibility between hydrophilic magnetic fillers and hydrophobic polymer matrices.

To address these issues, we investigated the surface modification of strontium hexaferrite fillers using dodecylbenzenesulfonic acid (DBSA). DBSA adsorption introduces steric repulsion that counteracts magnetic dipole–dipole and van der Waals interactions responsible for aggregation and improves filler–matrix compatibility. When combined with freeze-drying, surface modification significantly improves filler distribution, reducing particle cluster sizes from $\sim$500 μm to $\sim$100 μm as confirmed by micro-computed tomography. Magnetic measurements further support these findings: composites containing unmodified fillers exhibit constricted hysteresis loops characteristic of microstructural heterogeneity, whereas composites with DBSA-modified filler display smooth hysteresis loops consistent with a more uniform filler distribution. Additionally, field-assisted curing of composites with $\sim$40 wt% DBSA-modified filler yielded magnetically anisotropic MAEs, with the remanence-to-saturation magnetization ratio (M_r/M_s) increasing by $\sim$14% along the alignment direction, indicating improved particle alignment.

Overall, these results demonstrate that tailoring filler–matrix interfacial compatibility is a key strategy for improving both the microstructure and magnetic performance of MAEs, enabling a more reliable processing route for magnetically responsive soft materials.

References and acknowledgement

[1] M. R. Jolly, J. D. Carlson, B. C. Muñoz and T. A. Bullions, *Journal of Intelligent Material Systems and Structures*, 1996, 7, 613–622.
[2] A. V. Chertovich, G. V. Stepanov, E. Y. Kramarenko and A. R. Khokhlov, *Macromolecular Materials and Engineering*, 2010, 295.

This research has received funding from the European Union's Horizon Europe research and innovation programme under the Marie Skłodowska-Curie Actions Doctoral Network MAESTRI (grant agreement No. 101119614), and the Slovenian Research and Innovation Agency through the research core funding P2-0089.

Type:
Oral