Magnetic Attraction Meets Elastic Action: Optimizing Magnetoactive Elastomer Composites

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Magnetoactive elastomers (MAEs) are composite materials consisting of magnetic particles embedded within elastic polymer matrices, allowing their mechanical properties to be tuned in response to external magnetic fields. However, a fundamental understanding of their structure-property-function relationships remains lacking, particularly how processing conditions—such as particle concentration, use of solvent, and magnetic field exposure—affect their magnetorheological behaviour. Most research focuses on exploiting MAE properties rather than optimizing their design through precise material processing. This study aims to bridge this gap, beginning with the incorporation of carbonyl iron powder (CIP) into polydimethylsiloxane (PDMS) matrices. A key focus is to improve filler distribution and matrix interaction through surface functionalization. Our first MAEs were characterized for their rheological and mechanical properties, including stiffness, storage/loss modulus, and damping, under varying magnetic fields. Additionally, anisotropic MAEs will be investigated to enhance magnetic responsiveness while maintaining mechanical flexibility. By establishing key processing-structure-property relationships, this research aims to drive the development of high-performance MAEs for next-generation robotic actuators and adaptive functional materials.

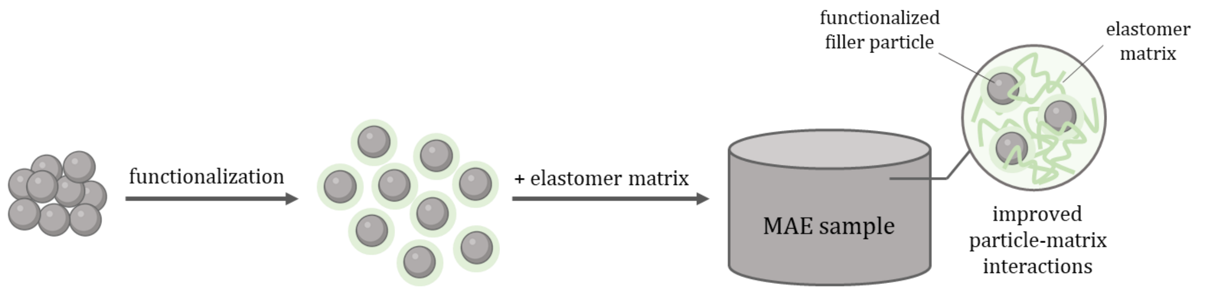

Figure 1. Schematic representation of the preparation of MAEs.

Marie Skłodowska-Curie Actions
Funded by the European Union
Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Research Executive Agency. Neither the European Union nor the granting authority can be held responsible for them.
Doctoral Network MAESTRI