# Reprogrammability of structural energy absorption via passive and active magnetic interactions

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**Abstract**

Magnetoactive polymers (MAPs) have gained significant research attention in recent years for their ability to respond dynamically to magnetic fields, allowing their application in soft robotics by taking advantage of previous research on metastructures that can change their structural behaviour through internal design modifications (1, 2, 3). Flexible magnetic metastructures present an advanced approach to designing structures with adaptive mechanical properties, taking advantage of the strategic integration of hard-magnetic elements to enable reprogrammable mechanical responses without the need for external actuation. These magnetic nodes, designed for specific stiffness and magnetization properties, are embedded into a flexible matrix that connect all them by hinges. When the structures are compressed, the hinges buckles leading to abrupt changes in the evolution of the force-displacement behavior due to the interaction of magnetic nodes during structural deformation.
The distribution of magnetic nodes enables changes in stiffness, in maximum force before structural collapse, in energy absorption, or even bistable configurational transitions without external actuation under quasi-static regime. When performing impact test in these metastructures, under dynamic regime, structures show remarkable tunability with changes in energy absorption and in impact arrest time. This response can still be modulated further by external magnetic fields that provide additional changes in energy absorption. More elaborate configurations of magnetic nodes can optimize specific structural responses.

This research highlights a new approach for the design of structural components with reprogrammable mechanical properties, achieved through the redistribution of magnetic elements or the application of external magnetic actuation.

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