Magneto Active Elastomers (MAEs) are smart materials that consist of magnetic particles cured in an elastomer matrix, giving the resulting composite macroscopic magnetic properties which display significant actuation in the presence of a magnetic field. The purpose of this study was to design actuators that are capable of complex motion for potential biomedical and soft robotic applications. Additionally, we compare the pros and cons of actuators made with hard and soft magnetic particles. To accomplish this goal, we first developed a framework for easy fabrication of complex actuators.

Actuators were comprised of MAEs embedded in PDMS, as this allowed for easy design customization. To create complex actuation, the angle of the MAE pieces was varied within the PDMS. By adjusting the geometric gradient of MAEs encased in silicone elastomer, different actuation patterns were created.

This study demonstrates a simple and effective way to fabricate actuators with a geometric gradient of embedded MAEs. Additionally, it shows that actuators utilizing a geometric gradient using MAEs with hard magnetic barium ferrite particles displayed greater actuation than those without a geometric gradient or which utilized soft magnetic iron oxide particles. Finally, we also investigated the degree of actuation of a shape memory polymer (SMP)-MAE layered composite, which were deformed in the presence of a magnetic field at an elevated temperature. These composites, printed at a lab at the University of Texas Austin, allow for a gradient in the volume percentage of ferro fluid in the composite. Actuating composite pieces with a gradient of magnetic material adds an interesting dimension to previously explored actuation.