3D-Printing polymer-based permanent magnets

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Manufacturing processes used to develop permanent magnets are time-consuming and demand very specific machinery to apply exceptionally high pressures, temperatures, and magnetic fields. Furthermore, these manufacturing processes generate by-products and hazardous waste, making the whole process environmentally-detrimental. On the other hand, the magnets produced using such approaches have the advantage of exhibiting extremely large magnetic fields. In this work we address this problem using 3D-printing technology to develop polymer-based permanent magnets, a much simpler technique that allows production in a more time-efficient and environmentally-friendly manner. This permits the development of different types of magnets by simply modifying specific parameters of both the matrix and the filler. Here we report the results of work to 3D-print magnetic materials on the micro-scale and their full magnetic characterization. 3D-printing materials with different magnetic properties at this scale, could allow their use in a wide range of applications in biomedicine, biotechnology, medical science, and information storage among many others. The M-H hysteresis loops, the curves of the change of magnetic moment and the surface plots of the magnetic field intensity and orientation of the 3D-printed samples before and after magnetic poling are shown in Figures 1 and 2, respectively.

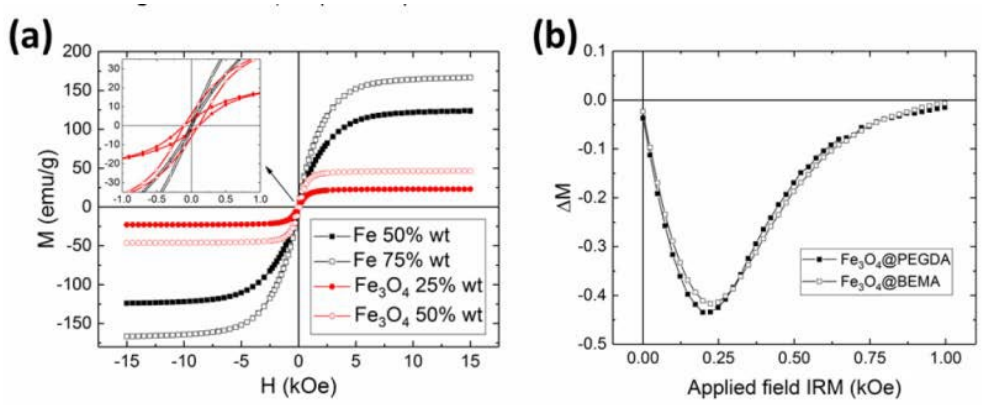

Figure1: (a) The M-H hysteresis loop plots of the 3D-printable composites. The top-left corner graph shows the low-field regime in close-up. (b) The change of magnetic moment of the synthesized magnetic composites.

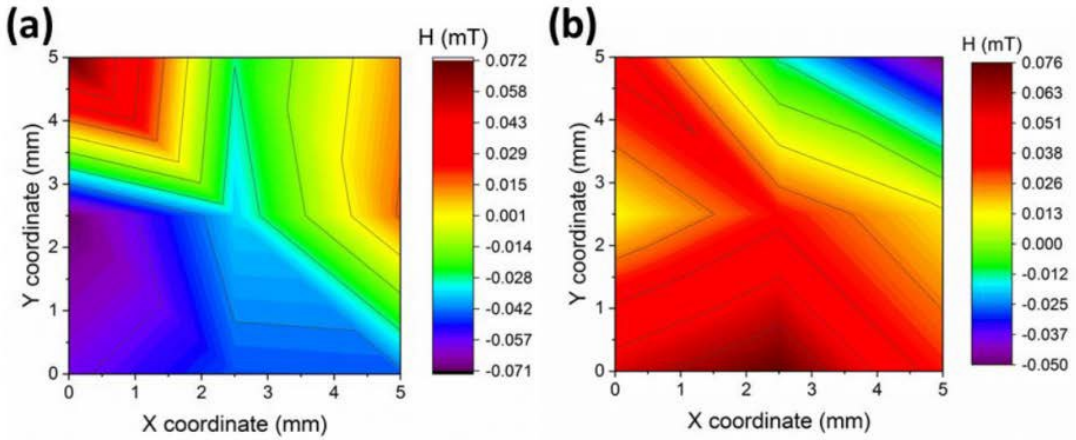

Figure 2: (a) and (b) show the surface plot of the orientation and intensity of the magnetic field displayed by one of the 3D-printed samples before and after magnetic poling, respectively.