Magnetic Field Modulation for Assembly and Manipulation of Responsive Nanoscale Optical Systems

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Nanoscale materials have proven useful as building blocks for systems which utilize constructive interference in the visible spectrum to create brilliant optical effects. In order for these systems to be implemented in real-world applications, though, there must exist a mechanism by which their structure, and effectively their structural color, can be finely tuned. The objective of this experiment is to investigate magnetic field modulation by polymer templates as a means to assemble arbitrary building blocks into nanoscale systems that exhibit visible structural color and possess unique, highly controllable arrangements. Various uniform nonmagnetic particles were fabricated and subsequently surrounded by a ferrofluid, causing them to act as magnetic holes and allowing them to be controlled by an external magnetic field. Patterned polyurethane templates were used as a substrate so that the particles would assemble into photonic structures or thin films of a shape and size determined by the magnetic gradient surrounding the patterns. The photonic assemblies exhibited tunability across the visible spectrum and the thin films displayed visible color dependent on their thickness and the viewing angle. By surrounding polymer templates and structural building blocks with ferrofluid, optical nanoscale assemblies were fabricated from a wide variety of materials which would previously not have been suitable for such responsive systems. Additionally, the use of patterned templates allowed for a much higher degree of control over the structure of the resultant assemblies. This method of fabrication marks a development which can be readily generalized to create responsive optical systems for niche applications such as color-based sensors and anti-counterfeiting devices.

Awards Won:

First Award of $5,000