Fabrication and Applications of Metallic and Polymeric Smart Materials using Two-photon Lithography

Advancements in lithography have enabled researchers to create two-dimensional (2D) and three-dimensional (3D) structures from various materials as sensors, integrated circuits, anti-counterfeit labels, shape-shifting structures for drug delivery and surgery. Of which, multi-photon lithography emerges as a promising technique to fabricate high resolution 2D and 3D, micro- to milli-meter sized structures with nanometer-scale resolution. We focus on 2 key areas: two-photon polymerization of stimuli-responsive, shape-shifting polymers and two-photon photoreduction of metallic salts. Via two-photon polymerization, we fabricate 10 - 30 μm sized shape-shifting protein microstructures that are not only able to undergo directional shape-shifting, but also geometrical shape-shifting from circles to polygons such as triangles, square, pentagons and hexagons. We also demonstrate the two-photon photoreduction of gold(III) chloride in the presence of surfactant to form monodisperse, gold nanoparticle microstructures with tunable properties, within a microfluidic channel for SERS sensing of small gaseous molecules. By varying fabrication parameters such as surfactant concentration, laser power and scanning speed, the density and morphology of written structures can be modulated to enable the robust fabrication of a large array of well-defined gold microstructures.

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