Shaping in the Third Direction; Synthesis of Patterned Colloidal Crystals by Polyester Fabric-Guided Self-Assembly

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Abstract: A polyester fabric with rectangular openings was used as a sacrificial template for the guiding of a sub-micron sphere (polystyrene (PS) and silica) aqueous colloid self-assembly process during evaporation as a patterned colloidal crystal (PCC). This simple process is also a robust one, being less sensitive to external parameters (ambient pressure, temperature, humidity, vibrations). The most interesting feature of the concave-shape-pattern unit cell (350 μm× 400 μm× 3 μm) of this crystal is the presence of triangular prisms at its border, each prism having a one-dimensional sphere array at its top edge. The high-quality ordered single layer found inside of each unit cell presents the super-prism effect and left-handed behavior. Wider yet elongated deposits with ordered walls and disordered top surfaces were formed under the fabric knots. Rectangular patterning was obtained even for 20 μm PS spheres. Polyester fabrics with other opening geometries and sizes (~300–1000 μm) or with higher fiber elasticity also allowed the formation of similar PCCs, some having curved prismatic walls. A higher colloid concentration (10–20%) induces the formation of thicker walls with fiber-negative replica morphology. Additionally, thick-wall PCCs (~100 μm) with semi-cylindrical morphology were obtained using S_iO_2 sub-microspheres and a wavy fabric. The colloidal pattern was used as a lithographic mask for natural lithography and as a template for the synthesis of triangular-prism-shaped inverted opals.

Keywords: colloidal crystals, polyester fabric, polystyrene, silica, sub-micron spheres, self-assembly, negative diffraction, super-prism effect