A portable technique for fabrication of colloidal array on any substrate

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Self organization of colloidal particles has many applications, particularly in fabrication of solar cells with advanced light management strategies. Colloidal crystals with hexagonal closed pack ordering can be obtained by simple spin coating in presence of trace amount of surfactant. By spin coating on a topographically patterned substrate we can also obtain ordered colloidal structures with non HCP ordering. Under appropriate condition the particles accumulate within the substrate grooves to align themselves along the geometry of the substrate. It is however not possible to obtain a non-HCP ordering on a flat substrate without any chemical or topographic patterning, which increases the number of processing steps. We have developed a method by which we can overcome this problem by fabricating the array on a patterned or flat flexible substrate and subsequently transfer the array on to another substrate. The flexible nature of the master makes it possible to transfer the array on to non planar substrates. Use of a patterned flexible template allows particles to be arranged with non-HCP orering, which when transferred to a flat surface manifests the formation of non-HCP ordering on a flat surface.

The transfer mechanism is based on the fabrication of the particle array on a PMMA surface. This PMMA layer was patterned by employing the method of soft lithography. The colloidal particles align in the grooves of the PMMA pattern, and an ordered non-HCP arrangement was obtained. As the PMMA layer gets degraded by UV exposure, the colloidal particles detach from the template and adhere to the bottom substrate. Detailed schematic of the proposed mechanism is shown in Fig. 1(a). Apart from fabricating the PMMA layer on a rigid UV transparent substrate, we can also use a flexible Sylgard 184 substrate. By use of a flexible substrate, the colloidal particles can be transferred onto non-planar surfaces as well. Thus our proposed method allows the colloidal structures to be transported across substrates irrespective of their surface energy, wettability or morphology.

Therefore, we can conclude from this work that non hexagonal close packed array of particles can be obtained on a topographically or chemically patterned substrate by direct coating technique. However, ordered non HCP patterns are difficult to fabricate on non-planar surfaces, and substrates with arbitrary geometry and textures. In order to overcome this limitation, a novel technique was developed, where the ordered array was fabricated on a patterned PMMA film, and was subsequently transferred to other substrates. Since the particle array is transferred onto a substrate, without exposing it to any kind of chemical or thermal environment, it can be utilized for placing particles on top of thin film solar cells for improving their absorption efficiency.

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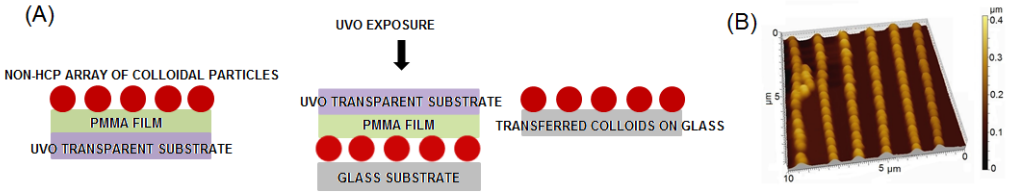

Fig.1. (a) Mechanism of transfer of colloidal particles, (b) AFM image of a transferred array on flat glass.

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