Colloidal binary monolayers

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The controlled creation of high quality, large scale colloidal monolayers is one of the key steps for surface patterning without the need for expensive equipment. Typically, these monolayers are generated by a self-assembly process of uniform colloids and serve as mask for metal evaporation lithography. The existing methods for the creation of such monolayers are typically producing high quality monolayers on a small area and they are prone to disturbances, inhibiting the creation of large scale monolayers. Thus, there is the need for robust methods, capable of creating high quality monolayers with a spatial extension of several square centimetres. Furthermore, the monolayers created so far are of hexagonal symmetry and are typically created from colloids without function.
Our work aimed at the establishment of universal methods for the creation of high quality large scale monolayers, monolayers with functional colloids and monolayers with complex structure, either non-hexagonal or binary monolayers based on hexagonal symmetry.
The methods established are based on the formation of monolayers at an air/water interface and the deposition of the preformed monolayer on a substrate rather than directly generating the monolayer on a substrate. An easy method was established using a surfactant solution as the interface. Balancing the attractive capillary force and the repulsive electrostatic force, monolayers generated at the air/water interface can be deposited on arbitrary substrates by lifting the monolayer from the interface to the substrate. With this technique plain and functional monolayers of hexagonal symmetry were created. For functional monolayers, colloids containing metal complex for non-conventional lithography or colloids containing a fluorophore and a photochrome for light triggered activation of fluorescence were used.
Using a Langmuir trough for the creation of the monolayers, more control is exerted over the monolayer formation, thus binary monolayers, monolayers of a defined amount of small colloids in the interstices of a monolayer of hexagonally closed packed large colloids were prepared. Large areas of stoichiometric domains (hundreds of μm^2) were achieved by adjusting the interfacial ratio of small and large colloids. By determining the interfacial ratio of colloids via surface-pressure-area isotherms, binary monolayers with a wide range of ratios of colloid radii and different amounts of interstitial filling were created. By surface lowering deposition, arbitrary substrates (silicon wafers, pre-patterned photoresist surfaces, etc.) were decorated with the binary monolayers.

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