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Self assembled monolayer of silica nanoparticles with improved order by drop casting

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Assembly of NPs into large-area monolayers on a solid substrate is fundamentally
interesting due to their unique optical and electronic properties. Furthermore, they have an impact on the creation of next-generation materials design [1] and for new devices that require monolayers with ordered structure over large areas formed with a simple method at low cost to meet the growing industrial needs. But controlling the deposition on a substrate to obtain two-dimensional and three-dimensional nanoparticle arrays is a complex process, and it occurs under specific conditions.
In this contribution, we report on the formation of large area, self assembled, highly ordered monolayers of stearyl alcohol grafted silica nanospheres of ~ 50 nm diameter on a silicon substrate based on the drop-casting method. Our novel approach to achieve improved order uses stearyl alcohol as an assistant by adding it to the colloidal NanoParticle (NP) dispersion from which the monolayers are formed. Additionally, a heat treatment step is added, to melt the stearyl alcohol in the monolayer and thereby give the particles more time to further selfassemble, leading to additional improvement in the monolayer quality. The formation of the monolayers is significantly affected by the concentration of the NPs and the stearyl alcohol, the volume of the drop as well as the time of the heat treatment. A high surface coverage and uniform monolayer film of SiO2 NPs is achieved by appropriate control of the abovementioned preparation parameters. Structural characterization of the obtained SiO2 NP monolayer was done locally by Scanning Electron Microscopy (SEM), and globally by X-ray reflectivity (XRR) and grazing incidence small-angle X-ray scattering (GISAXS), where the data was reproduced by simulation within the Distorted Wave Born Approximation (DWBA) [2]. In conclusion, our modified drop-casting method is a simple, inexpensive method, which provides highly ordered self-assembled monolayers of silica particles, if combined with a compatible additive and a heat treatment step. This method might be more general and applicable to improve the ordering between different particles in monolayers as well as multilayers after finding an appropriate additive [3].

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