

SELF-ASSEMBLING OF NANO-SIZED SiO_2 -PARTICLES ON PATTERNED SUBSTRATES

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INTRODUCTION: The structuring of surfaces on a nanoscale level - both chemically and topographically - has become an increasingly relevant field of research in nanotechnology with widespread application potential in various fields of science (e.g. biotechnology, optics, electronics).[1] Among patterned surfaces, organized particle layers and single particles attached to a surface have attracted special attention due to their interesting properties and application potential.

A major aim of nanotechnology is to produce nanoscopic functional entities and to incorporate these features into devices with a structural hierarchy ranging from the molecular to the macroscopic level [3]. One way to achieve such hierarchic structures is the production of a pre-pattern with conventional methods in the micrometer range on which nanoscale objects (in this case SiO_2 colloids) are self-assembled by choosing appropriate adsorption conditions.

METHODS: In this work, two different patterning techniques are used to generate a chemical / wettability contrast pattern that directs particle adsorption. With these two patterning methods – called SMAP (Selective Molecular Assembly Patterning) [4] and MAPL (Molecular Assembly Patterning by Lift-Off) – any kind of 2D structures in the micrometer range can be produced and the colloid assemblies formed subsequently on them can be controlled by adjusting the adsorption parameters (i.e. ionic strength, pH, concentration). These two patterning methods allow the production of pure metal oxide contrasts as well as the production of chemical contrasts by adsorbing different chemical species (Self-assembled monolayers, polyelectrolytes, polymers). With these variable patterning methods, influence of different chemical backgrounds (alkane phosphate SAMs, polymers, polyelectrolytes) and inter-actions between colloids and surfaces can be investigated. Furthermore, possible modifications of these patterning methods (with nano-imprinting techniques) will allow the production of structures in the 100nm range.

RESULTS: Different sub-monolayer to multilayer colloid patterns with 35nm silica colloids have been achieved with the patterning methods described

above. It was found, that particle-substrate interactions are generally weaker in the studied systems compared to the capillary forces occurring during the drying process. Thus, the most important effect that leads to the colloid pattern formation is the wettability contrast between the background and the pattern. Such a wettability contrast causes de-wetting of hydrophobic regions and the colloid suspension retreats to the hydrophilic regions dragging colloids along due to capillary forces.

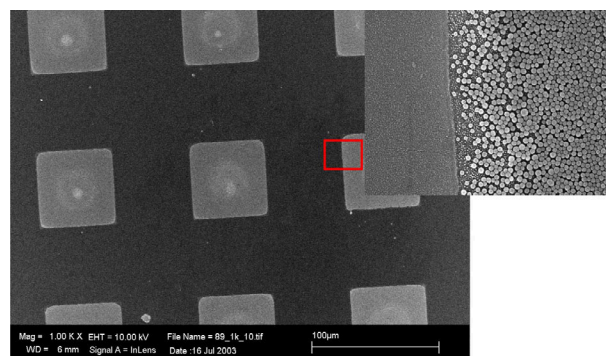


Fig. 1: SEM image of 60µm squares (SiO_2) covered with self-assembled SiO_2 particles (35nm). The TiO_2 background is modified with a hydrophobic alkane phosphate SAM and is particle free due to de-wetting during drying.

DISCUSSION & CONCLUSIONS: With the presented patterning systems it is possible to study drying processes and self-assembly properties of nano-colloids onto chemically customizable substrates and the influence of adsorption parameters on this process. Due to the ability to tailor the chemistry of the substrate and to vary the adsorption parameters, the nature of the self-assembled colloid structures can be controlled.

REFERENCES: ¹Masuda, Y., Itoh, M. et al. (2002). *Langmuir* **18**(10): 4155-4159. and references therein. ²A. Blaaderen, R. Ruel, P. Wiltzius, *Nature* **385** (1997) 321. ³Jonas, U. and C. Krüger (2003). *Journal of Supramolecular Chemistry*, in press. ⁴Michel, R., J. W. Lussi, et al. (2002). *Langmuir* **18**(8): 3281-3287.

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