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Functionalization of SU-8 with DNA for N/MEMS self-assembly

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Introduction

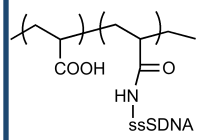
Microelectromechanical systems (MEMS) are widely used small electromechanical systems made of micrometer-sized components. Current manufacturing approaches that are based on top-down systems reach their limits when dealing with micrometer-sized components to be assembled. Self-assembly has emerged as a promising method towards the efficient packing of various parts at the micro/nano scale with MEMS. So far, approaches reported for microscale self-assembly are focused on capillary forces and geometrical affects. Therefore, it is of great interest to find new routes to the fabrication and assembly of multifunctional N/MEMS.

Aim

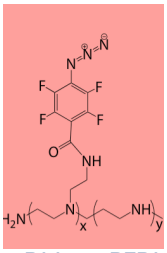
Our aim is to use DNA mediated selective, sequential and reversible self-assembly to functionalize SU-8 micro-components. In addition to the challenge of self-assemly which will be achieved by a mixture of geometric and chemical factors, we would like to use the DNA as temperature-triggerable mechanism to release the assembled parts. It could also be thought of a reversible and repeating assembly and disassemly in respect of the surrounding media.

DNA grafted polyacrylic acid

The coupling is between COOH groups of PAA and NH_2 of ssDNA through EDC chemistry in buffer.



PAA-g-DNA



PAAm-g-PFPA

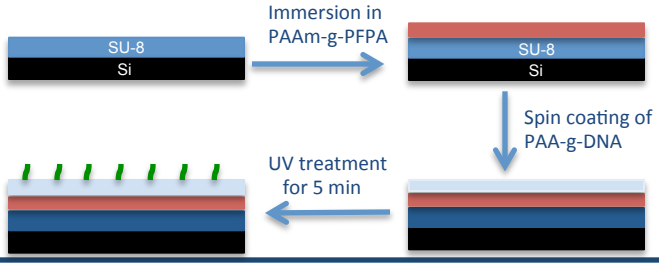
PAA MW: 1080000 g/mol
PAA MW: 90000 g/mol

PAAm-g-PFPA is an adhesion promoter comprising of a photoreactive group.

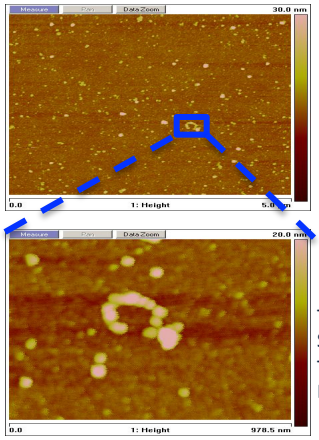
The PFPA chemistry has been applied to attaching PAA-g-DNA on SU-8 surfaces, by photo-activation, simplifying the self-assembly process.

Approach

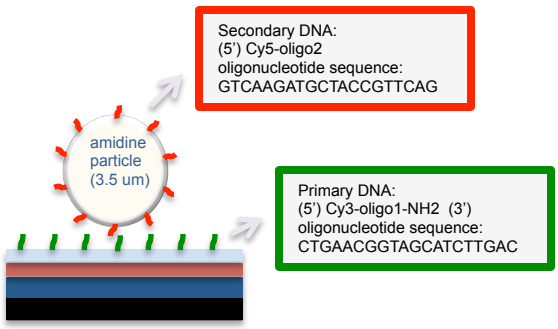
The negative epoxy-based photoresist SU-8 has a variety applications within microelectromechanical systems (MEMS), due to its excellent mechanical properties and thermal stability.



AFM images of DNA immobilized surfaces

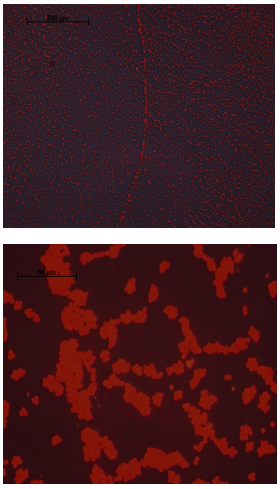


DNA hybridization

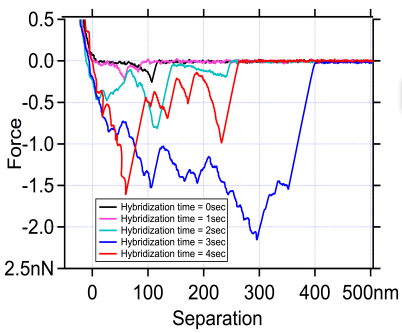


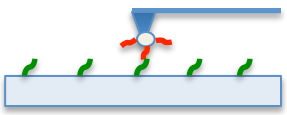
The PAA-g-DNA (primary) was grafted on SU8 surfaces.
Secondary DNA ias adsorbed to amidine particles electrostatically
The PAA-g-DNA coated SU8 samples were incubated with the complementary DNA amidine particles overnight

Florescence images



Stretching of Hybridized DNA structures using AFM





The tip was held in contact for different times to study the rate of hybridization.

After 4 sec of hybridization the nature of pull-off force remains the same.

Conclusions

✧ SU8 surface can be functionalized with DNA via photo-cleavable linker.

✧ Complementary DNA functionalized particles can self assemble to primary DNA functionalized SU8 surface

Outlook

✧ Temperature-based self-disassembly and hybridization will be studied.

✧ Amount of force needed to separate the DNA self-assembled surfaces needs to be calculated, considering the 'stretching and cleaving' of hybridrized DNAs.

References:

Ingrosso et al. Advanced Functional Materials 2007, 17, 2009.
Onea et al. Small 2007, 3, 1383.
Kusukabe et al. MEMS 2008, Tucson, AZ, USA, January 13-17.