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Nanostructuring of surfaces using AFM

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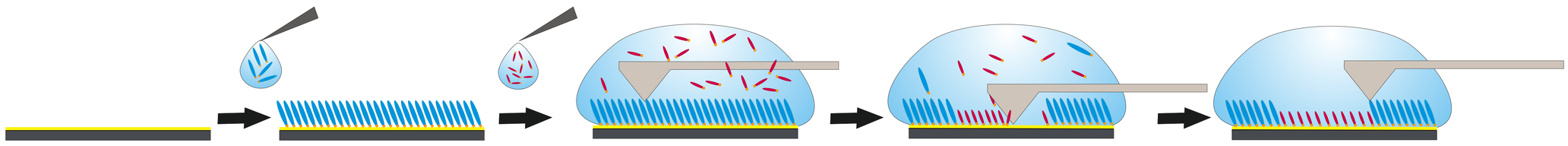
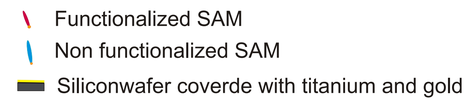
Introduction

Nanostructuring of surfaces is highly desired in several disciplines and can be achieved by different methods. Especially the usage of self-assembled monolayers (SAMs[1]) has been shown to be a versatile useful approach not only to tailor surface properties but also to structure surfaces using lithographic methods.
While shaving implies only removal of molecules, the grafting is performed in an organothiol solution containing liquid, enabling re-adsorption of a different SAM[2]. Both methods allow lateral structuring with resolutions of several nanometers and, therefore, offer some potential e.g. In the field of molecular electronics, where defined small regions of only few molecules of one species are desired for conductivity measurements.

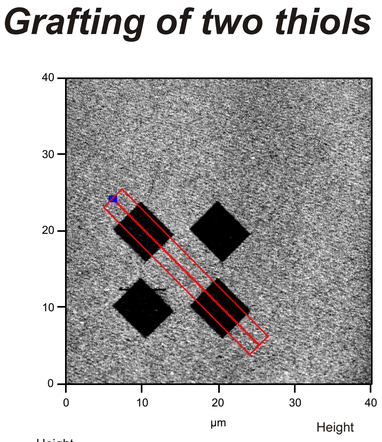


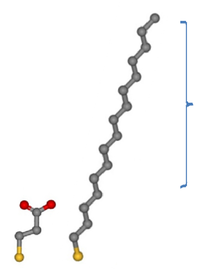
The matrix SAM is covered with an ethanolic solution of another SAM. After the removal of the matrix SAM molecules from the gold surface by the AFM tip, the vacant sites are filled up immediately with molecules out of the ethanolic solution and can be ivestigated by AFM with the same AFM-tip.

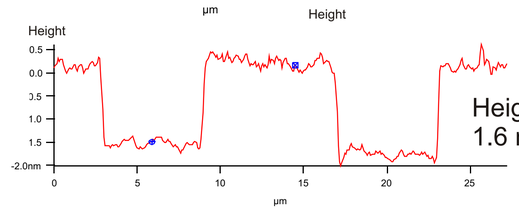


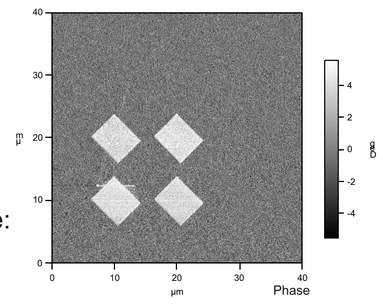
Results

Grafting of two thiols with different functional head groups



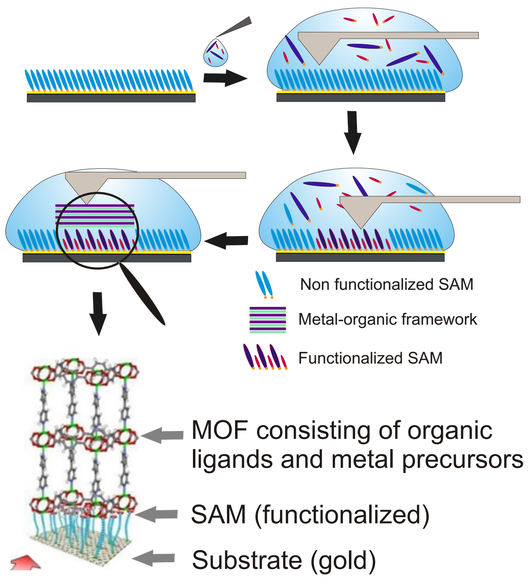


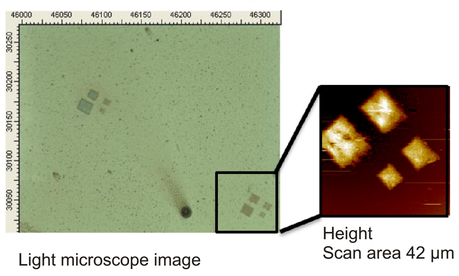


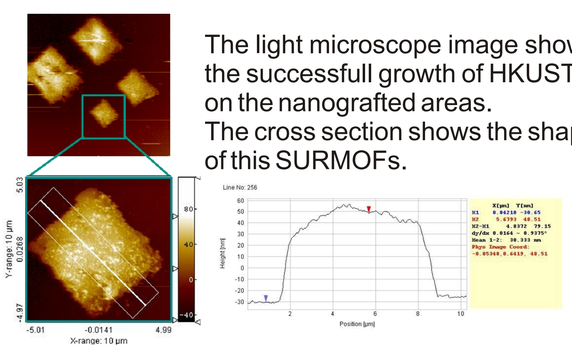


Nanografting area of mercaptopropionicacid (MPA) in decanethiol with the corresponding cross section and the phase image.

Nanografting as a base for site-selective metal-organic framework (MOF) growth

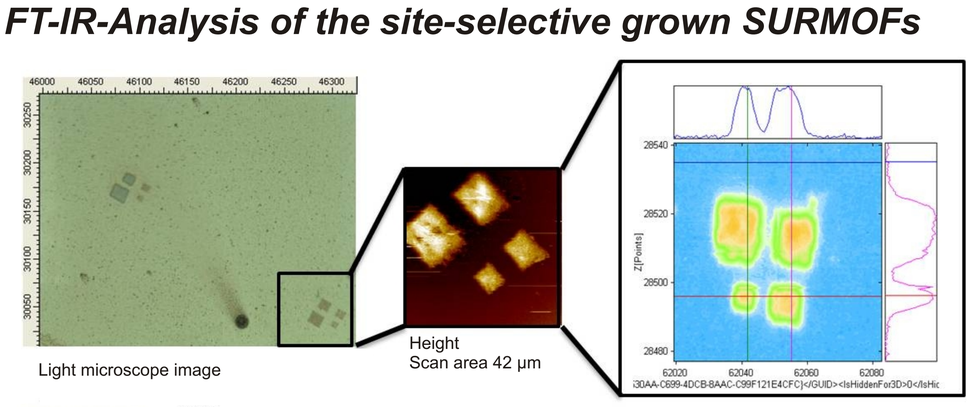


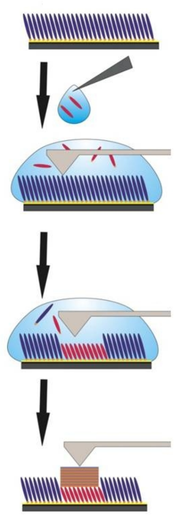


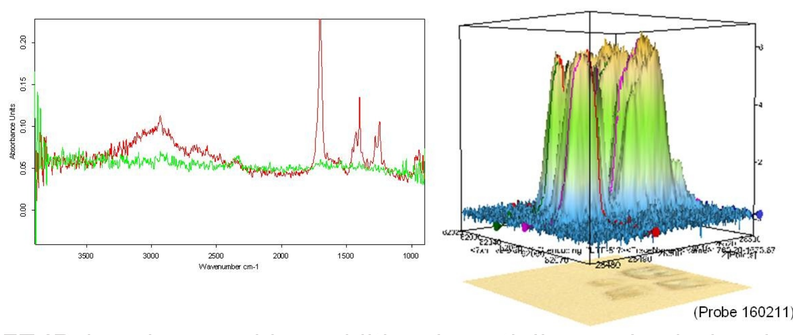


The light microscope image shows the successfull growth of HKUST-1 on the nanografted areas.
The cross section shows the shape of this SURMOFs.

FT-IR-Analysis of the site-selective grown SURMOFs







FT-IR imaging provides additional spatially resolved chemical surface information.The chemical image of the sample shows the site-selective growth of the SURMOF while the signal is generated by integrating the COO- symmetric and asymmetric stretching mode.

Conclusion

Nanografting:
- small and defined structures
- in-situ characterization of the produced structures
- cleaving of individual molecular bonds
- production of multi-functional nano patterns
- applications in the field of nanotechnology

Acknowledgement

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References

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2. Liu, Amro, Liu, Ann. Rev. Phys. Chem. 59, 367 (2008).
3. Kuppler, Timmons, Fang, Li, Makal, Young, Yuan, Zhao, Zhuang, Zhou, Coordination Chem. Rev. 253, 3042 (2009).