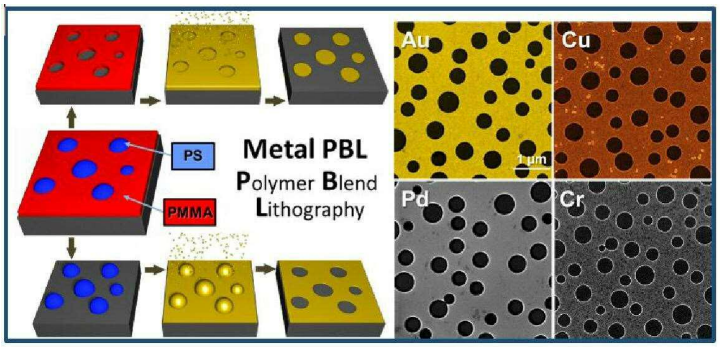
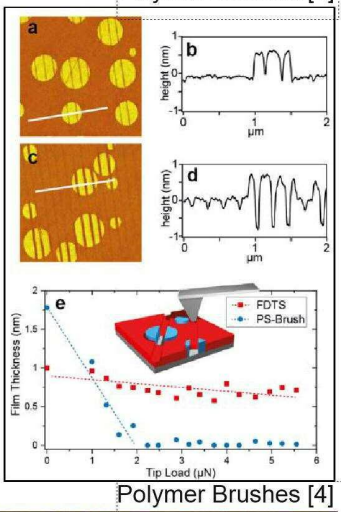
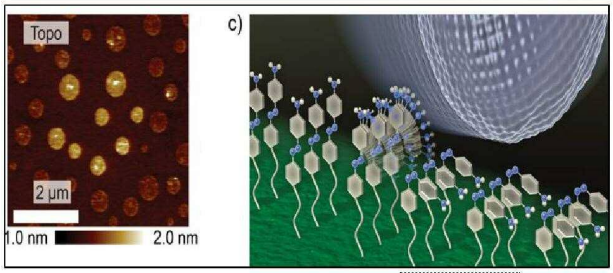
Thin polymer blends films as a tool for creating patterned metals, semiconductors, SAMs and brushes



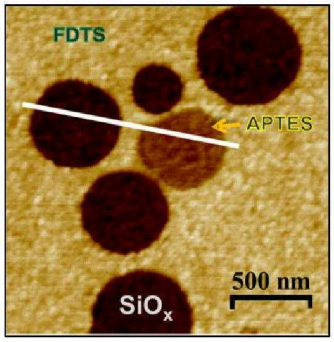
Metals [2]



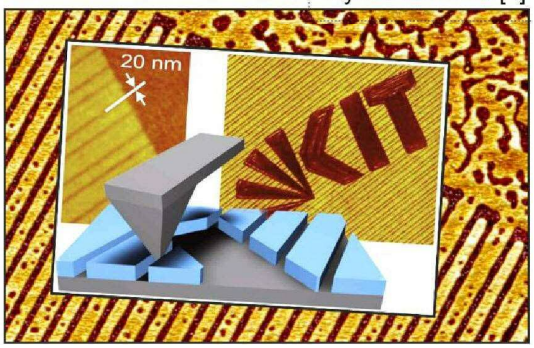
Polymer Brushes [4]



Switchable SAMs [3]



SAMs [1]



Polymer Brushes [4]

Stefan Walheim*[1,4] Roland Gröger[2,4], Cheng Huang[2], Tobias Heiler[2], Markus Moosmann[2], Jonathan Berson[2,4] and Thomas Schimmel [2,1,3] *Correspondence to: stefan.walheim@kit.edu

1. Institute of Nanotechnology (INT) and Karlsruhe Nano Micro Facility (KNMFi) Karlsruhe Institute of Technology, Herrmann-von-Helmholtz-Platz 1, D-76344 Eggenstein-Leopoldshafen, Germany
2. Institute of Applied Physics (APH), Karlsruhe Institute of Technology, Wolfgang-Gaede-Str. 1, D-76131 Karlsruhe, Germany
3. Materials Research Center for Energy Systems (MZE), Karlsruhe Institute of Technology, Strasse am Forum 7, D-76131 Karlsruhe, Germany
4. Center for Single-Atom Technologies (C.SAT), Karlsruhe Institute of Technology, Strasse am Forum 7, D-76131 Karlsruhe, Germany

Phase separation in thin polymer films during the spin coating process leads to a nano- and micro-structured surface of the coated substrate in a matter of seconds. By removing one of the two polymer components, the substrate can then usually be exposed and metals, self-assembled monolayers (SAMs), semiconductors or polymer brushes can be deposited in the exposed areas. This allows a new approach to study the function of the patterned deposited species such as plasmonics for metals or mechanical and photonic switchability for SAMs [3]. In a very recent work [4] we structured a SAM/brush hybrid structure and were thus able to characterise the structurability of the brush successfully. It has a lubricating effect and allows a 5000 times longer writing time or writing distance compared to uncoated silicon. The resulting arbitrary brush structure layout was successfully used as a template for the directed self-assembly of polymer blends, and the structure was ultimately transferred 30 nm deep into the silicon substrate by reactive ion etching.

[1] C. Huang, M. Moosmann, J. H. Jin, T. Heiler, S. Walheim, Th. Schimmel: Polymer blend lithography: A versatile method to fabricate nanopatterned self-assembled monolayers, Beilstein Journal of Nanotechnology 3, 620-628 (2012) [2] C. Huang, A. Forste, S. Walheim, Th. Schimmel: Polymer blend lithography for metal films: large-area patterning with over 1 billion holes/inch2, Beilstein Journal of Nanotechnology, 6 1205-1211 (2015). [3] J. Berson, M. Moosmann, S. Walheim, Th. Schimmel: Mechanically Induced Switching of Molecular Layers, Nano Lett, 19 (2), 816-822 (2019).
[4] R. Gröger, T. Heiler, Th. Schimmel, S. Walheim: Tip-Induced Nanopatterning of Ultrathin Polymer Brushes, Small, 2204962 (2023).