

Scanning Probe Lithography for Localized 2D Material Bio-Functionalization

Michael Hirtz

Institute of Nanotechnology (INT) & Karlsruhe Nano Micro Facility (KNMF), Karlsruhe Institute of Technology (KIT), Hermann-von-Helmholtz-Platz 1, 76344 Eggenstein-Leopoldshafen, Germany
michael.hirtz@kit.edu

Scanning Probe Lithography (SPL) techniques like dip-pen nanolithography (DPN), polymer pen lithography (PPL) and spotting with microchannel cantilevers (μ CS) offer unique opportunities for highly-localized chemical surface functionalization with resolutions in the micron to even nanometer scales (Figure 1). All these techniques have unique strengths in terms of resolution, obtainable throughput and patterning speed and broad compatibility with delicate chemical and biological inks [1]. Generally, they offer mild process parameters and are capable of multiplexing (i.e. deposition of different compounds within a desired micropattern). Hence, these methods are inherently of special interest for the generation of bioactive surfaces in biomedical applications [2].

One particular subset of applications for SPL methods is the printing of tailored supported lipid membranes (SLM) by DPN with phospholipids (L-DPN). This allows for highly targeted and multiplexed deposition of SLMs e.g. to graphene / graphene oxide surfaces that show unique properties in their interaction, thus could be used for biosensing applications [3,4]. Also, complex functional proteins can be deposited into arbitrary shaped micropatterns, e.g. to enable positioning of cells into specific places on a surface [5]. The talk will give a brief overview over SPL methods and introduce some examples specifically relevant for functionalization of 2D materials with bioactive or biological materials.

References

- [1] G. Liu, M. Hirtz, H. Fuchs, Z. Zheng, *Small*, 15 (2019), 1900564
- [2] H.-Y. Liu, R. Kumar, C. Zhong, S. Gorji, L. Paniushkina, R. Masood, U. A. Wittel, H. Fuchs, I. Nazarenko, M. Hirtz, *Advanced Materials*, 33 (2021) 2008493
- [3] M. Hirtz, A. Oikonomou, T. Georgiou, H. Fuchs, A. Vijayaraghavan, *Nature Communications*, 4 (2013) 2591
- [4] N. Willems, A. Urtizbera, A. F. Verre, M. Iliut, M. Lelimosin, M. Hirtz, A. Vijayaraghavan, M. S. P. Sansom, *ACS Nano*, 11 (2017) 1613
- [5] R. Kumar, S. Llewellyn, S. K. Vasantham, K. Nie, S. Sekula-Neuner, A. Vijayaraghavan, M. Hirtz, *Scientific Reports*, 12 (2022) 3895

Figures

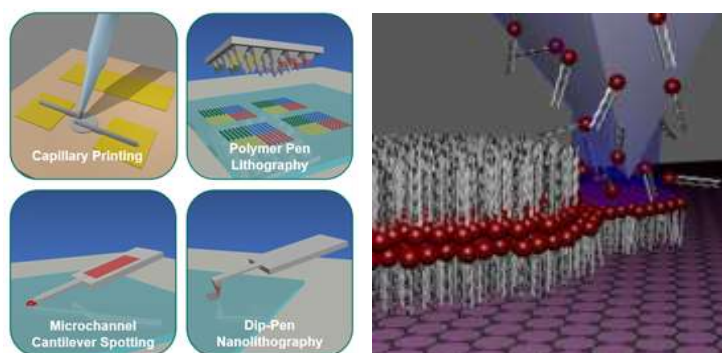


Figure 1: SPL methods (left) and a DPN tip writing a lipid membrane on graphene (right).