University of Basel
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PAUL SCHERRER INSTITUT PSI

MAGNET. MacEtch based n**A**nofabrication of hi**G**h aspect ratio silicon **N**anowires with magn**E**tic **T**ips

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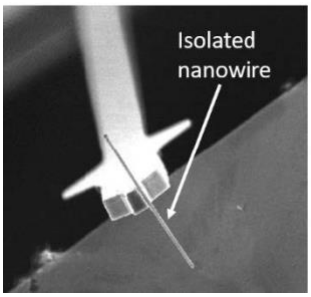
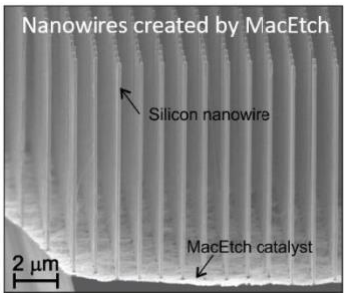
With recent advances and new applications, metal assisted chemical etching (MacEtch) is the new frontier of non-plasma nanofabrication of silicon at extreme aspect ratios [1]. Depending on catalyst, substrate doping type, substrate crystal, etchant formulation, and etch additives, a careful process optimization seems to be the key for unprecedented nanostructuring. With a record nanowire (NW) aspect ratio of 10'000:1 in gas-phase [1], MacEtch of silicon is still lacking of a systematic investigation and a comprehensive model [2] preventing its spreading as mass production for nanotechnology. Magnetic NWs have been used as transducers in a highly sensitive form of magnetic force microscopy (MFM), which is ideal for imaging subtle patterns of magnetization or current density [3]. Such imaging can provide microscopic information about length scales, inhomogeneity and interactions especially in poorly understood 2D materials. Until now, however, a reliable fabrication process producing NW MFM probes with high mechanical and magnetic quality has not been developed. Here we propose to apply MacEtch for the production of NWs with magnetic tips and to use these probes in NW MFM for sensitive magnetic imaging. We will use the clean-room facilities at PSI, including cutting-edge lithographic capabilities and gas-MacEtch. The magnetic properties will be measured at at Univ. Basel with magnetic force microscopy. Bosting the nanofabrication capabilities will synergistically address different scientific applications enabling even new possibilities in several fields. High aspect ratio nanogratings are expected to improve the sensitivity of grating based X-ray interferometry, a technology PSI has been pioneering and currently one of the world-leading research institution [4]. Fundamental studies about magnetism are on-going in the group at Univ. Basel. Among the nanostructures, magnetic NWs are attractive materials for various advanced technologies in sensing, data storage, spintronics, biomedicine, bio-interfaces and microwave devices, etc.





[1] Romano, L. *et al. Metal assisted chemical etching of silicon in the gas phase: a nanofabrication platform for X-ray optics*, http://dx.doi.org/10.1039/C9NH00709A (2020)
[2] Romano, L. *et al. Microfabrication of X-ray Optics by Metal Assisted Chemical Etching: A Review*, https://www.mdpi.com/2072-666X/11/6/589 (2020)
[3] Rossi, N. *et al. Magnetic Force Sensing Using a Self-Assembled Nanowire*, https://doi.org/10.1021/acs.nanolett.8b04174 (2019)
[4] Weitkamp, T. *et al. X-ray phase imaging with a grating interferometer*, http://www.opticsexpress.org/abstract.cfm?URI=oe-13-16-6296 (2005)

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