Direct Write Nanofabrication

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Progress in nanotechnology depends critically on the capability to fabricate, position, and interconnect nanometer-scale structures. While optical lithography still dominates large volume production, so called mask-less methods such as electron beam lithography or scanning probe methods are needed to create prototype devices and drive nanotechnology research.

In the first part of the talk, a short overview of the mask-less nanofabrication landscape will be given. The second part of the talk will focus on thermal Scanning Probe Lithography which (tSPL) has been developed at the IBM Research Laboratory in Zurich over the past five years. In tSPL a heated scanning probe microscopy tip with an apex-radius of typically 5 nanometers is used to locally evaporate organic resists and thereby create arbitrary patterns. Technologically important advancements, such as the demonstration of reliable high speed patterning at 0.5 MHz pixel rate and the development of robust CMOS compatible pattern transfer and metal lift-off processes, have been achieved demonstrating that tSPL has become viable nano-fabrication technology for real world applications.

A particular strength of scanning probe lithography methods is the fact that no high energy beams are required for creating the lithographic patterns thereby avoiding beam induced damage of the substrate and proximity effects due to back-scattering. In addition, scanning probes can be used as an atomic force microscopy probe for the non-destructive imaging of the patterned surface with very high resolution. We exploit this feature to implement a closed-loop control scheme which enables an autonomous and precise operation of the tool. Nanometer scale accurate reproduction of absolute depth values is demonstrated for 3D relief data. In addition, the scheme allows for a nanometer precise and marker-less overlay process of the next patterning level relative to existing nanostructures. These novel capabilities provide an intuitive and visually accessible platform for researchers to address future challenges in nanofabrication.

Urs Duerig, IBM Research – Zurich, Saeumerstrasse 4, 8803 Rueschlikon, Switzerland: Dr. Duerig received a degree in experimental physics and a Ph.D. degree from the Swiss Federal Institute of Technology, Zurich, Switzerland, in 1979 and 1984, respectively. He was postdoctoral fellow at the IBM Research Laboratory in Rueschlikon from 1984 until 1985 developing the first working optical near-field microscope in Dieter Pohl's group. In 1986, he became Research Staff Member and worked in the field of scanning tunneling and force microscopy, investigating metallic adhesion, growth morphology of magnetic thin films, and surface melting. In 1997, he joined the Probe Storage Group at IBM, leading the polymer storage media development. In 2008 he started the thermal probe lithography project, which lead to the foundation of an independent start-up company SwissLitho AG in 2012.

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