Functional Nano Patterns realized by Thermal and UV Nano Imprint Lithography

M. Baum, J. Besser, M. Wiemer, T. Gessner
Fraunhofer Institute for Electronic Nano Systems ENAS, Chemnitz, Germany
mario.baum@enas.fraunhofer.de

In comparison to microelectronics the nanoimprint lithography (NIL) is a quite young process which is used for the precise pattering in the nanometer scale. For high production volume the nanoimprint lithography should be more economical than direct writing technologies[1]. Especially in the field of surface patterning a wide range of applications exist in the medical and biological sector. One example is the well-directed structuring of implant surfaces to enhance and/or worsen the cell growth[2].

Within this paper we describe the realization of a polymer working stamp as a soft replication tool, molded from a Silicon master as well as a typically used process flow for pattern transfer via UV-NIL and thermal NIL. This process flow includes the NIL processes and the dry etching for pattern transfer. For the pattern transfer investigation certain materials e.g. Silicon, Silicon Nitride, and Aluminum were used. For the fabrication of these structures also different patterns like pillars, lines and meanders were varied. With thermal imprinting also micron scaled patterns are due to transfer, quite similar to hot embossing. Here soft tools for imprinting have the advantage of particle tolerant processing and accurate pattern transfer.

For ultraviolet (UV)-NIL 6 inch silicon wafers are used as substrates to be patterned. The wafers were coated with different materials like silicon oxide, -nitride or aluminum. After thermal pre-treatment and certain preparation steps the nanoimprint process was carried out by pressing the substrate and the working stamp together and by exposing the stack for 200 seconds under UV light using an EVG 6200 aligner system. After manual demoulding the substrates were dry etched. Each single step was characterized by SEM analysis and optical measurement tools. The promising results are shown in figure 1 and 2.

The main application fields of nano patterned devices are optical or photonic components, medical and biological surfaces (see figure 3), and microfluidic systems. Certain application examples will be demonstrated with the paper.

---

[1]S. Y. Chouet al. Applied Physics Letters, Vol. 67 (Issue 21): 3114-3116, 1995

[2]Baum,M.; et.al.: Nano patterned surfaces and their influence on living cells. Biomedizinische Technik 2011, Freiburg, 2011 Sep 27-30; Proceedings Biomed Tech 2011, 56 (Supplement 1) (2011) p Poster P86(ISSN0 939-4990)

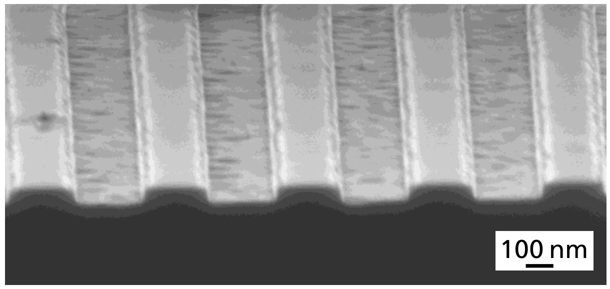

Figure 1: SEM image of 200 nm lines in a 100 nm thin Al layer

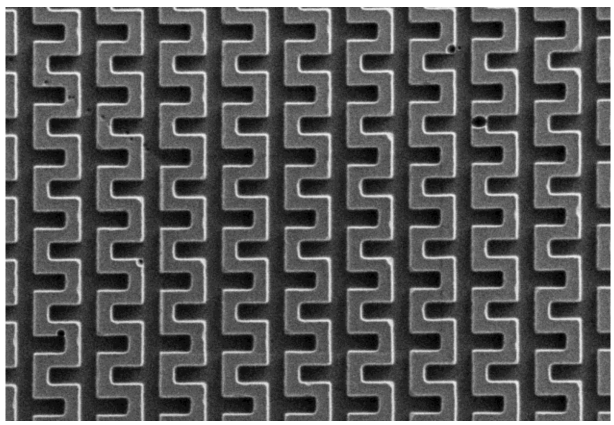

Figure 2: SEM image of 300 nm meanders in a 300 nm thin NIL resist (MRT, Germany)

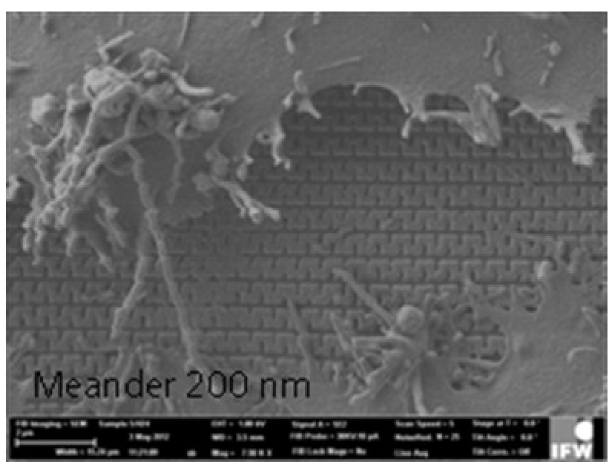

Figure 3: SEM image showing HeLa cells (cancer) on 200 nm meander structures in Silicon after 24 hours of culturing