Towards Additive Manufacturing of Silicon Micro and Nanostructures

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Abstract

Silicon (Si) is the most attractive material for high-performance micro- and nanoscale structures with applications in sensing and photonics. Current technology allows complex 3D Si structures to be implemented only with complicated fabrication schemes using semiconductor clean-room processes adapted for very high-volume manufacturing. Existing 3D printing (additive manufacturing) methods for micro and nanoscale 3D structures focus on materials such as polymers or metals. In this talk we will give a brief overview on state-of-the-art 3D printing technologies for micro and nanostructures. A new additive layer-by-layer manufacturing technology for the fabrication of arbitrarily shaped 3D micro- and nanostructures made of Si will be presented and discussed. The layer-by-layer fabrication process is based on alternating steps of chemical vapor deposition of Si and local implantation of gallium ions by focused ion beam (FIB) writing. In a final step, the defined 3D structures are formed by etching the Si in potassium hydroxide (KOH), where the ion implantation provides the etching selectivity. The feasibility of the technology has been demonstrated by forming simple 3D Si structures with dimensions as small as 30 nm. The implementation of the process scheme in a fully automated tool will enable printing of complex 3D Si micro- and nanostructures directly from computer-generated 3D drawings.

Biography

Frank Niklaus received the Dipl.-Ing. degree in mechanical engineering from the Technical University of Munich, Germany, in 1998, and the Ph.D. degree in MEMS from KTH Royal Institute of Technology in Stockholm, Sweden, in 2002. Since 2013, he is Professor at the Department of Micro and Nanosystems at KTH, where he is heading the Micro- and Nanofabrication Group. His research interests focus on innovative manufacturing, integration and packaging technologies for MEMS and NEMS.