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Preface

Preface for a special issue of *Microelectronic Engineering* Micro/Nano Biotechnologies & Systems 2014

In 2015 we celebrate the UNESCO 'Year of the light', 150 years after the first ascent to the Matterhorn (1865) and 20 years after the first publications on "nanoimprint lithography" (NIL). While photolithography has become the workhorse of high-volume manufacturing (HVM) of semiconductor chips, it is uncertain whether semiconductor chip manufacturing will follow the normal path of downscaling based on EUV-lithography. Everything seems to be ready but other techniques might win due to technological or cost issues. NIL has reached maturity and starts to replace photolithography in sapphire substrate patterning for light emitting diodes (LED) and will possibly make its way into manufacturing of semiconductor chips in 2016. During the last years, Microelectronic Engineering (MEE) has covered the ascent of several lithographic techniques from "exploratory research" and "next generation lithography" to HVM. Tools and materials seem to be ready and processes are developed that meet the requirements of a growing user community. The next years will show whether techniques will become widely used and successful, or will dwell in some laboratories and potentially vanish. It is still an endeavor to follow this path of different micro- and nanofabrication techniques, which are the heart of many micro- and nanotechnological applications.

This special issue on "Micro/Nano Biotechnologies & Systems 2014" contains a selection of papers, which were mainly presented on the "40th Micro and Nano Engineering, MNE 2014 conference" held from September 22 to 26 in Lausanne, Switzerland. The MNE conference series focuses on micro- and nanofabrication and manufacturing using lithography and other nanopatterning related approaches, as well as the application of micro- and nanostructures and devices in electronics, photonics, electro-mechanics, for the environment and life sciences. The large number of submissions led to a selection of papers from five relevant topical themes of the MNE 2014 conference, which then formed the basis of four special issues. At MNE 2014, 670 abstracts were submitted from 45 countries, numbers surpassing all previous MNE conferences. The conference program comprised 585 contributions. The special issue on Micro/Nano Fabrication 2014 is one of four issues covering the five conference topics, which were condensed to four special issues of Microelectronic Engineering (volumes 141, 143, 144, and 145). For the special issue on "Micro/Nano Biotechnologies & Systems 2014", 20 papers were submitted, which underwent critical review by at least two experts in the field with a rejection rate of 30%. In total, the 20 submissions account for 12% from the original 167 accepted abstracts from the thematic topic "Micro and Nano Fabrication Methods" at the MNE 2014 conference.

The special issue on "Micro/Nano Biotechnologies & Systems 2014" essentially covers a multidisciplinary approach for providing tools for research and discoveries in the Life Sciences as well as sensing platforms for the detection of various biologically-relevant analytes. A remarkable trend with this series of contribution is the increasing sophistication and complexity of samples, cells and tissues that are used with the developed technologies. This trend is not unique to these contributions but is broadly observed across journals and conferences. While using "simple" cell lines for developing and testing devices was the norm a few years ago, we can see technologists teaming with biologists and taking up the challenge of working with primary cells, tumors grown in vitro, and biological samples more representative of real problems rather than being just buffers spiked with known concentrations of analytes. The technical community obviously has taken up the challenge of developing devices, materials and methods for the next generation of experiments that involve more challenging but more relevant samples and contexts. This can be illustrated by taking just three examples. In a first example, "A portable fluorescent sensor for on-site detection of microalgae", Choi et al. fabricate disposable PDMS-based microfluidics that can be inserted in a small form factor fluorescence sensor. Portability is a key goal in this work because the sensor aims at detecting microalgae population in various samples including turbid water. The sensor in fact detects chlorophyll using a classical excitation/emission, albeit using a compact and low cost sensor. Liquid displacement is here driven by replenishing gas in a PDMS chip that had been pre-degassed. This work illustrates the convergence between microfabrication, component integration and the need for portable biosensors that can ultimately be connected for feeding information technology systems with data. The second example, "Shaping living tissues using microfabricated structures" by Vieu et al. describes how to insert and grow tumor spheroids inside high-aspect ratio PDMS structures. The structures are specifically coated either with cell adhesion molecules or a protein-repelling layer and form a mold, which can impose specific peripheries and shapes to the spheroids. Removing the mold is surprisingly easy and releases constraints from the spheroids, the evolution of which can then be studied using different and well-defined starting geometries. Such a microfabrication strategy may give insights about how cells and tumors interact with their microenvironment. This is right now a hot topic in cancer research and tissue engineering. The third and last example, "Using electrofluidic devices as hyper-elastic strain sensors: experimental and theoretical analysis" by Pineda et al. describes strain sensors made from very soft silicone elastomers and

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including metal liquid alloy. The sensor accomodates deformation over 200% and many deformation cycles. This work finds its motivation with recent developments on soft robots and wearable sensors/devices. Wearable and tactile devices may be exposed to challenging deformation conditions and it would be valuable to monitor strains/stimuli during the life cycle of such devices. The materials, designs, and fabrication strategies of such sensors might even inspire the development of wearable devices that can be very resilient.

While taking a limited number of examples cannot provide an exhaustive account of all articles contributing to this special issue, these specific examples hopefully illustrate the increasing maturity of research and exploratory work done on micro- and nanotechnologies for applications in biology. All together, these contributions exhibit an impressive range of techniques and expertise and provide as well many examples of well defined problems, which may inspire readers for their own work.

Guest Editors
Aleksandra Radenovic
EPFL, Lausanne, Switzerland

Emmanuel Delamarche
IBM, Rueschlikon, Switzerland