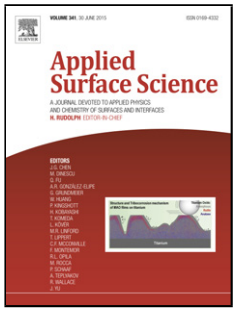

Title: Towards nanopatterning by femtosecond laser ablation of pre-stretched elastomers

Author: Salvatore Surdo Simonluca Piazza Luca Ceseracciu Alberto Diaspro Martí Duocastella

PII: S0169-4332(15)02561-1
DOI: http://dx.doi.org/doi:10.1016/j.apsusc.2015.10.142
Reference: APSUSC 31623

To appear in: *APSUSC*

Received date: 11-6-2015
Revised date: 16-10-2015
Accepted date: 20-10-2015

Please cite this article as: S. Surdo, S. Piazza, L. Ceseracciu, A. Diaspro, M. Duocastella, Towards nanopatterning by femtosecond laser ablation of pre-stretched elastomers, *Applied Surface Science* (2015), http://dx.doi.org/10.1016/j.apsusc.2015.10.142

Towards nanopatterning by femtosecond laser ablation of pre-stretched elastomers

*Salvatore Surdo, Simonluca Piazza, Luca Ceseracciu, Alberto Diaspro and Martí Duocastella**

Nanophysics Department, Istituto Italiano di Tecnologia, Via Morego 30, 16163, Genova, Italy

**marti.duocastella@iit.it*

Diffraction limits the focusing capabilities of an optical system seriously constraining the use of lasers for nanopatterning. In this work, we present a novel and simple approach to reduce the minimum feature size of a laser-direct write system by ablating a pre-stretched material. In particular, by focusing and scanning a femtosecond laser beam on the surface of a uniaxially pre-stretched elastomeric membrane we are able to obtain microstructures according to a desired pattern. After removing the stress applied to the elastomer, the membrane relaxes to its original size and the ablated patterns shrink while preserving their shape. In this way, the minimum feature size that is typically determined by the optical properties of the focusing system can be now controlled by the strain applied to the elastomer during the ablation process. We demonstrate this approach by ablating lines on a stretchable polymeric membrane at different strain conditions. Experimental results are in good agreement with theoretical predictions. The proposed method opens up new interesting possibilities for the rapid prototyping of micro- and nano-structures suitable for a wide range of applications such as soft-lithography, micro-/nano-fluidics and lab-on-chip.

Keywords: laser material processing, femtosecond laser, elastomers, stretchable materials, optical nanopatterning.

I. Introduction

Surface nanopatterning is crucial to provide materials with desired optical, chemical or mechanical properties [1-7]. Widely used strategies include electron-beam lithography and photolithography [8-11]. Fostered by the semiconductor and microelectronics industries, these technologies have successfully achieved patterning of inorganic materials with resolutions down to 20 nm [11]. However, applying these methods to more delicate materials, i.e. organic or biological materials, remains cumbersome. In particular, the need for harsh solvents and bases renders these technologies incompatible with many biological molecules, and often prevents them to be directly applied to proteins and cells. Moreover, e-beam lithography, being a vacuum-based technology, is inherently constrained to the use of solid materials – most biological materials are usually dispersed in liquid solutions.

A promising approach for patterning delicate materials at the micro- and nanoscale, ranging from biomolecules to living cells, is soft-lithography [12-17]. Briefly, soft-lithography refers to a group of methods in which a desired material is