University of Belgrade, Institute for chemistry, technology and metallurgy
Center for microelectronic technologies

Book of Abstracts

COST MP1402 SCIENTIFIC WORKSHOP

"ALD and related ultra-thin film processes foradvanced devices"

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Funded by the Horizon 2020 Framework Programme of the Europian Union

Plasmonic enhancement of photocatalytic optofluidicmicroreactors with corrugated thin metal films

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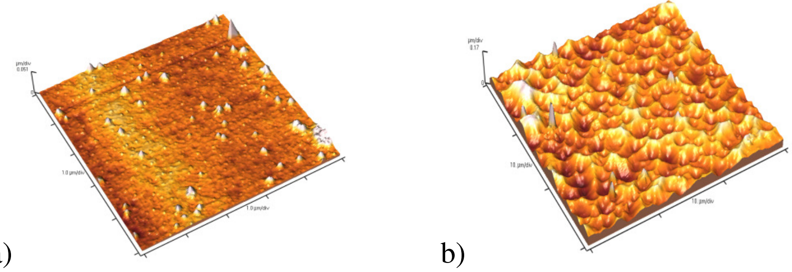
Keywords: plasmonics; microreactors; optofluidics; micromachining

Plasmonics deals with electromagnetic waves that are bound to an interface between conductor with free electron plasma and dielectric, and are evanescent in the perpendicular directions. This ensures extreme localizations of electromagnetic near fields in subwavelength volumes [1,2].A number of systems where plasmonic activation is used for photocatalysis has been reported until now [3-6]. A vast majority of these relies on localized surface plasmon resonance on nanoparticles, which may have either monolithic [7] or core-shell structure [8]. In our experiment we propose the use of disordered rough plasmonic surface for the enhancement of photocatalytic microreactors. The basic idea was to fabricate a microreactor structure with the microchannel bottom surface roughened by wet chemical etching and subsequently covered by a thin gold layer (plasmonic material).

Experiments in wet chemical etching was performed on two single crystal, n-type silicon wafers, double side polished, 3" in diameter. Thermal oxide was used as a masking layer on Si wafers. A protective oxide had a thickness value about 0,6 μm for chemical etching in KOH (potassiumhydroxide) and 1 μm for chemical etching in TMAH (tetramethylammonium hydroxide). Thermal oxide was etched in BHF (buffered hydrofluoric acid) from the top side of wafers, after that wafers were cut on 6 pieces, samples. One set of samples was etched in 30 wt.% KOH water solution at 80 °C for 2 min, 4 min, 6 min, 8 min, 10 min, with etching rate of 1,1 μm/min. And the other set of samples was etched in 25 wt.% TMAH water solution at 60 °C for 2 min, 3 min, 4 min, 5 min, 6 min, with etching rate of 0,16 μm/min.All samples were cut in half, and one half of each sample was gold sputtered. As a coupler between propagating and surface modes for plasmonic enhancement of photocatalytic optofluidicmicroreactors thin layer of gold, Au, was used with sublayer of chrome, Cr. Sublayer must be present for purpose of good adhesion of gold on silicon surface. The minimum of thickness value for gold and chrome as sublayer have to be around 20nm, 10 nm respectively. Thickness value of layer and sublayer, combined, must be smaller then value of roughness of silicon surface. The roughness of the surface of the three-dimensional images was determined with atomic force microscope TM Microscopes – Veeco in contactless mode.



a) b)

Fig. 1. Measured surface profile of single crystalline (100) wafer etched in a)TMAH b) KOH

Different surface profiles were obtained by different profiling mechanisms.We obtained better surface with samples which were etched in 30 wt. % KOH water solution. This opens a path toward surface profile tailoring and optimization in the sense of maximizing the coupling efficiency and tuning it to a desired spectral range. The approach can be used in general optofluidics and for lab on chip devices.

Acknowledgment

Authors acknowledge COST action MP1402, HERALD, for the support and possibility of presenting and disseminating the results of this work.

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