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# MICRO- AND NANO-STRUCTURES FOR OPTICAL DETECTION OF BIOMOLECULES

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High accuracy, very low surface roughness of deposits, and extended versatility leads focused electron beam induced deposition (FEBID) to be perfectly suited to nano-optic device production e.g. photonic band gap (PBG) structures [1]. Here we present the fabrication of a transparent two-dimensional PBG structure.

Our FEBID equipment is based on a Cambridge S100 scanning electron microscope (SEM) with thermionic tungsten filament. The electron beam is controlled with a Nabity Systems patterning software (NPGS). A modified internal syringe supplies the volatile precursor in the SEM chamber to the substrate.

The classical $SiO_2$ CVD precursor Tetraethyl orthosilicate (TEOS) was chosen as it also decomposes into a transparent dielectric material under electron irradiation. Refractive index and absorption of deposits prepared in our SEM were subject of investigation. High resolution (5x5μm$^2$) spectroscopic micro-ellipsometry measurements were carried out with a Nanofilm EP3 (Nanofilm Technologie GmbH, Göttingen, GE) on deposited rectangles of 70nm thickness. We obtained the complex index of refraction ñ between 350nm and 900nm wavelength. At $\lambda$ = 632nm ñ equals 1.85 + i $3.9 \cdot 10^{-4}$. These values were used as input parameters for the photonic structure design (Fig. 1) with maximum PBG at this wavelength.

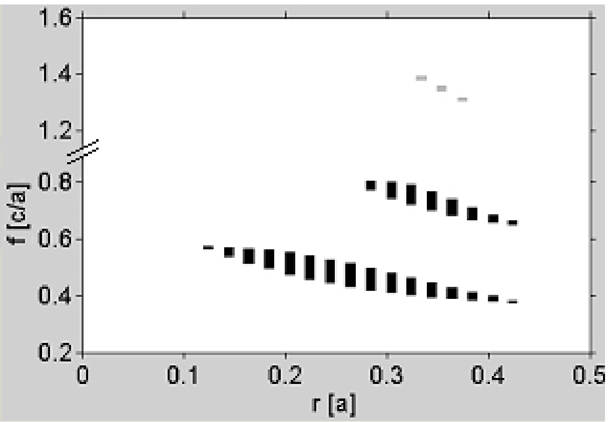


*Fig. 1: The photon frequency f normalized to the lattice constant (a) as function of the pillar bottom radius r shows the forbidden photonic states for the two polarizations (black =TM, grey = TE) of a two-dimensional cylindrical pillar hexagonal arrangement.*

Furthermore, growth rates and geometrical dimensions of the deposits for different irradiation conditions were determined.

The proposed PBG structure is based on a 2-D hexagonal lattice with missing central pillar in order to create a micro-cavity. Parameters are: lattice constant (a) 470nm, pillar diameters 320nm, pillar heights 500nm.

Deposition parameters were based on the dynamic and geometrical properties of FEBID tips with TEOS: beam current 100pA, dwell time for each pillar 120s, deposition divided in 30 overlays, 30 automatic realignments in total.

Observation (Fig. 2) shows that the deposited pillars have dimension errors below 3% of the targeted values. Deposition on a 2mm thick microscope slide covered by a 10nm thick antimony doped tin oxide layer suppressed structure's distortions due to charging effects. Implementation of multiple beam re-alignments on alignment marks compensated electron beam drift.

Optical analysis of the PBG structure is currently under investigation.

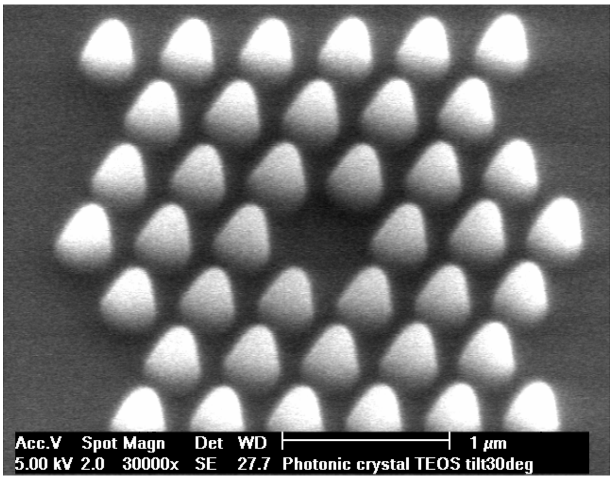


*Fig. 2: SEM image of the PBG structure, 30° tilt view. Hexagonal lattice and micro-cavity are well observable.*

[1]H.W.P Koops, O.E. Hoinkis, M.E.W. Honsberg, R. Schmidt, R. Blum, G. Bottger, A. Kuligk, C. Liguda, M. Eich, Microelectronic Engineering, vol 57-58, 2001, pp.995-1001.