Laser direct writing of efficient 3D TiO_2 nano-photocatalysts

Ioannis Syngelakis[1,2*], Maria Manousidaki[1], Elmina Kabouraki[1], Apostolos Kyriakakis[1,2], George Kenanakis[1], Argyro Klini[1], Stelios Tzortzakis [1,2], and Maria Farsari[1]

[1] Institute of Electronic Structure and Laser (IESL), Foundation for Research and Technology Hellas (FORTH), N.Plastira 100, 70013 Heraklion, Crete, Greece
[2] Department of Materials Science and Technology, University of Crete, 70013 Heraklion, Crete, Greece
*Corresponding author email: isyngelakis@iesl.forth.gr

Nowadays there is increasing demand for functional nanodevices for energy applications technology. This study unveils the realization of three-dimensional (3D) structures coated with titanium nanorods (NRs) for enhancing photocatalytic performance by increasing the active surface area [1]. These novel devices are fabricated combining four distinct techniques: multi-photon lithography, post-thermal treatment, pulsed laser deposition, and aqueous chemical growth. The photocatalytic activity of the 3D devices is evaluated through the degradation of organic pollutants such as methylene blue and stearic acid [2]. The devices exhibit a striking decomposition coefficient ($k = 0.059 min^{-1}$), highlighting their enhanced photocatalytic efficiency. In addition, we propose a rapid fabrication 3D holographic printing [3] to create large area TiO_2-coated micro-structured photocatalytic devices at the mesoscale regime for further enhancing devices' photocatalytic capabilities. By combining additive micro-manufacturing TiO_2 NR coating, and holographic printing, our work introduces a promising avenue for the development of advanced nanodevices with superior photocatalytic performance in sustainable energy applications.

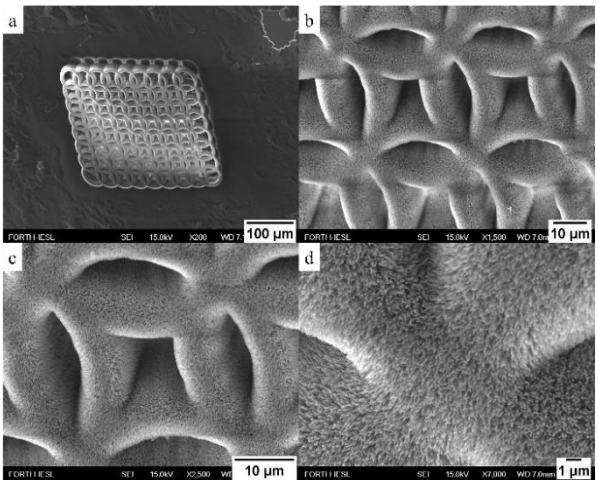

Figure 1: SEM images of 3D structures covered by TiO_2 NRs (a) Perspective view, (b) magnification view of the TiO_2 NRs, (c) higher magnification, and (d) even higher magnification.

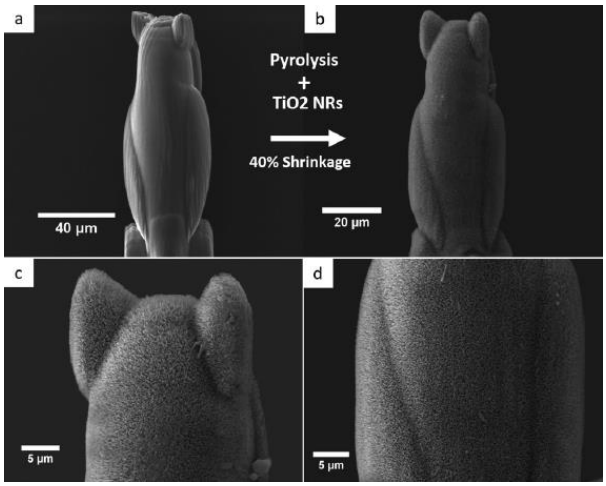

Figure 2: SEM image of the 3D owl micromodel fabricated by 3D holographic printing. The height of the owl is measured to be 136µm. (b) The 3D structure presented in (a) after pyrolysis and TiO_2 NRs development. The structure was shrunk down by 40%, resulting in a total height of 85µm, (c) and (d) Detailed images of the TiO_2 NRs coated structure shown in (b).

References: [1] I. Syngelakis et al.; [2] A. Mills and J. Wang; [3] M. Manousidaki, D. G. Papazoglou, M. Farsari and S. Tzortzakis