THE INFLUENCE OF BALL-MILLING ON THE OPTICAL PROPERTIES OF PRINTED TITANIA PATTERNS REINFORCED BY ORGANOSILOXANE BINDER

Oldrich Zmeskal[a], Veronika Schmiedova[a], Petr Dzik[b], Jakub Tkacz[a] and Michal Vesely[b]

[a]Center fo Materials Research, Faculty of chemistry, Brno University of Technology, Purkynova 118, 612 00 Brno, Czech Republic
[b]Department of Physical and Applied Chemistry, Faculty of Chemistry, Brno University of Technology, Purkynova 118, 612 00 Brno, Czech Republic

Transition metal oxide and silica mixtures represent a perspective group of active materials that have recently been proposed as for various heterogeneous photocatalysis processes. Surprisingly, silica present in minor amount isn't dentrimental for charge transfer in the hybrid semiconductor-silica layer and among other applications allows for the fabrication of titania-silica photoanodes and other photonic components [1].
In this paper, we report about the influence of ball-milling on the optical properties of silica-bonded particulate titania patterns fabricated by inkjet printing. A previously optimized printing protocol [2] was used to fabricate composite titania-silica patterns of various area and thickness. The employed „ink", consisted of a commercial titania nanoparticles (Evonik P-25) and a recently reported organo-silica binder [3]. The previous studies proved the binder presence is beneficial for a number of reasons (stability of the stock suspension, rheological behavior during inkjet printing and bonding the printed nanoparticles). However, the soluble organo-silica binder needs to be mineralized in order to render it fully insoluble and significantly improve the printed layer mechanical properties. As reported recently [4], three different processes can be employed for this purpose: (a) thermal annealing, (b) UV-curing, and (c) atmospheric plasma treatment in a coplanar dielectric barrier discharge.
All three processes yield composite titania-silica patterns with interesting photonic functionality. However, the way the two components interact is to a great extend depending on the texture of the titanium dioxide, which can be conveniently controlled by ball-milling the liquid formulation prior to printing it. Since the titania texture has a direct impact on the optical properties, spectroscopic ellipsometry can be used to extract valuable information about the extent of milling. By correlating ellipsometric data with measurements obtained by other methods (nitrogen sorption, mechanical profilometry), we have shown that as the titania aggregates are broken into smaller fragments and eventually primary crystallites, the porosity and surface roughness is decreasing. Thus ellipsometric measurement can be employed as quick process control tool.

Keywords: materials printing, titanium dioxide, texture, porosity, ball milling

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