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Photoactive TiO2 and Ta doped TiO2 1D nanotubes grown by electrochemical anodization of Ti and TiTa films deposited by DC pulsed magnetron sputtering on FTO transparent substrates

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The self-organizing electrochemical anodization yielding 1D nanostructures such as nanotubes of various metal oxides and their doped versions is relatively well-established process. These nanoarchitectures are being increasingly utilized for photonic applications such as photocatalysis and photoelectrochemistry due to very high specific surface area enhancing the solar harvesting efficiency and superior charge transfer performance. In this work we describe a novel approach to obtain 1D TiO_2 nanotubes directly grown on FTO glass, which represents suitable transparent substrate for aforementioned photonic applications. In this two-step approach we first deposited pure Ti and TiTa layers by a DC pulsed magnetron sputtering. These films were next transformed to the nanotubes by an electrochemical oxidation process. We investigated the correlations among deposition plasma parameters (deposition pressure, temperature of substrate, applied power, and a plasma activation of FTO substrate prior to the deposition), properties of the deposited Ti and TiTa films (crystalline structure, density, adhesion to the substrate, density of pinholes, etc.), and structural (crystallinity, adhesion to the FTO substrate, density of defects, etc.) and particularly functional (photoelectrochemical characteristics) properties of the grown TiO_2 based nanotubes. The films prepared were described by a broad portfolio of characterization techniques involving XRD, Raman spectroscopy, SEM, HRTEM, XPS, tribology measurements, etc. The functional properties were examined based on PEC measurements involving linear sweep voltammetry, chronoamperometry, OCP, IPCE, impedance spectroscopy, and hydrogen evolution.

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