Recent Advancements in Development of Anodic Metal Oxide Nanotubular and Nanoporous Layers

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In the literature, anodic TiO_2 nanotube (TNT) layers are typically synthesized on planar Ti substrates, such as Ti foils, which can be easily connected to a potentiostat during the anodization [1,2]. However, non-planar 3D Ti substrates, including meshes, spheres, and complex geometries, offer significant advantages for industrial applications, such as flow-through reactors and photocatalytic cleaners, due to their high surface area within a compact volume.

Bipolar anodization allows TNT layer formation on 3D Ti substrates without direct potentiostat connection [3-5]. In such a bipolar anodization set-up, the substrate is not directly connected to the potentiostat but is placed in an electrolyte between two feeder electrodes. Due to the electric field between the feeder electrodes, the substrate is polarized and can be anodized if the applied potential between the feeder electrodes is high enough. This approach allows for the formation of gradient TNT structures and facilitates the anodization of complex Ti geometries, including small spheres and 3D-printed structures [3-5]. Beyond TNT layers, a similar anodization process can be applied to W substrates to fabricate WO_3 nanoporous (WO_3 NP) layers [6]. WO_3 NP layer formation follows identical principles to TNT fabrication, with electrolyte composition and anodization parameters optimized for well-defined nanoporous morphologies.

In this presentation, the preparation of TNT layers on small Ti and Ti6Al4V spheres [7,8], 3D-printed Ti and TiNb substrates [9], and WO_3 NP layers on 2D and 3D W substrates using bipolar anodization is presented. Their applications in liquid- and gas-phase photocatalysis will be discussed. Additionally, we will explore the use of closed bipolar electrochemical cells, consisting of two closed half-cells with Ti and W substrates as an obstacle between cells for the preparation of TNT and WO_3 NP layers with the same and/or different dimensions on opposite sides of Ti and W foils [6,10].

References

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