# Investigation of nanostructured $TiO_2$

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## 1. Abstract

Materials are very important in several fields. Nanostructured $TiO_2$ is a commonly investigated and employed material thanks to its some excellent properties related to its biocompatibility, non-toxic and semiconducting capacity and for the possibility to use it in dye-sensitized solar cells, biomedical fields, photocatalysis, etc. [1, 2]. At the end of 20$^{th}$ century some research reveals the viability to develop highly well-organized arrays of $TiO_2$ nanotubes employing a simple procedure, like electrochemical anodization on a metallic Ti surface and the investigation on such topic has been continued during the time. By exploring the possibility of developing and modifying the properties of such structures is possible to use them in a wide range of applications. Other studies confirmed that creating disorder into regular nanostructure specific optical behaviors are obtained [3]. Using electrochemical anodization (EA), where the interested material is introduced in an anodization cell, and by employing different procedure settings, as current parameters, electrolyte type, and anodization time, self-arranged nanotubular $TiO_2$ can be obtained. The mechanism of nanotubes development is complex and arises when the formation of oxide at the metal-oxide interface and its etching at the oxide-electrolyte interface are in competition.

Our study is integrated in this large research topic and here some results on the development and characterization of nanostructured $TiO_2$ layer on Ti alloys metallic substrates will be shortly presented. Even if such layers were developed for biomedical purposes, the same process can be used also for materials for photonics and/or optoelectronics applications. The experimental setup for electrochemical anodization (Fig. 1a) of the samples was of two electrode types. For each experiment the samples were positioned at the anode and the cathode was a 20 mm diameter disc in pure Cu. For the two types of electrolyte were employed, one of them aqueous electrolyte (1M $H_3PO_4$ + 0.5 wt% HF), and the other one organic electrolyte (0.5 wt% $NH_4F$ + 2 wt% $H_20$ + ethylene glycol). The current was supplied by a programmable dual range DC power supply 9184B (BK Precision). Experiments in aqueous electrolyte were made at an anodization potential U = 20 V, applied with an initial ramp Ur = 0.2 V/s, for a duration T = 30 min. When using organic electrolyte anodization potential was U = 20, 40, and 60 V, Ur = 1 V/s, and duration T = 10, and 30 min. In house realized Nanosource2 software was used to supervise the anodization tests, and to check and record the process parameters. After anodization, the samples have been cleaned and investigated. Microstructural analysis confirms the nanostructured nature of the layers as reported in Fig.1b. More details on the results can be found in [4].

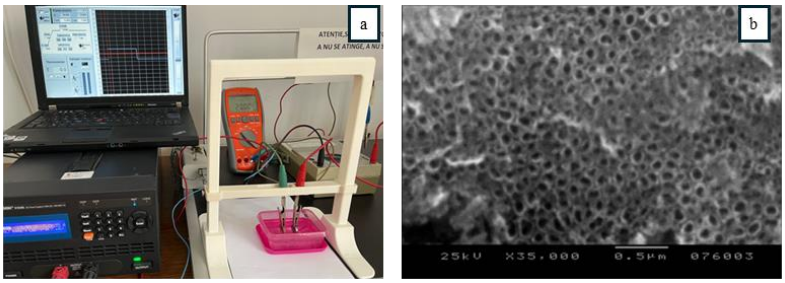


Fig. 1.The designed and built experimental setup and image (a) during the electrochemical anodization experiments and (b) SEM image of the nanostructured layer\

## 2. References

[1] Cotton, J.D.; Briggs, R.D.; Boyer, R.R. et al. State of the Art in Beta Titanium Alloys for Airframe Applications, JOM, 2015, 67,1281–1303. https://doi.org/10.1007/s11837-015-1442-4.
[2]Sarimov, R.M.; Glinushkin, A.P.; Sevostyanov, M.A.; Konushkin, S.V.; Serov, D.A.; Astashev, M.E.; Lednev, V.N.; Yanykin, D.V.; Sibirev, A.V.; Smirnov, A.A.; Baimler, I.V.; Simakin, A.V.; Bunkin, N.F.; Gudkov, S.V. Ti-20Nb-10Ta-5Zr Is Biosafe Alloy for Building of Ecofriendly Greenhouse Framework of New Generation. Metals, 2022, 12, 2007. https://doi.org/10.3390/met12122007
[3] Guo, M., Xie, K., Wang, Y. et al. Aperiodic TiO2 Nanotube Photonic Crystal: Full-Visible-Spectrum Solar Light Harvesting in Photovoltaic Devices. Sci Rep 4, 6442 (2014). https://doi.org/10.1038/srep06442.
[4]Strnad, G.; Jakab-Farkas, L.; Gobber, F.S.; Peter, I. Synthesis and Characterization of Nanostructured Oxide Layers on Ti-Nb-Zr-Ta and Ti-Nb-Zr-Fe Biomedical Alloys. J. Funct. Biomater. 2023, 14, 180. https://doi.org/10.3390/jfb14040180