Electrochemical Synthesis of Ag-TiO2 Nanoparticles for Water Treatment and Antibacterial Applications"

Ionela Petcu[a], Raluca Negrea[b], Ana T.S.C. – Brandão[c], Cosmin Romanitan[d], Oana Brincoveanu[d], Nikolay Djourelov[e], Iuliana Mihalache[d], L. Monica Veca[d], Gabriela Isopencu[a], Carlos M. Pereira[c], Liana Anicai[f], Cristina Busuioc[a], Sabrina State[d,g]

[a]*Faculty of Chemical Engineering and Biotechnologies, National University for Science and Technology POLITEHNICA Bucharest, 1-7 Gheorghe Polizu Street, 011061 Bucharest, Romania*
[b]*Brunel University London, Kingston Lane, Uxbridge, UB8 3PH, United Kingdom*
[c]*CIQUP/IMS - Chemistry Research Center, Faculty of Sciences, University of Porto, Rua do Campo Alegre 1021, 4169-007 Porto, Portugal*
[d]*National Institute for Research and Development in Microtechnologies - IMT Bucharest, 126a Erou Iancu Nicolae, 077190 Bucharest, Romania*
[e]*Extreme Light Infrastructure - Nuclear Physics Horia Hulubei National Institute for Physics and Nuclear Engineering, 30,Reactorului Street, 077125 Magurele, Ilfov county, Romania*
[f]*Center for Surface Science and Nanotechnology- National University for Science and Technology POLITEHNICA Bucharest, 1-7 Gheorghe Polizu Street, 011061 Bucharest, Romania*
[g]*Faculty of Medical Engineering, National University for Science and Technology POLITEHNICA Bucharest, 1-7 Gheorghe Polizu Street, 011061 Bucharest, Romania*

ionelapetcu26@gmail.com

Titanium dioxide (TiO_2) is a versatile compound often utilized for its photocatalytic properties, particularly in applications such as environmental remediation. Nevertheless, TiO_2 has an intrinsic bandgap of approximately 3.23 eV, which restricts its photocatalytic capabilities to the ultraviolet (UV) region. To overcome these limitations several approaches have been proposed. One of the most used methods is represented by loading TiO_2 nanoparticles (NPs) with silver (Ag). Ag-TiO_2 NPs extend photocatalytic activity to visible light and enhance the antimicrobial properties of oxide. The electrochemical route represents one of the simple and cost-effective procedures to synthesize TiO_2 and Ag-TiO_2 NPs. A promising alternative of aqueous electrolytes during electrochemical synthesis is represented by deep eutectic solvents (DES), which are environmentally friendly, cost effective and exhibit stability concerning air and moisture [1]. TiO_2 NPs were obtained through anodic dissolution of Ti metal in DES. The synthesis was performed at a constant current density for 3 h. Ag NPs have been electrochemically deposited on the TiO_2 NPs involving the "sacrificial anode" method using the same DES electrolyte. The photo reactivity of the TiO_2 and Ag-TiO_2 NPs was evaluated under UV radiation and solar light illumination for the degradation of methyl orange (MO) dye. It was demonstrated that Ag-TiO_2 NPs have high photodegradation efficiency of above 91%. Furthermore, the degradation mechanism was explored using various scavengers. The bactericidal effect of the composite was asset against Gram-positive (*B. subtilis*) and Gram negative (*E. coli*) strains. Clearly, the incorporation of Ag improved the antibacterial properties of TiO_2.

References

[1] Chakhtouna et al., "Recent progress on Ag/TiO2 photocatalysts: photocatalytic and bactericidal behaviors," Environ. Sci. Pollut. Res., vol. 28, no. 33, pp. 44638–44666, 2021.

Figures

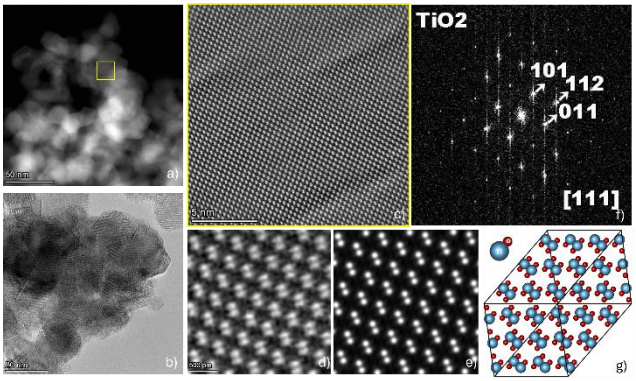

Figure 1: TiO_2 NPs: (a) low-magnification STEM image and (b) HRTEM image; (c) and (d) STEM images at atomic level showing the atomic arrangement of TiO_2 anatase phase; (e) simulated HAADF-STEM image; (f) FFT pattern corresponding to STEM image (c); and (g) atomic model of the anatase phase.