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PLASMA THIN FILM INTERNATIONAL UNION MEETING
13-17 September 2021
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Bi_2O_3 nano-sheets and nanotubes synthesized by discharges in liquid nitrogen

A. V. Nominé[1], M. Trad[1], Th. Gries[1], C. Noel[1], J. Ghanbaja[1], A. Nominé[1,2], V. Milichko[1,2], T. Belmonte[1,*]
[1]*Université de Lorraine, CNRS, IJL, F-54000 Nancy, France*
[2]*ITMO University, St. Petersburg 197101, Russia*
**corresponding author*

Abstract content

Bismuth oxide has a narrower band gap than TiO_2 [1]. It is an excellent photocatalyst for water photolysis and organic pollutants degradation under visible light. As an important type of layer-structured p-type semiconductor, the photocatalytic behaviour of Bi_2O_3 is pretty different from N-type TiO_2. It is also dependent on the allotropic phase as Bi_2O_3 adopts many polymorphic forms, the most common being monoclinic α-phase, tetragonal β-phase, body-centered cubic γ-phase, and face centered cubic δ-phase. In this work, we show how it is possible to synthesize easily Bi_2O_3 nanoparticles by nanosecond pulsed discharges in liquid nitrogen. By creating high-voltage (10 kV) discharges between Bismuth electrodes separated by a distance of 100 µm typically, Bismuth nanoparticles are produced with three size distributions. Oxidation occurs in a second step, after nitrogen evaporation. Therefore, a part of the nanoparticles exhibit a core-shell structure if oxidation is incomplete. When the applied voltage is lowered to 4-5 kV, ultra-thin nano-sheets and nanotubes also form. The mechanisms responsible for the growth of these new structures are still under investigation but in the case of nanowires, self-catalyzed vapor–liquid–solid route seems highly probable [2, 3]. The microstructure and composition of the nano-objects are characterized by X-ray diffraction, high-resolution TEM (HRTEM) and electron energy loss spectroscopy (EELS). If Bi_2O_3 nanoparticles are amorphous, nano-sheets are cubic, which opens interesting perspectives for their use as active photocatalysts.

Thanks/Acknowledgement
The authors acknowledge the French PIA (programme d'investissements d'avenir) project Lorraine Université d'Excellence (Ref. ANR-15-IDEX-04-LUE) for financial support.

References
[1] C. H. Ho et al. Optics express 21, 11965 (2013) [2] Y. Qiu et al. Advanced materials 18, 2604 (2006) [3] B. Sirota et al. Thin Solid Films 520, 6118 (2012)

Picture showing the 3 types of Bi2O3 nano-objects