Description for the general public

Bismuth (III) oxide, with simple chemical formula Bi_2O_3, is very well known for its occurrence in α, β, γ and δ crystalline phases (Fig. 1). These materials has been intensively studied for many years and their stability range in polycrystalline state, as well as physical properties are well described. What is more, Bi_2O_3 seems to show different properties, according to its crystalline phase, which makes it a very interesting material from the perspective of science path for solid state matter, along with possible practical applications.

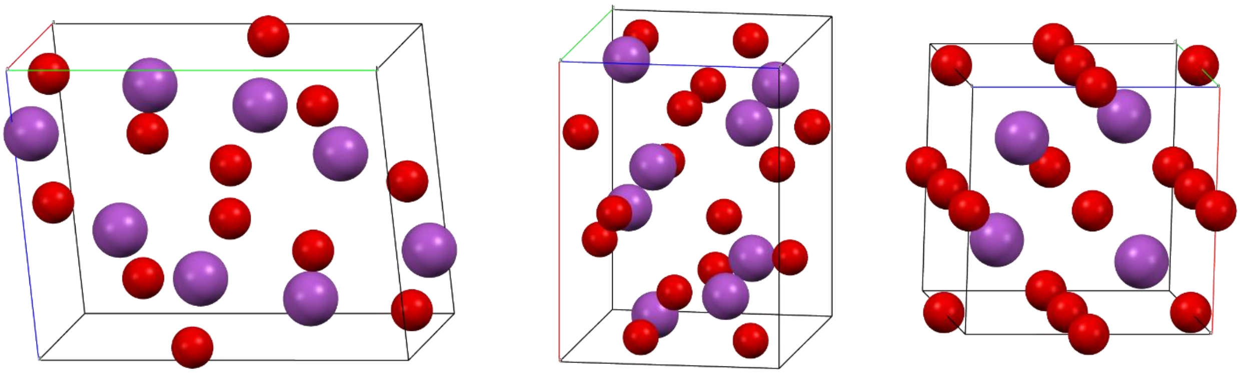

Fig. 1. Unit cells of the most important phases of bismuth (III) oxide (from left to right): monoclinic (α); tetragonal (β); face centered cubic (δ), generated by Mercury software (ref. http://www.ccdc.cam.ac.uk/mercury/*) from CIFs no. 1010004, 1545547, 1010311, respectively.*

The aim of this project is to obtain glass-ceramics composites Bi_2O_3, materials in which very small grains (ordered structures) of this compound would be embedded in glassy matrix (disordered structures). The size of the grains would be below 100 nm. Proposed method of obtaining this kind of composites is rapid cooling from liquid phase via twin-rollers technique, which means pouring the melt between two rollers with good thermal conductivity, rotating in the opposite direction with a high speed. This approach was successful for forming this kind of materials from V_2O_5 (vanadium oxide) (Fig. 2).

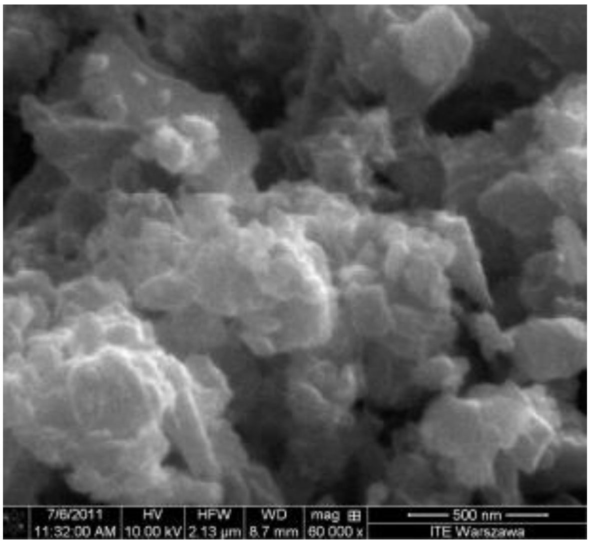

Fig. 2 TEM image (Transmission Electron Microscopy)[T.K. Pietrzak et al. *Solid State Ionics (2012) 225]*

What is a big advantage of this method is its reproducibility and flexible regulation of the cooling rate (by changing the rotation speed of the rollers), which could be the way to obtain various phases, mentioned before (Fig. 1). It is, for instance, possibility to obtain an excellent oxide conductor, which is δ–Bi_2O_3, stable at room temperature. That would be quite an impressive success, as this phase is usually stable at high temperatures. Investigation of structural and electrical properties of as-received samples and possible differences from polycrystalline materials (the kind of materials were grains are attached to each other, without glassy matrix) is probably a perspective scientific path. But not only that. In addition to simple scalability of mentioned technique, it seems to be a reasonable field of development in technology.

For instance, obtaining mentioned before stable, high conductive δ–Bi_2O_3 phase at the room temperature will results in improvement in Solid Oxide Fuel Cell field. However, also the general impact may be significant, as Bi_2O_3 is widely used in many industrial sections (e.g. medical supplies, chemical processes as a catalyst).