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Supplementary materials

Oxygen-ion and proton conductivity in the $Ba_3InGa_2O_{7.5}$ complex oxide with incomplete oxygen sublattice

Nadezhda Kochetova [a *], Veronika Cherepanova [ab], Alyona Pikalova [a], Artem Gilev [a]

a: Institute of Natural Sciences and Mathematics, Ural Federal University, Ekaterinburg 620000, Russia

b: Institute of Hydrogen Energy, Ural Federal University, Ekaterinburg 620009, Russia

[*] (E-mail: Nadezhda.kochetova@urfu.ru)

The $Ba_3InGa_2O_{7.5}$ sample undergoes hydrolysis decomposition during the treatment in water vapours at temperatures lower than ~450 °C. X-ray data of the fully hydrolysed sample after treatment in wet atmosphere at 250 °C as described in Experimental demonstrate the presence of the following phases: $BaGa_2O_4$, $Ba_2In_2O_4(OH)_2$, $Ba(OH)_2$ or some hydrated forms of barium hydroxide (Figure S1).

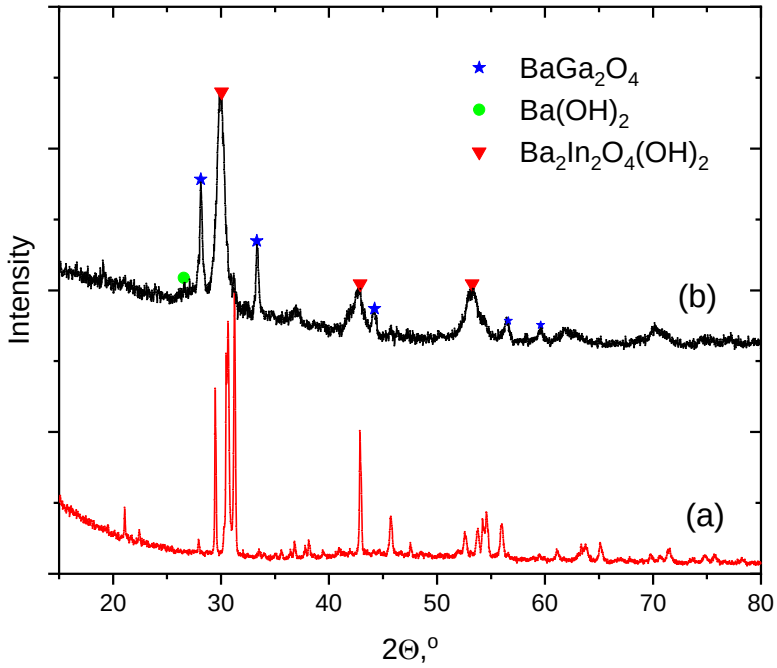

Figure S1 The XRD data for the $Ba_3InGa_2O_{7.5}$ complex oxide, as prepared sample (a) and the sample after treatment at 250 °C in wet atmosphere (b).

SEM images of the hydrated sample hydrated at 250 °C (Figure S2) demonstrate a heterogeneous surface, represented by grains of different morphologies. On the image obtained using BSE signal a phase contrast is clearly observed. The results also confirm the decomposition of the $Ba_3InGa_2O_{7.5}$ sample.

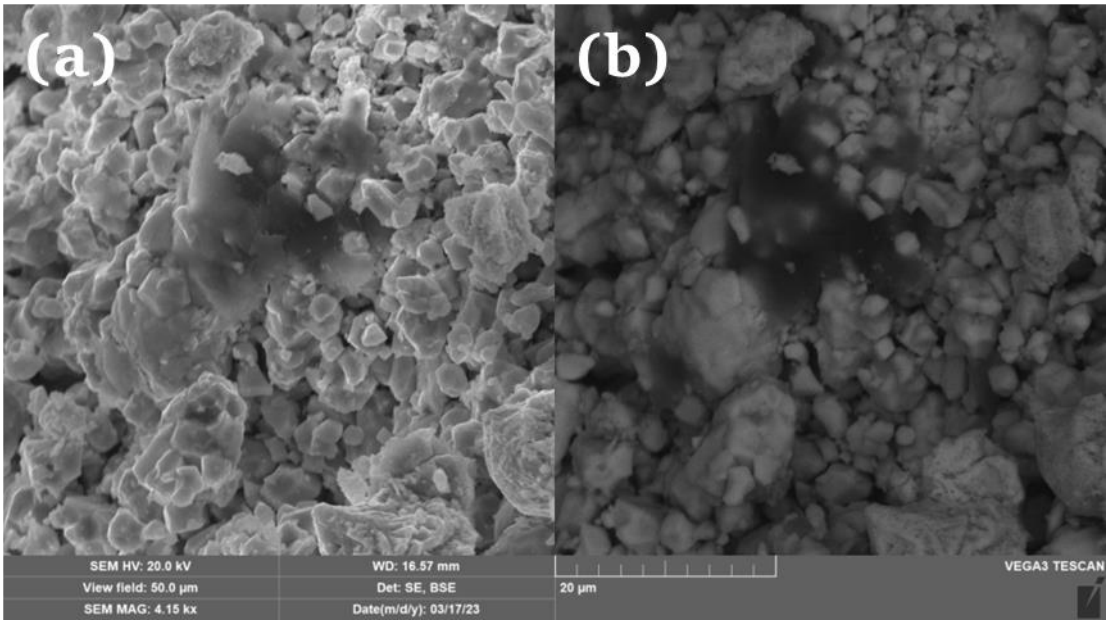

Figure S2 The SEM images of the $Ba_3InGa_2O_{7.5}$ sample after treatment in wet atmosphere, secondary electrons SE signal (a) and back-scattered electrons BSE signal (b).

The thermogravimetric analysis data obtained during heating of the decomposed in wet atmosphere sample show complex dehydration pattern (Figure S3). Several dehydration steps are visible on the TG-curve, which are consistent with the mass spectrum of water and correspond to the dehydration processes of the various phases in the system.

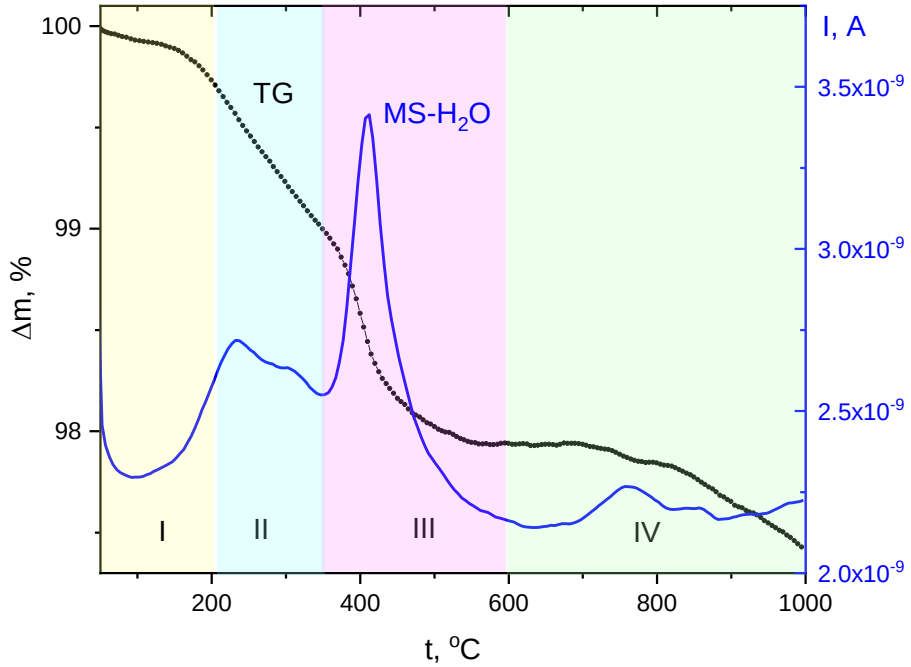

Figure S3 The TG-data and mass spectrum of H_2O for the previously hydrated at 250 °C sample (I – removal of adsorption water; II – removal of crystal water from the hydrate form of barium hydroxide $Ba(OH)_2 \cdot xH_2O$; III – removal of water from the oxyhydrate phase of barium indate $Ba_2In_2O_4(OH)_2$; IV – decomposition of $Ba(OH)_2$).

The sample previously treated at 500 °C in wet atmosphere demonstrates a slight mass change during the heating (Figure S4). The process realized in the extended temperature interval, but the main change is observed at 300–500 °C. The mass lost is associated with the water molecules removing and corresponds to ~0.12 mass.%, which in about 0.05 mole of H_2O per formula unit.

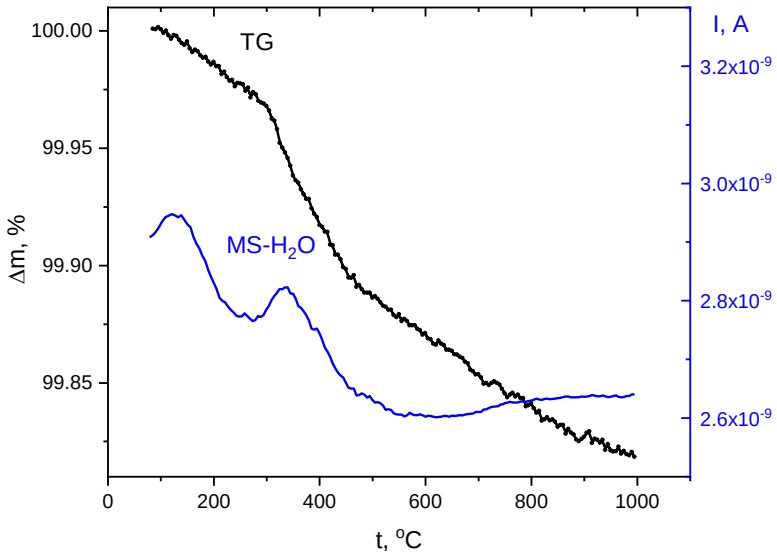

Figure S4 The TG-data and mass spectrum of H_2O for the previously hydrated at 500 °C sample.