Influence of rapid heat treatment on the photocatalytic activity of barium titanates

Mahsa Abedi[a,*], Haythem Basheer[a], Ákos Kukovecz[a], Zoltán Kónya[a], Tamás Gyulavári[a], Zsolt Pap[a,b,c]

[a] Department of Applied and Environmental Chemistry, University of Szeged, Rerrich sqr. 1, H-6720, Szeged, Hungary

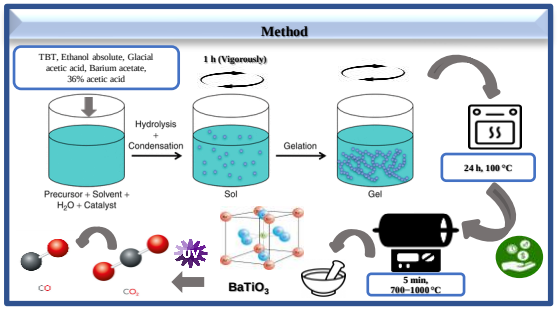
[b] Nanostructured Materials and Bio-Nano-Interfaces Center, Interdisciplinary Research Institute on Bio-Nano-Sciences, Babes-Bolyai University, Treboniu Laurian 42, RO-400271, Cluj-Napoca, Romania

[c] Institute of Research-Development-Innovation in Applied Natural Sciences, Babes-Bolyai University, Fântânele str. 30, RO-400294 Cluj-Napoca, Romania

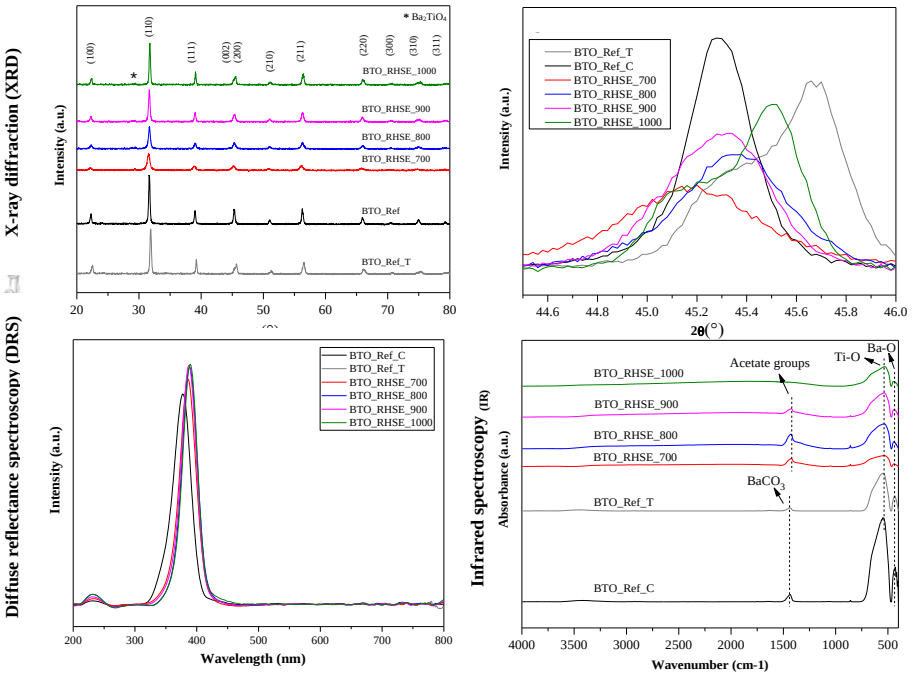
*e-mail: mahsa.sh.abedi@gmail.com

Introduction

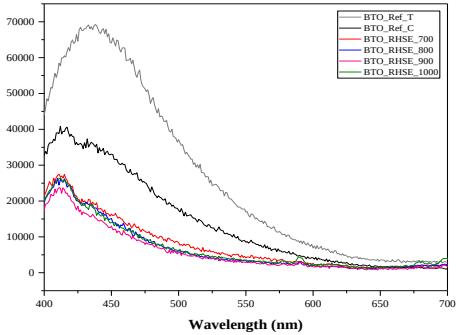
Alkaline earth metal titanates are promising materials for photocatalytic applications. Barium titanate (BTO), with its tunable size and morphology, spontaneous polarization, rapid charge carrier migration, and band bending, is extensively suited for photocatalytic applications. BTO photocatalysts were synthesized by sol-gel method and the material was subjected to rapid heat treatment with short exposures. Finally, the structural and optical properties of the samples were correlated with their photocatalytic activity to identify the causal relationship between them. As references, commercially available cubic and tetragonal barium titanates were used, with the addition of benchmark P25 TiO_2.



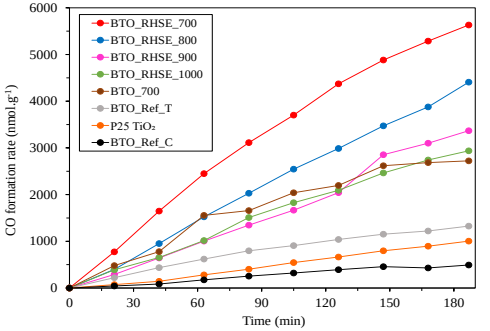
Characterization



Photoluminescence spectroscopy (PL)

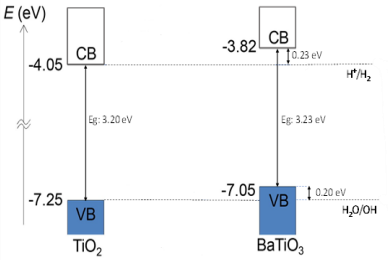


Photoreduction activity



Photoreactor

The photocatalytic CO_2 reduction experiments were conducted using a flow microreactor featuring two concentric glass (quartz) cylinders: an inner cylinder (height = 25 cm, diameter = 6.4 cm) and an outer cylinder (height = 25 cm, diameter = 10.2 cm). During the experiments, the temperature was kept constant by recirculating cooling water.



Sample Name	Crystallite Size (nm)	Specific Surface Area ($m^2 \cdot g^{-1}$)	Band Gap$_{1st,der}$ (eV)	CO Yield ($nmol \cdot g^{-1} \cdot min^{-1}$)
BTO_RHSE_700	16.8	14.9	3.20	179
BTO_RHSE_800	23.7	12.5	3.19	139
BTO_RHSE_900	28.5	4.2	3.19	110
BTO_RHSE_1000	33.4	2.9	3.18	94
BTO_Ref_	31.8	10.6	3.28	19
BTO_Ref_T	29.3	2.7	3.24	38
P25 TiO_2	25.4	49.6	3.11	33

Summary

- The XRD patterns for cubic and tetragonal BTO are nearly identical, with the only distinction being the splitting of the (200) peak in the tetragonal case due to slight structural distortion
- All samples show a broad emission peak at ~412 nm with a shoulder at ~433 nm, attributed to the direct recombination of electrons and holes
- The samples show superior activity in the photoreduction of CO_2 to CO outperforming the commercial barium titanates and even P25 TiO_2
- The high photoactivity was mainly attributed to the specific surface areas

Acknowledgements

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