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ABSTRACTS

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Bismuth Silicate Composite Materials Prepared via Gel Process: Phases Formation, Electrochemistry and Photocatalytic Performance

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The dependence on fossil fuels has raised concerns regarding the sustainability and environmental impact of modern energy production. The renewable energy sources are the best alternative that can address these issues. Photocatalysis is the chemical process of harvesting solar energy, which is considered renewable, safe, economically feasible and clean technology. Many new photocatalytic materials were developed, since publication of the remarkable paper about the photoelectrochemical water oxidation on a titanium oxide single crystal photoanode [1]. Among them, the Bi-based materials have attracted attention [2] due to their special electronic structure. The family of bismuth silicates (Bi_2SiO_5 , $\text{Bi}_4\text{Si}_3\text{O}_{12}$, and $\text{Bi}_{12}\text{SiO}_{20}$) have been studied in a lesser extent, though they possessed photocatalytic activity. The bismuth metasilicate phase Bi_2SiO_5 is more interesting due to the perovskite-like structure and higher catalytic performance [3,4].

The report is focused on the preparation of composite materials based on bismuth silicate phase via simple gelation process that was not applied to $\text{Bi}_x\text{Si}_y\text{O}_z$ compounds yet. The prepared gel was calcined under different thermal modes. The synthesized samples were investigated by X-ray diffraction (XRD) analysis, IR spectroscopy, ultraviolet-visible diffuse reflectance spectroscopy, nitrogen adsorption-desorption measurements. The features of the processes at the semiconductor/liquid interface were studied by electrochemical methods. Photocatalytic activity was tested in model reaction of rhodamine B (RhB) photodegradation under Xe lamp irradiation (250 W).

Synthesis via gelation leads to the formation of composite materials regardless of the Bi/Si atomic ratio used and the thermal treatment mode. Simultaneously, the calcination mode affects the phase content and their distribution. At low temperature (300–400 °C), the bismuth beta-oxide was formed as the main phase, while at higher temperature (≤ 600 °C) the bismuth metasilicate was obtained as a primary phase in the composition. The increase of the Si content in the system facilitates the formation of larger amount of Bi_2SiO_5 phase in samples calcined at 600 °C for 2 h. Moreover, it was shown that both the amount of Si precursor along with thermal treatment conditions (temperature, duration) allows controlling the specific surface area (10–100 m^2/g) of the composites investigated. Conversion of the prepared photocatalysts in rhodamine B photodegradation varied in the range of 41–65 % (for 4 h). In addition, the RhB absorbance spectra point out the selective substrate deethylation. The highest performance was demonstrated by the samples containing 4 phases: Bi_2SiO_5 , $\text{Bi}_{12}\text{SiO}_{20}$, $\beta\text{-Bi}_2\text{O}_3$, and $\alpha\text{-Bi}_2\text{O}_3$. The difference in the optical properties as well as S_{BET} values for the most active samples (65 % conversion for 3 samples) may

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be associated with different phase distribution. Electrochemical data, including EIS measurements, will be also discussed along with the photocatalytic and electrophotocatalytic properties.

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