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One-step microwave assisted "self-impregnation" of TiO_2 nanostructures with Ag for boosted photocatalytic hydrogen production

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TiO_2-based materials are widely used in photocatalysis due to their high reactivity, physical and chemical stability, low toxicity and cost. Production of H_2 by clean and renewable resources, such as water in the water splitting reaction (WS), is doubtless an actual need to decrease pollution on Earth. Key factors for the production of H_2 by WS are controlled size, shape and crystallography of the photocatalysts [1]. Seeking for that and for a green method, microwave assisted chemistry (MWAC) was used for the photocatalysts syntheses. In this study, we investigate pure and doped TiO_2 nanostructures – nanoparticles (NPs) and nanoplates (NPls) – synthesized by MWAC in only one step.

P25 (EVONIK) was used as a precursor for the synthesis of TiO_2NPls in NaOH and $AgNO_3$ aqueous solution. The NPls were neutralized with HCl and washed with distilled water. Alternatively, Titanium(IV)bis(ammonium lactate)dihydroxide (TALH) solution was used as a precursor for the synthesis of TiO_2 NPs in an aqueous $AgNO_3$ solution using MWAC. Finally, the NPls and NPs were calcinated in air atmosphere. The nanostructures were characterized by XRD, UV-vis diffuse spectroscopy, TEM, XPS and BET. The photocatalysis was carried out using a high pressure Xe/Hg lamp of 350 W (Sciencetech Inc.). The H_2 photogeneration was evaluated by gas chromatography (chromatograph Shimatsu GC-2010) equipped with a thermal conductivity detector.

TEM images show TiO_2 NPs with an average diameter of (4.8 ± 1.1) nm and TiO_2NPls below 100 nm decorated with Ag NPs with an average diameter of (3 ± 0.9) nm. The measured band gap was 3.1 eV for the TiO_2/Ag NPs using both 0.001 and 0.01 wt% of $AgNO_3$; and 3.3 eV and 3.1 eV for the TiO_2/Ag NPls using 0.001 and 0.01 wt% of $AgNO_3$, respectively. Photocatalytic hydrogen generation results showed an increased in the H_2 production rate when Ag NPs impregnated the TiO_2 nanostructures.

References:
[1]K. Takanabe, K. Domen, Chemcatchem 4 (2012) 1485-1497.