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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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INTRODUCTION

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. The present work couples the preparation of TiO_2 nanostructures using the MWAC method with simultaneous impregnation of silver in only one step. The photocatalysts were characterized by XRD, TEM and UV-vis DRS techniques. The photocatalytic hydrogen generation results, under UV-Vis irradiation, showed an increase in the H_2 production rate when Ag NPs impregnated the TiO_2 nanostructures.

METHODOLOGY

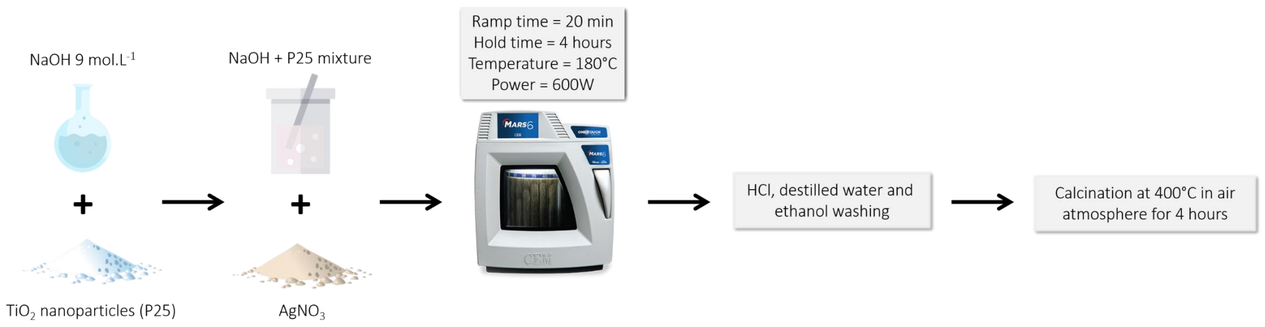

Figure 1: Flow chart of TiO_2 NPls/AgCl NPs MWAC synthesis.

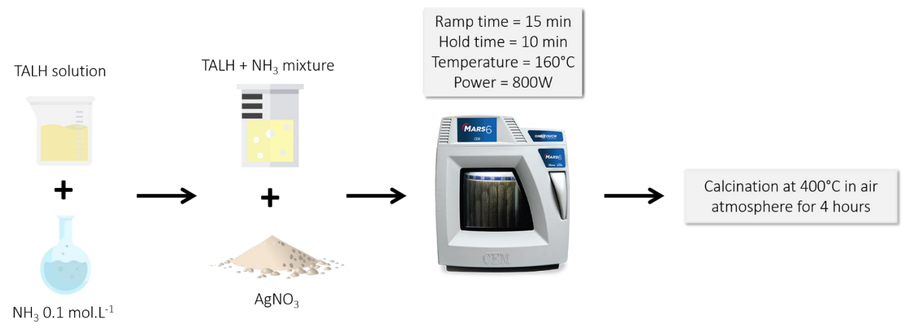

Figure 2: Flow chart of TiO_2 NPs/Ag NPs MWAC synthesis.

Photocatalytic experiments under UV and visible light irradiation were carried out in a quartz photochemical reactor using a Hg/Xe high pressure lamp[2].

RESULTS

Table 1: UV-Vis DRS spectra of pure and impregnated samples.

Sample	Bandgap (eV)
P25	3.57
TiO_2 NPls/AgCl NPs 0.001wt%	3.34
TiO_2 NPls/AgCl NPs 0.01wt%	3.07
TiO_2 NPs	3.11
TiO_2 NPs/Ag NPs 0.001wt%	3.10
TiO_2 NPs/Ag NPs 0.01wt%	3.10*

* UV-Vis DRS spectra with an intense absorption band at about 2.8 eV

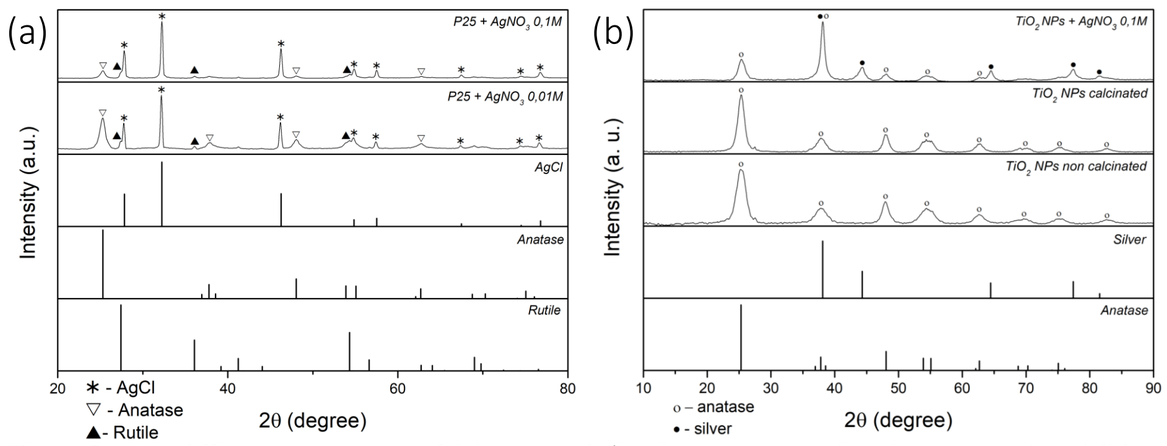

Figure 3: XRD diffraction patterns of (a) TiO_2 NPls/AgCl NPs 0.01 wt% and 0.001 wt% and (b) TiO_2 NPs/Ag NPs 0.01 wt% and pure TiO_2 NPs calcinated and non calcinated.

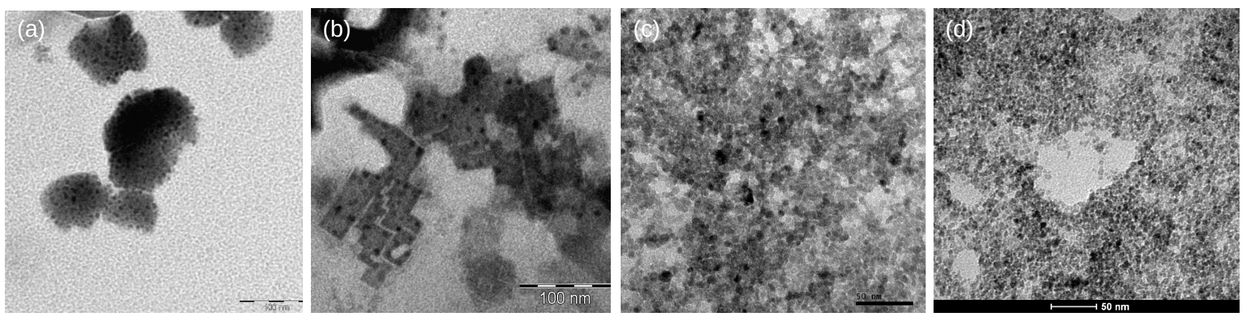

Figure 4: TEM images of TiO_2 NPls/AgCl NPs 0.01 wt% in (a) pH=7, (b) pH=1, (c) pure TiO_2 NPs and (d) TiO_2 NPs/AgNPs 0.01 wt%.

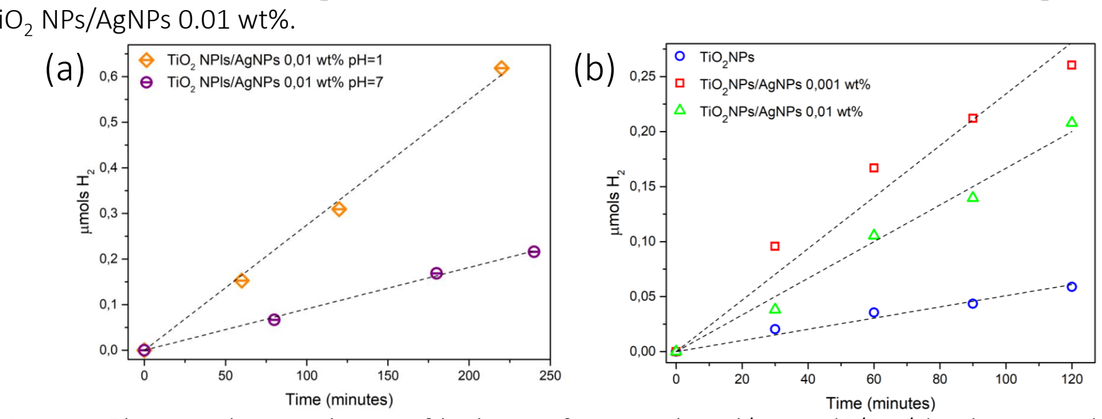

Figure 5: Photocatalytic evolution of hydrogen from methanol/water (1/8 v/v) solution on (a) TiO_2 NPls/AgCl NPs 0.01 wt% in pH=1 and pH=7 and (b) TiO_2 NPs/Ag NPs 0.01 wt% and 0.001 wt%.

CONCLUSION

- Microwave-assisted synthesis methodology demonstrated to be an effective and green strategy to prepare TiO_2 based nanostructures, with simultaneous impregnation of Ag, all in only one step.
- The impregnation of TiO_2 NPls with AgCl NPs led to a photocatalyst with different arrangement forms due to the pH, presenting a higher H_2 evolution rate on acid pH.
- The samples of TiO_2NPs impregnated with AgNPs showed a H_2 evolution rate about 5 times higher than the pure TiO_2NPs.

REFERENCES

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

[2] C. Backes, F. Scheffer, M. Pereira, S. Teixeira, D. Weibel; Braz Chem Soc; 25:2417-24(2014).

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CAPES

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