Functionalization of 2D-layered materials with dyes for photocatalytic applications

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Photocatalysis is a an appealing strategy to exploit solar energy for fuel production and pollutant utilization. The performance of the photocatalysts is far from practical applications and research on more efficient, sustainable and cos-effective photocatalysts is highly required. Innovative 2D materials with unique layered structures are expected to enhance photocatalytic activity due to excellent mobility of charge carriers and extremely high specific surface area.
In our work by functionalizing non-covalently dye molecules (porphyrins, xanthenes) to 2D-layered materials (GO, RGO, $Ti_3C_2T_x$) we constructed novel nanomaterials that were tested in photocatalytic hydrogen production and rhodamine B photodegradation [1-4]. Spectroscopic and theoretical calculations allowed to propose complete picture of the mechanism of hydrogen production in the photocatalytic reaction in systems containing eosin Y and graphene material with particular emphasis on the dynamics of charge transportation.

We explored the correlation between the photocatalytic activity and GO morphology (size and thickness). We applied the technique based on the combination of time-dependent sonication and iterative centrifugation cascades, which were designed to achieve nanosheets size and thickness selection. Our results clearly demonstrated that both size and thickness of GO flakes do matter for the photocatalytic hydrogen production, but the latter one has more profound impact on the hydrogen production efficiency.
We also carried out photocatalytic hydrogen evolution experiment of the EY/$Ti_3C_2T_x$/$CoSO_4$ system under incident light wavelength. Hydrogen evolution rate of 40.9 mmol h^{-1} g^{-1} and AQE = 35.7% at 505 nm has been obtained which is even higher than for the analogue system in which $CoSO_4$ was replaced by the H_2PtCl_4 and higher than for the system where GO was used as a support.

References

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Acknowledgement: *This work was supported by the National Science Centre (Grant Number: 2015/19/D/ST5/00682)*