Enhancing HER rate over Pt-TiO_2 nanoparticles under Controlled Periodic Illumination - role of illumination's parameters

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In hydrogen production by water splitting, two reactions are involved: Hydrogen Evolution Reaction (HER) and Oxygen Evolution Reaction (OER), both with efficiency issues. In a previous work, [1] our group demonstrated the possibility to enhance HER rate through HCOOH photocatalytic reforming on Pt-TiO_2 nanoparticles (bipyramids) under Controlled Periodic Illumination (CPI) in respect to continuous illumination, at the same time-averaged incident photon flux. In this work we further investigated this phenomenon demonstrating that duty cycle and metal co-catalyst have key roles in boosting HER under CPI. According to our hypothesis, this is due to the material's behavior at different light-time/dark-time ratios and affinity for H respectively. Till now we have found CPI affecting HER only for metals with optimal affinity (Pt, Rh, Pd).

Hydrogen absorption and desorption energies are strongly dependent on the potential at the metal nanoparticles. [2] We observed CPI inducing oscillations in catalyst's potential, but HER rate is improved only on metals with low Tafel slope. We suppose low-affinity metals to be ineffective because of high Tafel slopes and weak potential responsiveness to variations of the light intensity.

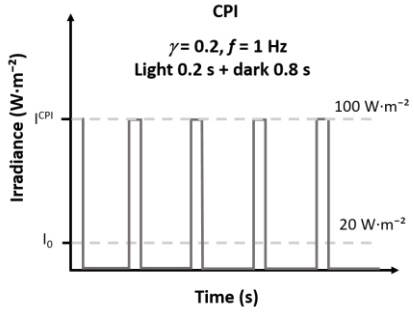

Fig. 1. Graphical description of the Controlled Periodic Illumination technique.

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References:

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