UNDERSTANDING FACTORS INFLUENCING PHOTOCATALYSIS –

CAN WE DESIGN EFFICIENT PHOTOCATALYSTS?

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We reveal the role of the TiO2 phase composition in various types of photocatalytic reactions, controlled either by reduction or oxidation counterparts. We hypothesize that the choice of the optimal phase composition of TiO2 should take into account both the nature of photocatalytic reaction and intrinsic physicochemical properties of the composite photocatalyst. To verify this hypothesis, we report the phase-tunable syntheses of TiO2 nanoparticles under mild temperatures (up to 200°C), which resulted in two series (A and B) of materials characterized by different anatase-to-rutile ratios, but otherwise similar morphologies. The synthesized materials were examined in water oxidation, hydrogen peroxide reduction, photocurrent generation and methanol-assisted water reduction [1]. The optimal phase composition depends on the reaction type – high contents of rutile or anatase should be considered for H2O2 reduction and water oxidation, respectively, while water reduction requires moderate contents of both polymorphs. The A series appeared more active in oxidation-controlled reactions, while the B series facilitated reduction-controlled processes. The DOS analysis confirmed, that rutile is a significantly better reducer, whereas anatase is a better oxidant [2-4]. Presented data show that a synergistic effect observed usually for anatase/rutile composites can result from both, intrinsic and extrinsic factors. The intrinsic factors are responsible for the improved photocatalytic activity of the material related to its physicochemical properties, e.g., efficiency of charge separation, lifetime of photogenerated charges, absorption properties, redox characteristics, porosity, specific surface area, etc. The extrinsic factors are strongly related to the redox reactions to be performed at the photocatalyst surface, both oxidation and reduction. Therefore, the design of the optimal photocatalyst must take into account both, intrinsic and extrinsic factors.

During the presentation some new ideas on designing new active photocatalysts will be presented and briefly discussed.

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