Study of the structural and photocatalytic properties of thermally reduced tio2 powders

Marta Macyk,1\* Karol Cieślik,1 Dominik Wrana,1 Benedykt R. Jany, 1 Joanna Kuncewicz,2 Wojciech Macyk,2 Franciszek Krok1

# 1Instytut Fizyki im. M. Smoluchowskiego, Uniwersytet Jagielloński, ul. Łojasiewicza 11, 30‑348 Kraków

# 2Wydział Chemii, Uniwersytet Jagielloński, ul. Gronostajowa 2, 30‑387 Kraków

\*autor korespondencyjny: marta.macyk@student.uj.edu.pl

 Titanium(IV) oxide is one of the most famous photocatalysts in the world. One way to modify its properties is a thermal reduction. Such treatment leads to changes in a crystal stoichiometry resulting in the appearance of the available electronic states within the forbidden gap, near the conduction band edge. In this work the influence of thermal reduction on rutile powders morphology and photocatalytic properties was examined. Materials were annealed at the temperature range of 700-1100oC under Ultra High Vacuum conditions. The scanning electron microscopy and X-ray powder diffraction analyses showed the growth of crystallites sizes as a function of the reducing temperature. The electronic structure and photocatalytic properties of modified powders were examined with spectroelectrochemical and photoelectrochemical methods, respectively. Significant differences were found in the photoinduced reducing properties of annealed TiO2, eventually leading to their change to oxidizing properties for powders reduced at 900oC. It was also found that the band gap energy of the annealed powder did not change significantly and was in the range of 3.06-3.10 eV. Furthermore, the efficiency of hydrogen production as a result of photocatalytic water reduction reaction was investigated leading to the conclusion that the reduced materials are better photocatalysts than unmodified rutile (Figure). The highest efficiency was achieved for the powder reduced at 800oC, for which the amount of hydrogen produced was several times greater than for the original, untreated material.