

Opponent assessment for the dissertation of Kasidid Yaemsunthorn

**„Phase-Dependent Photocatalytic Activity of TiO<sub>2</sub> – the Role of Intrinsic and Extrinsic Factors “**

I have had the privilege of reviewing the dissertation titled " Phase-Dependent Photocatalytic Activity of TiO<sub>2</sub> – the Role of Intrinsic and Extrinsic Factors " by Kasidid Yaemsunthorn. The author has undertaken a comprehensive study in the field of the phase-dependent photoactivity of anatase and rutile TiO<sub>2</sub> through a series of photocatalytic reactions involving both oxidation- and reduction-based processes and has made a significant contribution to the existing body of knowledge.

The work is written in English, prepared on 155 pages and cited 227 respectable literary references. It contains the original results been taken by the public (1 article accepted, and 2 articles submitted in international journals with impact factor).

The General Introduction (Chapter 1) precede the experimental part of the work. There are aptly explained terms to which the work relates: photocatalysis, photocatalysts, TiO<sub>2</sub>, efficiency, and reduction-based applications. Attention is also paid to motivation and objectives. This part is well and briefly composed on 17 pages and it quotes 94 literary sources. The Chapter 2 consists of three topics. The first part is the investigation of the phase-dependent photoactivity of TiO<sub>2</sub> materials and includes the synthesis, characterization and photocatalytic activity of nanoparticles. The second topic describes the mixed-phased yellow TiO<sub>2</sub> materials and demonstrate the improvement strategy. The third section is focus on the alternative and advanced applications of TiO<sub>2</sub>, including dark photocatalysis, photocatalytic reactions in biphasic media, and selective CO<sub>2</sub> reduction. Chapter 3 provides an in-depth analysis of the impact of anatase and rutile crystal phases on reduction-based applications that are less commonly used, specifically the reduction of nitroaromatics to aniline derivatives. This chapter is divided into two parts based on intrinsic (material properties) and extrinsic (reaction conditions) factors. The principle of analytical methods, materials and chemicals, methods of synthesis, photoelectrochemical measurements, photocatalytic studies, are shown in the

Chapter 5 Experimental section. Results and discussion of this work are summarised in Chapter 4 Summary and perspectives.

The dissertation contains an abundance of original experimental data. The level of processing demonstrates the ability to target individual creative work of student. The writing style of the dissertation is scholarly and professional, with a clear and concise presentation of ideas. The author effectively communicates complex concepts and constructs persuasive arguments throughout the document. The use of appropriate references and citations enhances the credibility of the work. The work has not blind spots and "clear lines stretches whole work." The dissertation exhibits a high level of scholarship and demonstrates the candidate's competence in conducting research.

I have the following comments and questions:

- Page 11. "Charge separation: The absorbed energy will be wasted as heat or emitted light if the charges are allowed to quickly recombine, rather than being utilized in a chemical process." What is the approximate recombination time of electrons and holes? Could Ph.D. student compare this recombination rate ( $\text{TiO}_2$ ) with other semiconductors?
- Could Ph.D. student explain why defect states significantly affect the properties of  $\text{TiO}_2$ .
- What could have caused the high TOC content of samples A10, A30 and A62?
- Page 58. Could Ph.D. student explain the concept of "Dark photocatalysis"?
- Page 104. Give an example of calculating AQY
- Could Ph.D. student describe the photoreactor which was used for hydrogen generation? The recommended photocatalyst concentration (1 g/L) was not used in the experiments. On what basis was a different photocatalyst concentration used? Were no products other than hydrogen observed in the generation of hydrogen from aqueous methanol solution?
- The work contains an abundance of results obtained by different methodologies (preparation of photocatalysts, characterization, testing photocatalytic activity). Can author tell which one did he gain himself?
- Define your contribution to the publication listed.

The work contains some inaccurate wording and formal shortcomings, such as:

- Physical variables and units of all variables and abbreviations are not mentioned in the list of symbols and abbreviations.

- List of Figures and Tables is missing.
- Variables in the text should be in italics - not always the case.
- The two pictures on page 7 and 8 have the same number - Figure 1.3.
- The values of specific surface area (SSA) (page 29, Table 2.1.) should be rounded to whole numbers.

### ***Conclusion***

Despite my comments, PhD. thesis of Kasidid Yaemsunthorn represents a valuable contribution to the studies unequivocally reveal the phase-dependent photoactivity of anatase and rutile, highlighting their different contributions to photocatalytic performance. I am requesting that the PhD student Kasidid Yaemsunthorn should be admitted to further stages of his doctoral dissertation, and it meets the requirements set for the PhD candidates and given in the Act from 20. 7. 2018 - The Law on Higher Education and Science (Dz. U. 2018 poz. 1668 including further changes).

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