

To the kind attention of
PhD Board
Institute of Fluid-Flow Machinery,
Polish Academy of Sciences

Milan, April 8th 2025

The present document provides an independent review of the thesis dissertation titled
“Processing and diagnostics of semitransparent photoelectrodes based on titania for energy conversion applications”

by MSc Dujearic-Stephane Kouao. The review was made based on letter no. RN-421-6/24 sent by Grzegorz Żywica, D.Sc., Ph.D., professor of IMP PAN, the Deputy Director for Scientific Issues, dated March 6th, 2025

The PhD work of MSc Kouao has delved into the production of semitransparent photoelectrodes by growing nanostructured titanium oxide films on TCO, and their characterization with a focus on energy conversion and sensing technologies. Several anodizing methods were applied to substrates with different composition and geometry, demonstrating an excellent control over the techniques required to deposit metallic titanium layers on transparent substrates and convert deposited titanium into nanotubular oxides, which the candidate successfully combined to obtain suitable morphology for the specific application. The ability to produce anodic nanotubes on glass fibers is especially interesting for its possible technological relapses, as generally nanotubes production by anodizing is conducted on flat substrates. Moreover, the candidate eventually produced titanium oxide nanostructures modified with non-noble elements, namely, on-purpose synthesized MXenes, which also demonstrated ability in the chemical synthesis and laser ablation processes. All these materials find collocation in the domain of nanostructures, and all of them show potential in practical applications.

The solutions proposed have shown large originality, especially in the search for complex geometries and composites with non-noble compounds, which allowed a consistent increase in photoresponse. The experimental variables investigated in the synthesis of such nanostructures were modified parametrically over sufficiently wide ranges, in order to find the best morphology

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for the application envisioned. The full set of characterization techniques applied to the developed materials indicates excellent theoretical and practical knowledge in the relevant scientific field; indeed, the candidate was able to combine morphological and microstructural characterization methods with electrochemical ones, which are crucial in the fields of application considered, to give a full appraisal of the materials produced. Given the amount and variety of experimental work directly executed by the candidate, as assessed in the Author contribution statements annexed to the thesis, the candidate has demonstrated ability to conduct scientific work independently.

As for the thesis document writing, the work is clear, well organized and complete, and its coherent and defined structure facilitates results tracking. Graphs and schemes presented are well prepared and easy to understand.

Below is a list of few questions whose answer would add value to the conclusions section.

- The candidate indicates that 2 h light stability corresponds to a good photostability – is it possible to contextualize this on the basis of the application envisioned, or of other benchmark materials?
- Regarding article 4, the author indicates that the materials obtained show high recyclability – can you pls add a few more information on this aspect? Is it recyclability or reusability, and up to which extent?
- More generally speaking, given the wide spectrum of materials prepared, would it be possible to give a final ranking among the solutions here provided? For instance, is it possible to correlate each different material the candidate has developed with a specific application in the spectrum investigated in this work, taking into account the scalability of the process in the specific field of application?

In conclusion, I state that the reviewed dissertation meets the requirements of Article 187 of the Act of July 20, 2018 - the Law on Higher Education and Science (as amended). I request its admission to further stages of the proceedings for the award of the degree of Doctor in Engineering and technical sciences in the Mechanical engineering discipline.

Kind regards,

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