ITI HiFunMat Master Internship Proposal

☒ M 1 ☒ M 2

Self-decontaminating protective clothing: Photocatalytic textiles based on metal oxides

Internship supervisor

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Collaboration with a HiFunMat member (*please indicate their name*)	☒ No ☐ Yes :

Student profile looked for

Master program (*more than one box can be ticked)*	☒ Material science and engineering ☒ Chemistry ☒ Physics
Other indications if necessary	

Internship description

The different challenges of the next decades may bring an increase in geopolitical tensions and thus a risk of conflicts accompanied by an eventual use of Chemical Warfare Agents (CWA). As a result, protections against CWA need to be improved and the addition of self-decontaminating properties to military clothes is a promising tool to avoid (cross-)contamination issues.

The aim of the project is to develop photocatalytic textiles, i.e. textiles capable of degrading these toxic substances under the effect of sunlight. For this purpose, two materials will be used together to obtain enhanced photocatalytic properties. Titanium dioxide (TiO_2) [1], the most effective material and the most studied in photocatalysis, is only active under UV light, which represents only 5% of the solar spectrum. It will therefore be combined with a tungsten oxide (WO_3) [2], which is capable of absorbing visible light, but has a lower intrinsic activity due to the higher recombination of charges. The synthesis of TiO_2/WO_3 [3] composites will improve photocatalytic activity under visible light and charge separation via a heterojunction phenomenon. The synthesized composites will then be deposited on textiles using a "Layer-by-Layer" method [4] (Figures 1 and 2). This method enables both a control of the thickness of the photocatalytic layer and a strong adhesion on fibers.

The aim of this internship will be to explore several ways of synthesizing these composites to obtain the best possible interface, enabling efficient charge transfer between the two materials. The WO_3/TiO_2 ratio will also have to be optimized to obtain interesting photocatalytic properties under solar illumination. These materials will then be characterized (UV-Vis, XRD, SEM, Zeta, BET, IR…) and deposited on textiles so that they can be tested for the degradation of organophosphorus compounds.

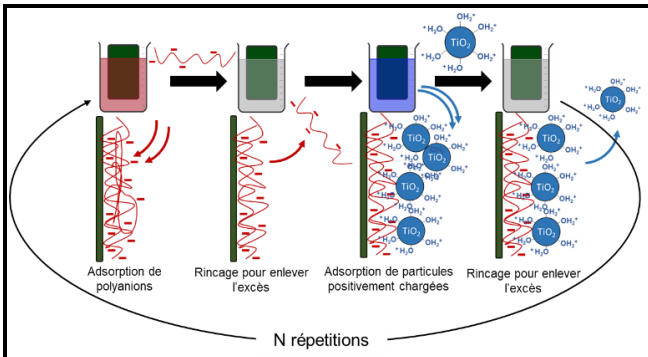

Figure 1. Layer-by-layer deposition principle

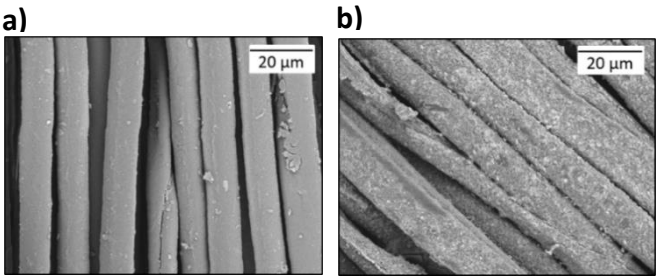

Figure 2. Textile a) not functionalized b) with TiO_2

[1] A. Komano *et al.*, « Titanium dioxide photocatalytic decomposition of ethyl-S-dimethylaminoethyl methylphosphonothiolate (VX) in aqueous phase », *Appl. Catal. B Environ.*, vol. 134-135, p. 19-25, mai 2013, doi: 10.1016/j.apcatb.2012.12.036.

[2] I. M. Szilágyi *et al.*, « WO3 photocatalysts: Influence of structure and composition », *J. Catal.*, vol. 294, p. 119-127, oct. 2012, doi: 10.1016/j.jcat.2012.07.013.

[3] C. Shifu, C. Lei, G. Shen, et C. Gengyu, « The preparation of coupled WO3/TiO2 photocatalyst by ball milling », *Powder Technol.*, vol. 160, nº 3, p. 198-202, déc. 2005, doi: 10.1016/j.powtec.2005.08.012.

[4] L. Truong-Phuoc *et al.*, « Layer-by-Layer Photocatalytic Assembly for Solar Light-Activated Self-Decontaminating Textiles », *ACS Appl. Mater. Interfaces*, vol. 8, nº 50, p. 34438-34445, déc. 2016, doi: 10.1021/acsami.6b12585.