Toward smart textile : new coatings for photocatalytic decontamination of toxic gases

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Decontamination is an important application in catalysis given for example the threat of chemical warfare agents against civilians populations or emergency response personnel. It would be highly desirable to equip textiles with catalytic functions that could actively destroy toxic agents rather than having only a barrier function.

Here we propose multicomponent coatings for the photocatalytic decontamination of toxic gases[1], realised by the LbL-technique[2] (Fig.1). Due to its easy processing construction on a wide range of surfaces and the versatility of the chosen materials, some coatings with tunable properties at nanoscale precision can be realised.

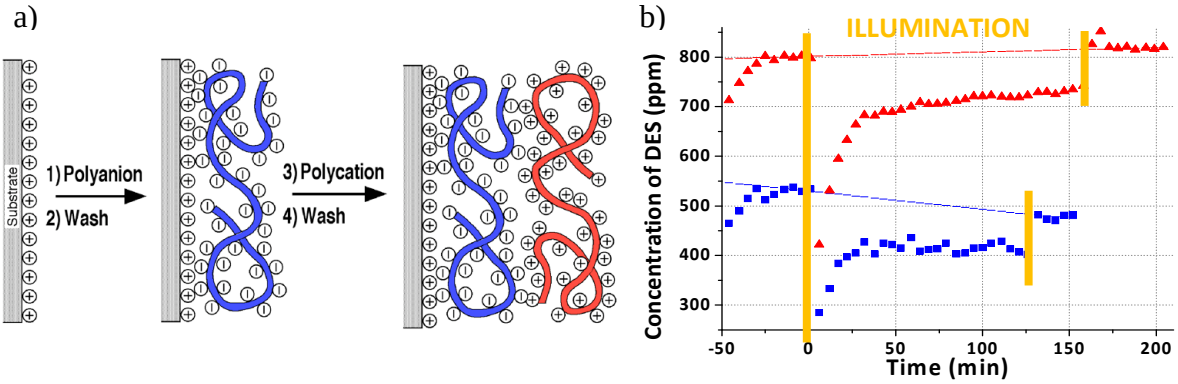

Fig.1 : a) Schematic principle of LbL techniqueand b) photocatalytic degradation of DES with time on stream under UV-A illumination on two films containing 10 layers of TiO_2/PDDA.

Thus, multicomponent coatings made of TiO_2/PDDA and TiO_2/Graphene (for modifying their adsorption behaviour and for enhancing their catalytic properties) have been successfully built.

The photocatalytic activity of the films was evaluated by studying the photo-oxidation on a continuous flux of gaseous diethylsulfide (DES, a model compound of mustard gas) under UV-A illumination, in a specific plug flow reactor. Results obtained for LbL films of TiO_2/PDDA are presented on Fig.1.

On Table 1, the photocatalytic activities between different kind of coatings immobilized on a glass slide are compared. More specific tests on textile on the photooxydation of dimethyl methylphosphonate (DMMP, a model compound of Sarin) have been also realised. Thus, the two phases (gas and liquid) are tested, that corresponds to the behaviour of a chemical weapon.

Sample	DES transformed	Quantity of TiO_2 estimated by ICP-AES	Conversion (mg DES/min.mg TiO_2)
Drop casting of TiO_2	1,5 mg	3,3 mg	2×10^{-3}
LbL of TiO_2/PDDA	4,6 mg	4,3 mg	6×10^{-3}
LbL of TiO_2/Graphene	2,3 mg	0,6 mg	20×10^{-3}

Table 1 : Evaluation of the quantity of DES destroyed after 180 min under UV-A Illumination on several samples

The first observation is that TiO_2/PDDA LbL film exhibit a larger activity than a drop-casting coating, pointing out the added value of LbL film building. Furthermore, addition of graphene resulted in a drastic enhancement of photocatalytic performances, may be due to the close contact between TiO_2/Graphene material, likely induced by the LbL deposition[3].

To conclude, the elaboration of smart textiles having photocatalytic properties and enhanced adsorption abily for the elimination of highly concentrated toxic chemical model compounds seems to be quite promising, and more specific tests are under investigation.

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References :

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[3] Patent in preparation, article to be submitted