Prototyping of photocalytic microreactor and testing of photodegradation of organic dye

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Introduction

A photocatalytic microreactor is defined as a microfluidic device which is integrated with a photocatalytic nanometer coating (ex.: TiO_2 nanoparticles) deposited on the inner surface of microchannels.[1] This device is capable of degradation of organic dye solution in water in a continuous flow under the action of ultraviolet (UV) light. The specific goals of this work are the presentation of a rapid and economically viable way for the prototyping of photocatalytic microfluidic devices and the evaluation of their capability for photodegradation of organic dyes dissolved in water by ultraviolet-visible spectrophotometry (UV-VIS).

Results and Discussion

Fast prototyping of polydimethylsiloxane (PDMS)/TiO_2/glass microreactors includes several procedures such as mold preparation, microchannels confection over PDMS surface, deposition of TiO_2 nanoparticle film (commercial Degussa P25) over the microchannels, followed by O_2 plasma treatment of PDMS/TiO_2 and glass surfaces, in order to make both surfaces compatible and hydrophilic, and finished by sealing of these two parts (Figure 1).

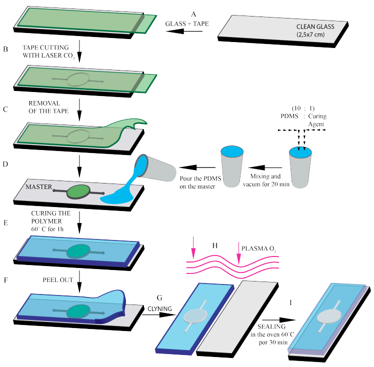

Figure 1. Schematic diagram depicting adopted procedure for low-cost microfabrication of a PDMS/Glass microreactor.

The efficiency of this procedure for prototyping PDMS/TiO_2/glass photocatalytic microreactors was evaluated by fluxing solutions two organic dyes, methylene blue and rhodamine B, inside microchannels with different flow rate between 2 e 4 mL h^{-1}. The results of the UV-VIS analysis of the photodegradation of the two dyes are resumed in table 1. When fluxing velocity of 2 mL h^{-1} was applied, discoloration of ~ 65% has been achieved for both dye solutions, while PDMS/glass microchannels, without TiO_2 nanoparticles (control), demonstrated much lower discoloration, confirming that TiO_2 photocatalytic film has been successfully deposited over PDMS microchannels.

Tabela 1. Photodegradation evaluation of two dyes obtained by means of the follow equation at diferentes flow rate:[2]

$$D = \frac{A_0 - A_x}{A_0} \times 100$$

TEST	Flow Rate (mL h^{-1})	(D) Discoloration (%)	
		Rodamina B 10^{-6} mol L^{-1}	Methylene blu 10^{-5} mol L^{-1}
Control	2	24,0	42,3
P25	2	64,6	65,2
Control	3	17,3	23,1
P25	3	42,8	54,6

Conclusion

A photocatalytic microreactor was successful homemade with easy and low cost-production. A rapid prototyping of microreactor allows us to test a small quantitative of TiO_2 nanostructure material and to characterize the efficiency of the photodegradation activity in flow mode condition. This microreactor technology (MRT) is useful to achieve some requirements of the green chemistry, such as: use of small quantitative of solutions and photoactive materials, reduced wastes, and rapid test analysis. This microdevice will be tested for selective organic oxidation in flow reaction.

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