LIGHT-INDUCED MOTION OF MICROENGINES BASED ON MICROARRAYS OF TiO_2 NANOTUBES

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In this work, we demonstrate that TiO_2 micro/nanotubular structures, fabricated by means of electrochemical anodization of Ti sheets, can act as self-propelled microengines when they are exposed to UV irradiation. Single nanotubes with conical internal shape with inner diameter varying from 50 to 120 nm and clusters of TiO_2 nanotubes represented in figure 1, show propulsion through liquid consisting of oxygen peroxide and pure water. When exposed to UV-light, the microarrays of TiO_2 nanotubes exhibiting conical internal shapes show directed motion in confined space as it is indicated in figure 2d.

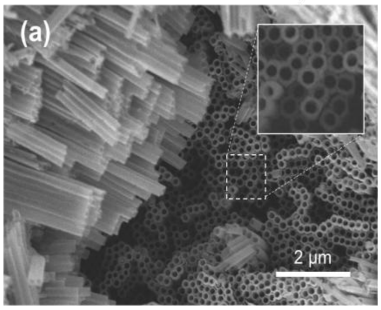

Figure 1 SEM image of a microarray of TiO_2 nanotubes

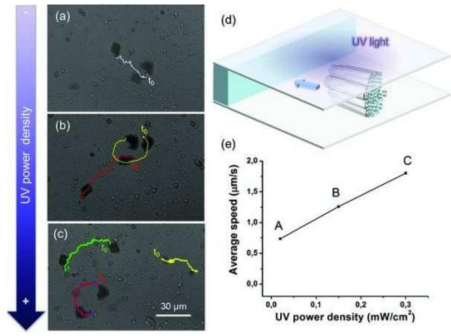

Figure 2 Optical images (a, b, c) of a microarray of TiO_2 nanotubes moving under the UV illumination (d), along with the corresponding tracking (starting point is labeled by t_0). The average speed associated to the aforementioned tracks is represented in panel (e). The power density of the UV irradiation constitutes (a) 0.02 μW/cm^2, (b) 1.5 μW/cm^2, (c) 0.3 μW/cm^2.

This light-induced motion of micro/nanoengines can be attributed to diffusiophoresis and localized nanobubble generation inside of the tubes due to the photocatalytic reactions occurring at the huge inner surface inherent to arrays of TiO_2 nanotubes. [1] The intensity of the UV light will influence the chemical reaction speed and therefore the micro/nanoengines motion speed too (figure 2a-c,e).

Depending on the postfabrication annealing conditions, different crystalline phases of TiO_2 nanotubes are obtained. The anatase crystalline phase, is the most photocatalytically active [2], therefore, the efficiency of microengines consisting of TiO_2 anatase phase nanotubes is the best one. Controlled pick-up, transport, and release of individual and agglomerated particles are demonstrated using the UV light irradiation of microengines. Due to the biocompatibility of TiO_2, these micro-nanoengines find great potential in biomedical applications, for instance, they can act as drug delivery system. [3]

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[1] F. Mou, Y. Li, C. Chen, W. Li, Y. Yin, H. Ma, J. Guan, *Small* 2015, *11*, 2564.
[2] M. Paulose, O. K. Varghese, G. K. Mor, C. A. Grimes, K. G. Ong, *Nanotechnology* 2006, *17*, 398
[3] W. Gao, R. Dong, S. Thamphiwatana, J. Li, W. Gao, L. Zhang, J. Wang, *ACS Nano* 2015, *9*, 117.