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Article

Sol-Gel Coatings for Subaquatic Self-Cleaning Windows

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XPS set-up

A SAGE 100 system (Specs GmbH, Germany) was used as for the XPS analysis. Base pressure in the analysis chamber was approximately 2e-7 mbar. The X-ray source was MgKα operated at an anode voltage of 12.5 kV and 250 W of power. Spectra were recorded, following a 50 min Ar sputter, at a take-off angle of 90°. The pass energy for the hemispherical analyzer was 50 eV for these survey scans. Spectra were analyzed using casaXPS software, and the elemental composition was determined by integration of peak areas using a standard Shirley background to be TiO_2 with trace levels of carbon.

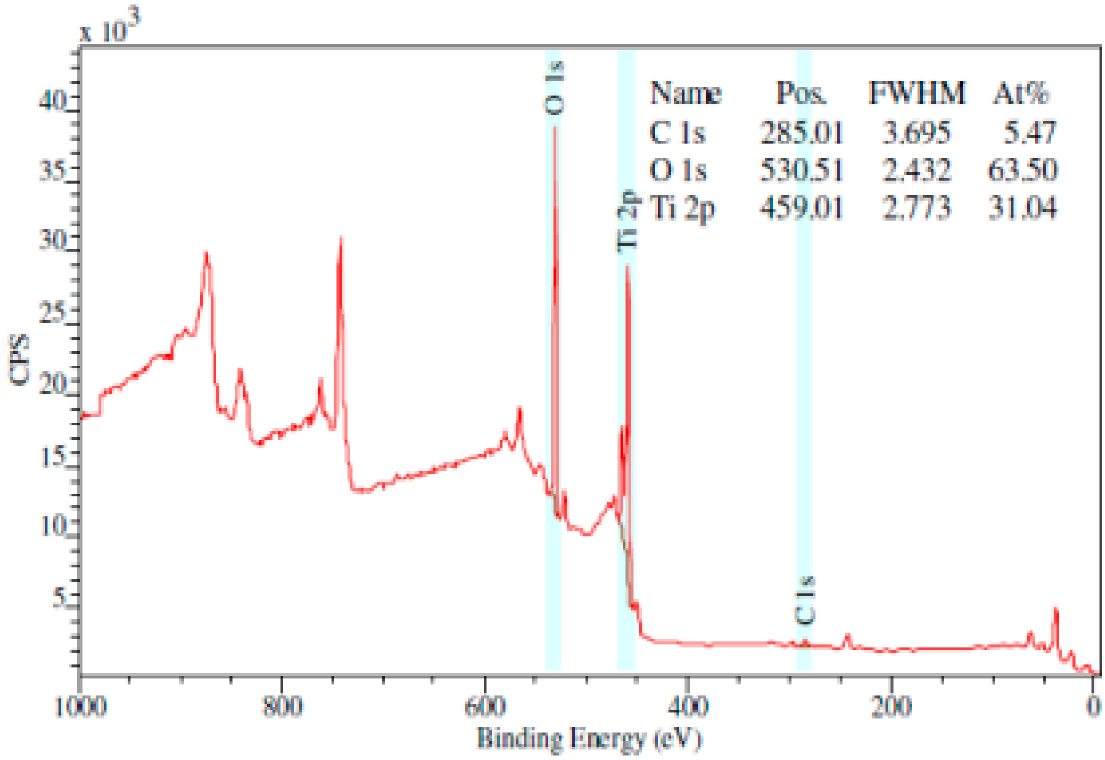

Figure S1. XPS spectrum for titania sol-gel annealed at 500 °C.

Raman analysis

The structural phase of the ceramic may be controlled through the annealing process. Titanium dioxide is known to exist in several phases which produce distinctive electromagnetic spectra under Raman microscopy. The titanium-based sol–gel was annealed at 500 °C. Raman analysis was performed on a Renishaw InVia Raman microscope in order to identify the structural phase of the annealed coating. The 514 nm wavelength laser source was deployed, and the Renishaw CCD sensor was utilised at five exposures per second with accumulations of 10 traces per plot to reduce noise. The spectrum for anatase was detected and is displayed in Figure S1.

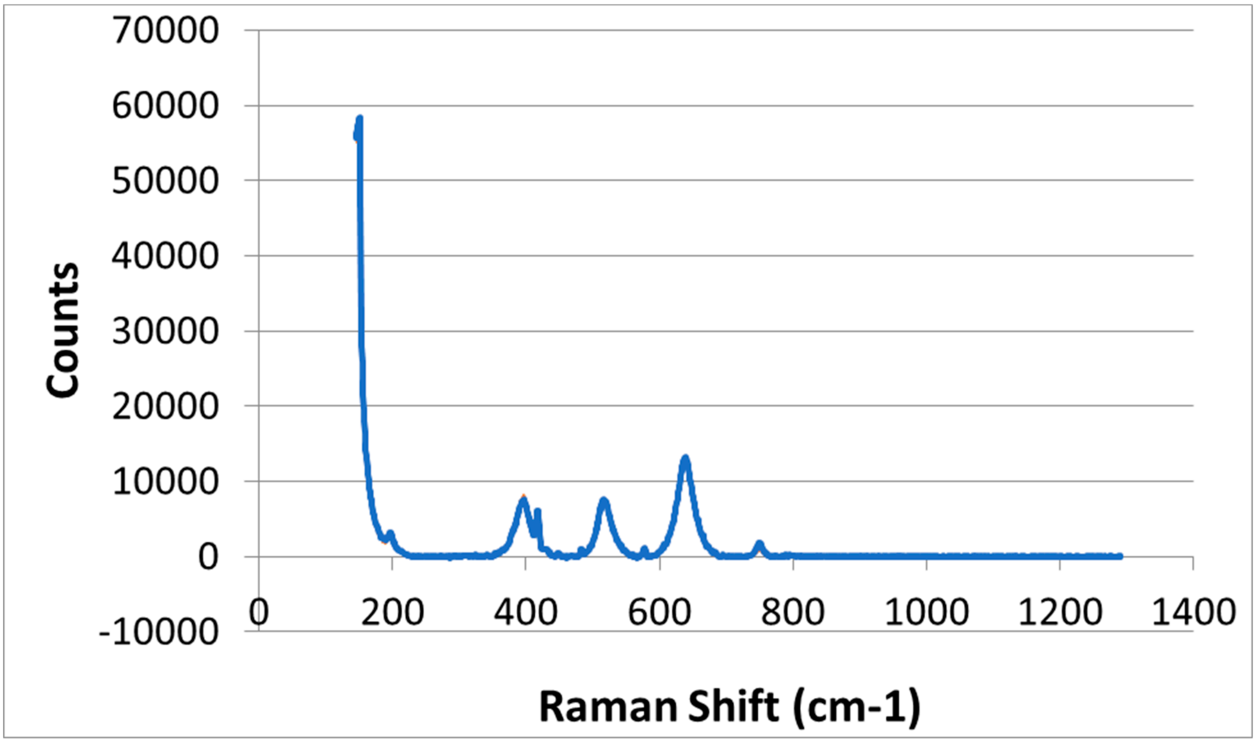

Figure S2. Recorded Raman spectrum for titania sol-gel annealed at 500 °C conforming to the known anatase polymorph spectrum. [1].

AFM Analysis

A Bruker Icon atomic force microscopy (AFM) in tapping mode was used to characterise the surface topography. It is shown in Figure S that the anatase surface layer does not have distinct grain boundaries and posseses an intrinsically smooth surface finish with sub-1 nm Ra.

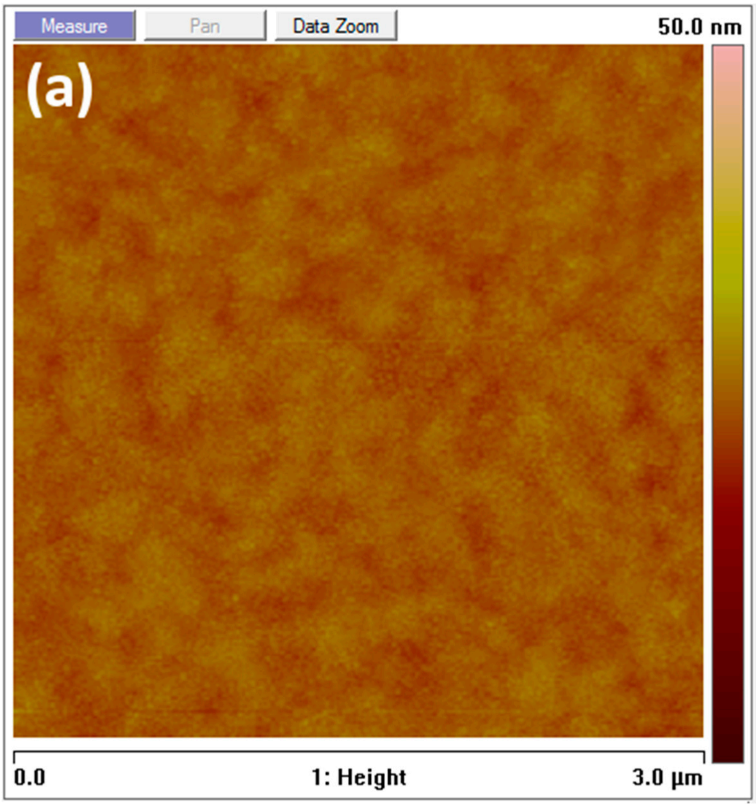

Figure S3. AFM surface profile scan of a 3.0 x 3.0 µm² area of a synthesized anatase TiO_2 coating. Effect of evaporating a thin non-active surface film.

Table S1. Water contact angle measurements before and after UV exposure for a sapphire control, TiO_2 sol-gel coating and a TiO_2 sol-gel coating with 5 nm of Au evaporated on to the surface.

WCA (degree)	Sapphire	Titania	5nm Au surface
contaminated	80.05	78.93	72.27
post 24H UV	66.23	11.37	59.32
delta	13.82	67.55	12.95

It may be observed from Table S1 that 5 nm of Au has performed very similarly to the non-active sapphire control even though Au will not oxidize and can conduct electrons. This proves that an entire surface layer prevents the self-cleaning effect to function despite it being known that sporadic metal junctions may be beneficial.[2]

Photographic analysis

Photographic comparisons are drawn in Figure S4 between the cleanliness of the various coatings following the subaquatic test.

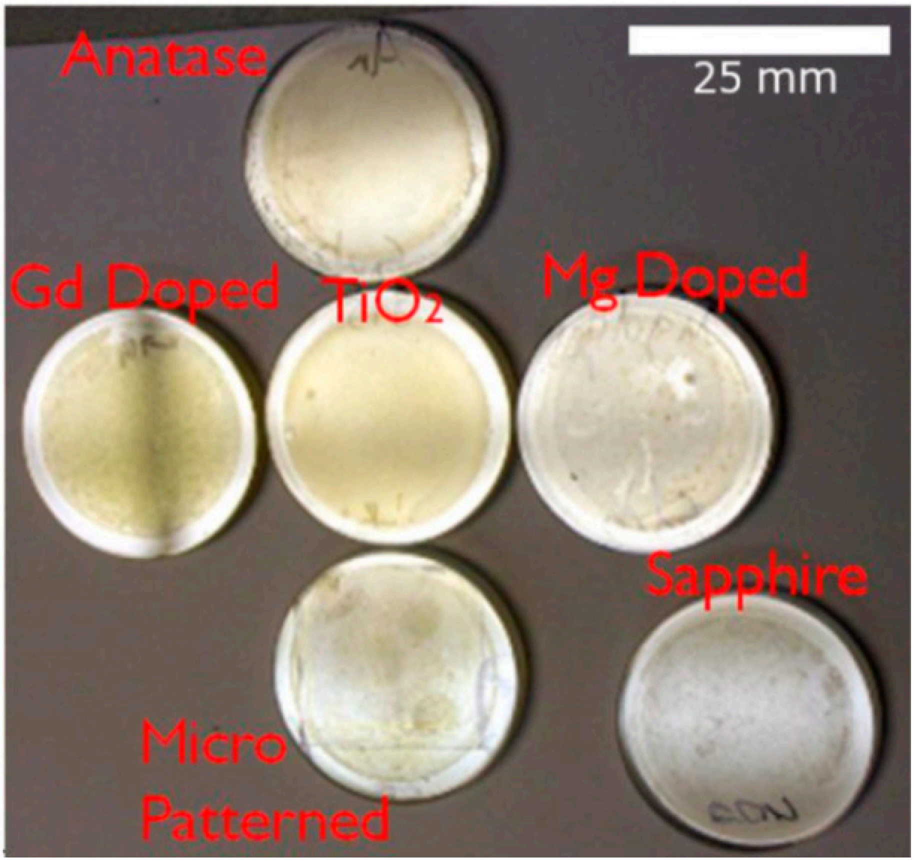

Figure S4. Visual reference between the tested windows following sub-aquatic cleansing tests.

References

[1] T. Ohsaka, F. Izumi, Y. Fujiki, Journal of Raman spectroscopy, 7 (1978) 321-324.

[2] A.L. Linsebigler, G. Lu, J.T. Yates Jr, Chemical reviews, 95 (1995) 735-758.