Observation of visible light activated self-cleaning of stearic acid in thin films of tantalum oxynitride synthesized by AACVD

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ABSTRACT: In this work we demonstrate the use of tantalum oxynitride films for self-cleaning. UV activated photocatalysts have been successful in commercial applications as self-cleaning coatings, yet limited work has been conducted on the application of more recently discovered visible light activated photocatalysis for this application. Tantalum oxynitride is an established visible light photocatalyst, and in this paper we investigate its potential for self-cleaning applications. Thin films of tantalum oxynitride were formed from ammonolysis of tantalum oxide films at temperatures between 550 °C and 750 °C, themselves formed using aerosol assisted chemical vapour deposition of tantalum ethoxide. Investigation of the films using XRD, UV-vis spectroscopy and XAFS identify that amorphous tantalum oxynitride is formed during the ammonolysis, with complete conversion under conditions of 700 °C for 24 hours. The self-cleaning ability of this film was assessed using stearic acid as a model pollutant, with a degradation rate of 2.5(2) × 1013 molecules min-1 cm-2 when exposed to a 5-sum solar simulator, equipped with a UV cut-off filter. We can therefore conclude the ability of tantalum oxynitride as a self-cleaning visible light photocatalyst, and also publish for the first time a scalable chemical vapour deposition route to tantalum oxynitride thin films

Supplementary Information

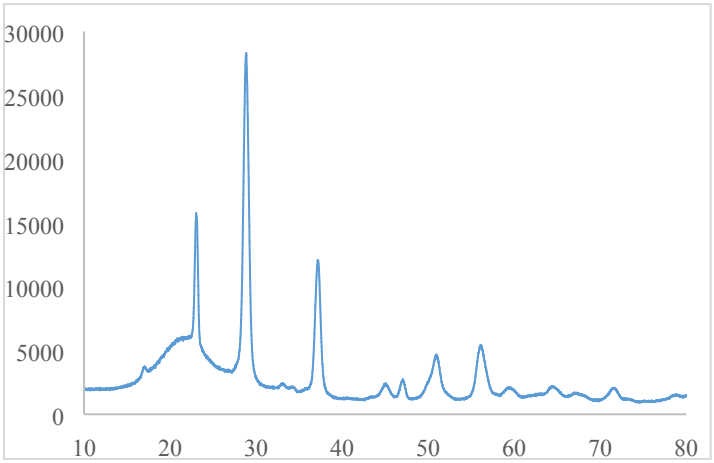


Figure S1. XRD pattern of deposited tantalum oxide film, after annealing at 900°C, showing Bragg peaks which match the pattern expected for Ta_2O_5.

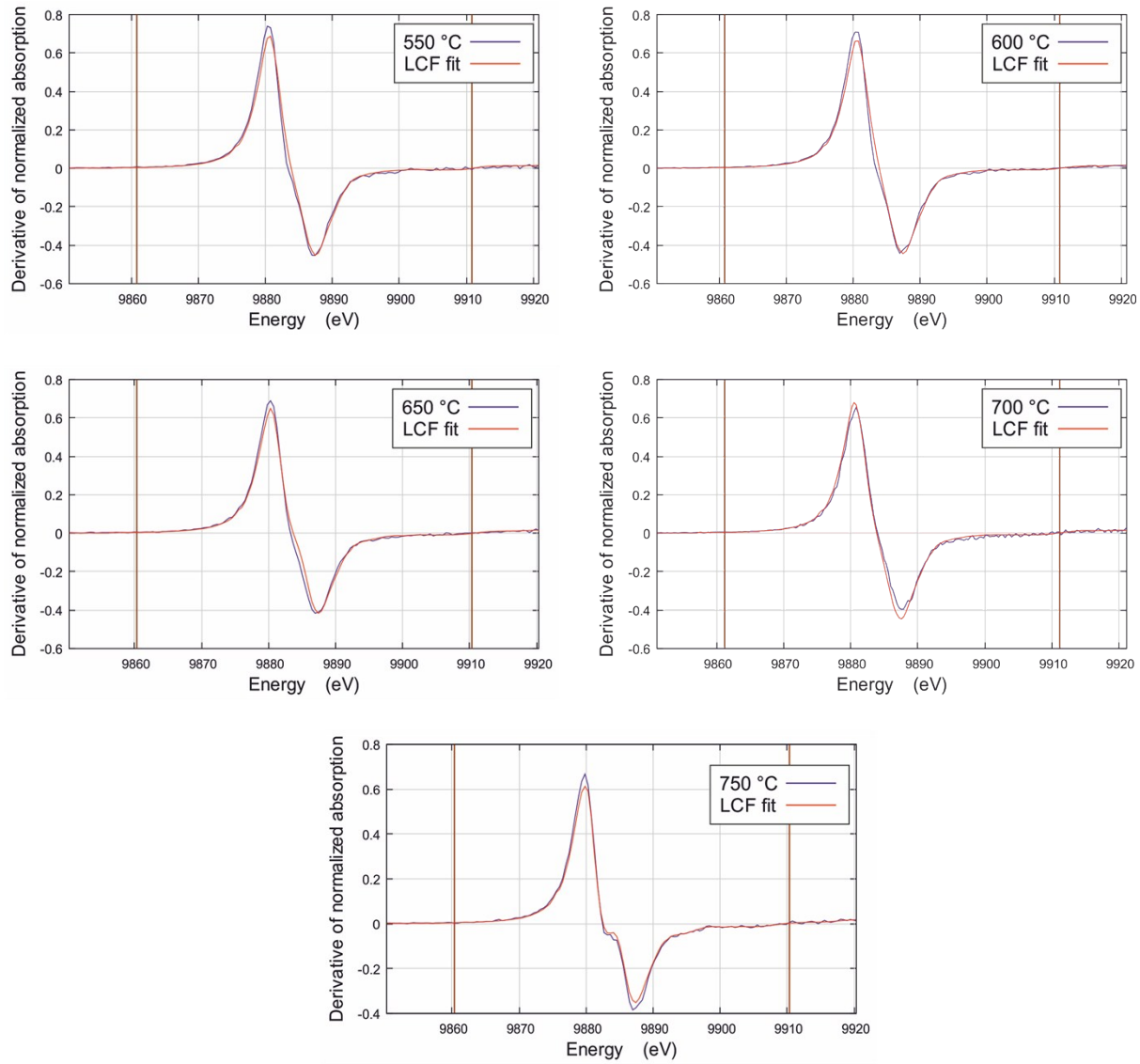


Figure S2. Results linear combination fitting of the XANES spectra for the five tantalum oxynitride films, with the spectra of the Ta_2O_5, TaON and Ta_3N_5 powders. Data shown is the derivative of the absorption.

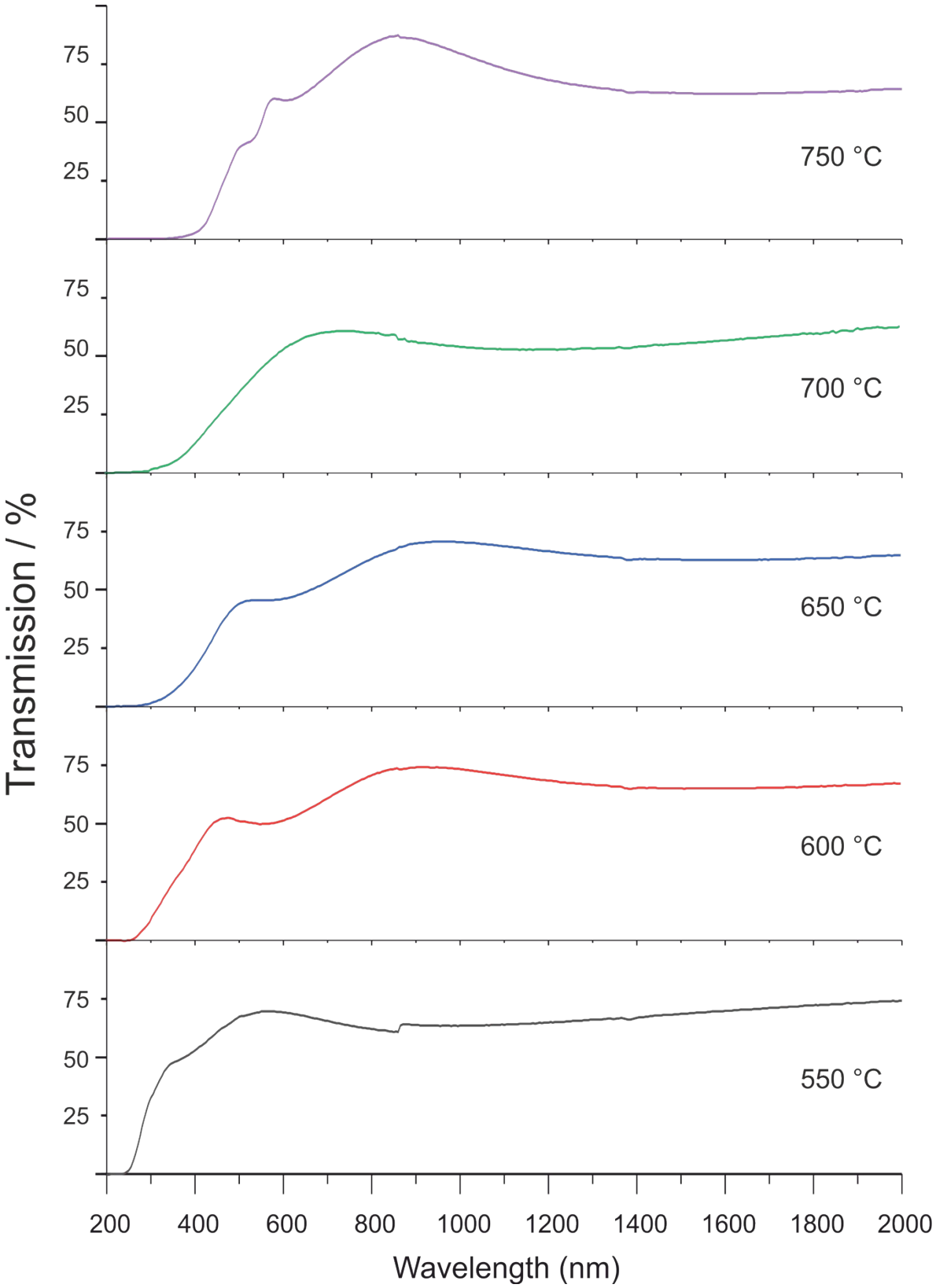
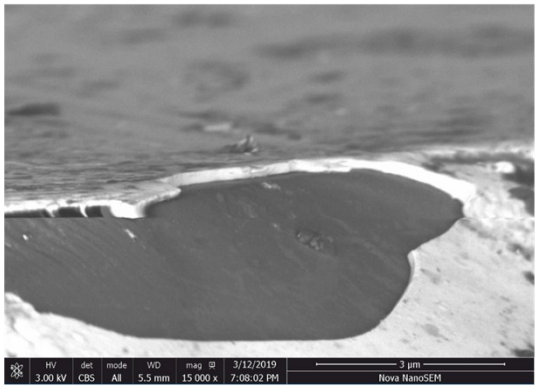
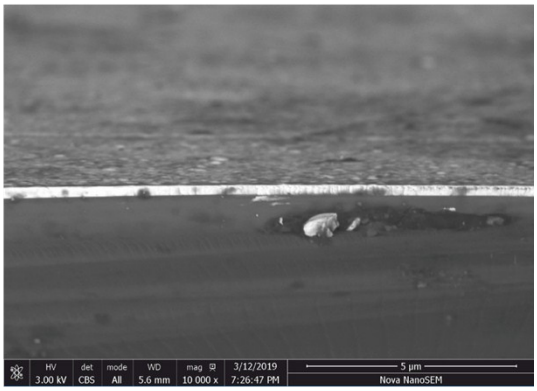


Figure S3. Transmission Spectra recorded across the range 200 nm to 1000 nm for the five tantalum oxynitride films.

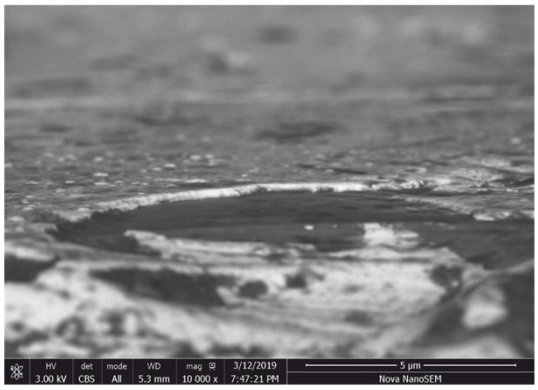
550°C



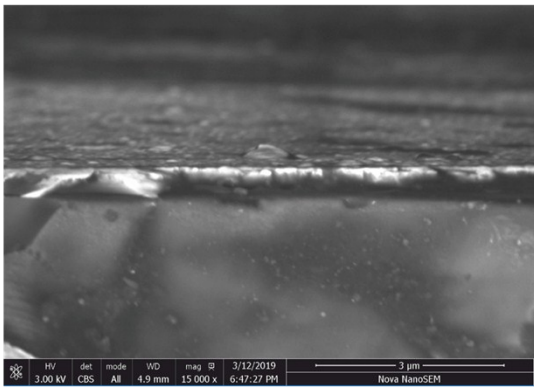
600°C



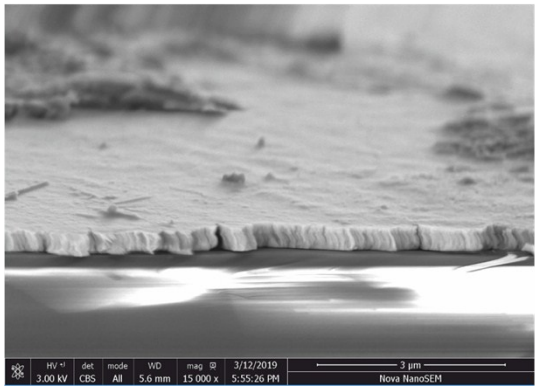
650°C



700°C



750°C



Unannealed Ta_2O_5

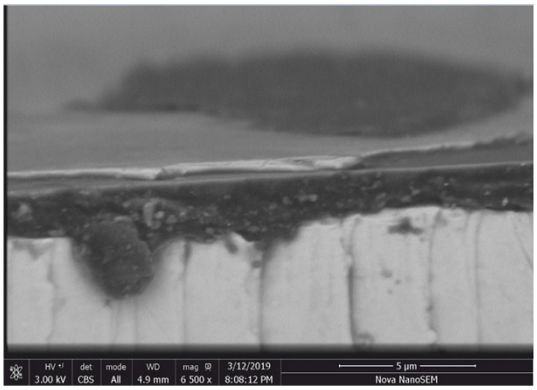


Figure S4. Side-on scanning electron microscope images, used to determine film thickness.

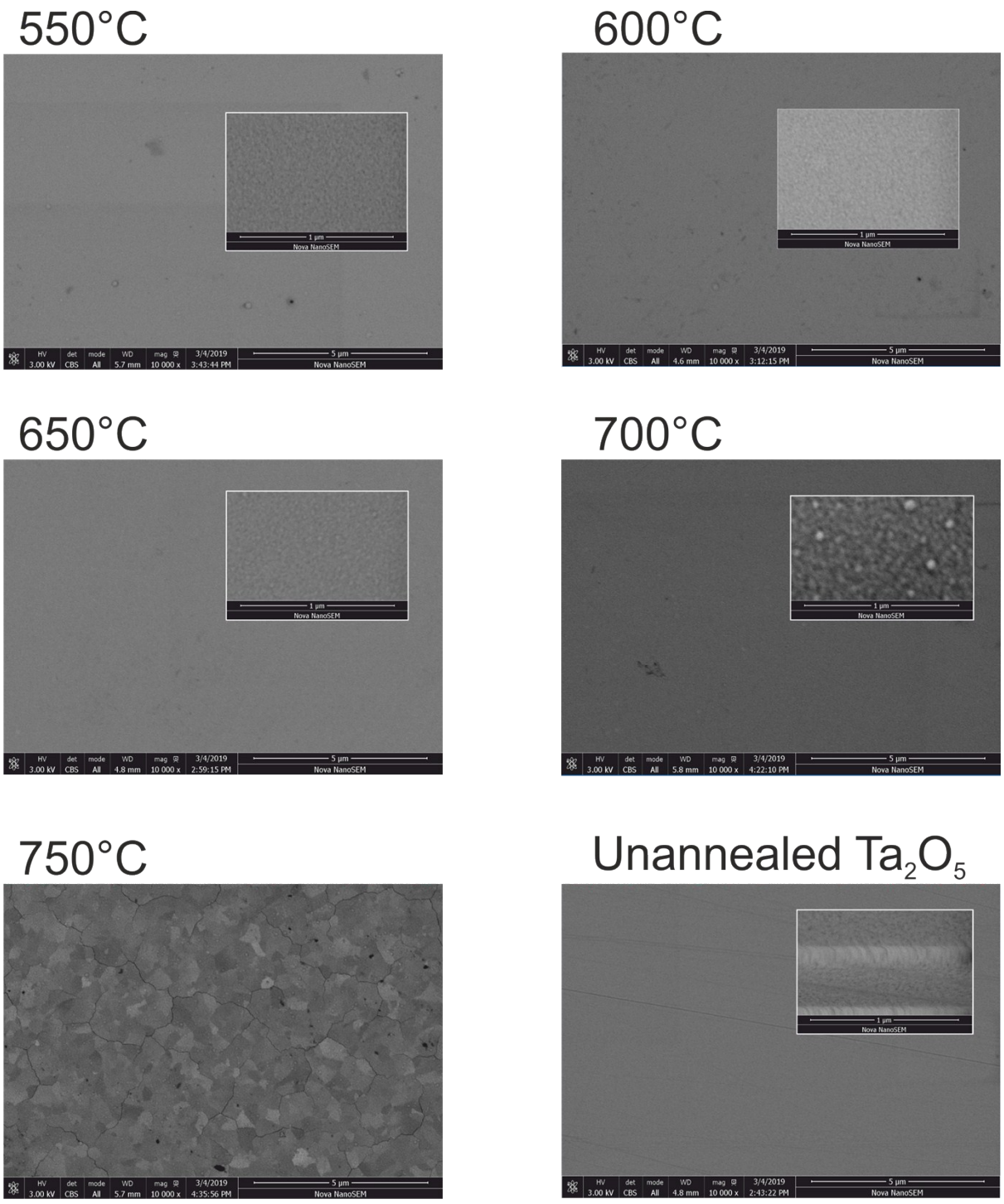


Figure S5. Top-down SEM images of unannealed Ta2o5 and films annealed under ammonia from 550 to 750 °C. Images are taken at 10k magnification, insets show 50k magnification, where available.