Atmospheric-Pressure Plasma-Enhanced Chemical Vapour Deposition (AP-PE-CVD) For Growth Of Thin Films At Low Temperature.

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The use of plasma enhanced chemical vapour deposition at atmospheric pressure shows considerable promise for relatively inexpensive deposition of thin films of a wide range of materials at significantly lower temperatures than conventional, thermal, CVD. We have studied such deposition using an audio-frequency glow discharge plasma reactor. This consists of parallel plate electrodes covered by a dielectric defining a laminar flow gas channel in which the plasma is generated in flowing helium. The substrate to be coated was held within the plasma region during discharge and precursor flow. An approximately sinusoidal potential with a peak voltage of about ±10 kV and a frequency of around 33 kHz was applied to the electrodes.

Thin film coatings of titanium oxide on glass and plastic have been deposited and characterised. Scanning electron microscopy (Fig. 1) showed granular film with grain sizes ranging from about 50-300 nm, but also indicated morphology variations from film to film. X-ray powder diffraction analysis gave no clear peaks, implying that the films are amorphous. Rutherford backscattering analysis showed the films to consist primarily of titanium dioxide.

Photocatalytic oxidation activity of one of these films on cellulose acetate was measured by monitoring the degradation of a film of stearic acid by infrared spectroscopy. The results (Fig 2) show a very active film which compares favourably to those produced by solution methods and to the Degussa P25 benchmark (1).

As a first step towards a better understanding of the plasma and better control of the coating process, electrical measurements and analysis were undertaken. The applied potential and total current were measured and from these were calculated the memory and gas potentials, by the method of Massines *et al.* (2), and the expected reactance current. These were plotted for one electrical cycle (Fig. 3) and indicate that the glow discharge is active with moderately high current for most of the cycle. This is in contrast to similar plasma systems reported previously (2, 3) and is probably due to the higher potentials and frequencies used here. Initial electrical measurements with precursor gases added were also made and compared.

1. R. Fretwell and D. P., *J. Photochem. Photobiol., A*, **143**, 229 (2001)
2. F. Massines, A. Rabehi, P. Decomps, R. Ben Gadri, P. Ségur and C. Mayoux, *J. Appl. Phys.*, **83**, 2950 (1998)
3. R. Ben Gadri, J.R. Roth, T.C. Montie, K. Kelly-Wintenberg, P.P.-Y. Tsai, D.J. Helfritch, P. Feldman, D.M. Sherman, F. Karakaya and Z. Chen, *Surf. Coat. Technol.*, **131**, 528 (2000)

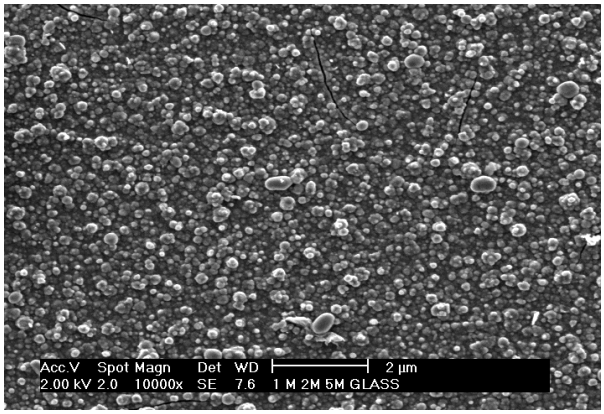

Figure 1. Scanning electron micrograph (x10K) of a titanium oxide coating on glass.

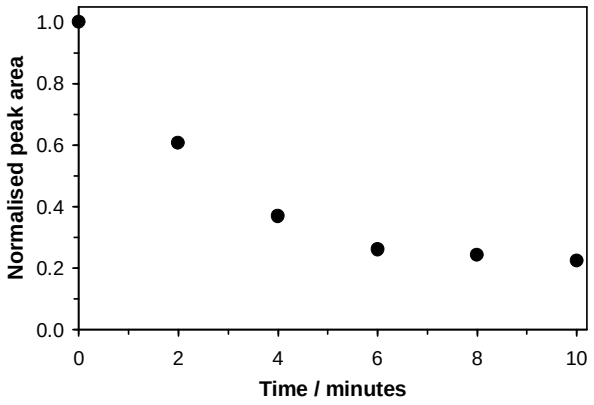

Figure 2. Photocatalytic activity of a titanium oxide film on cellulose acetate.

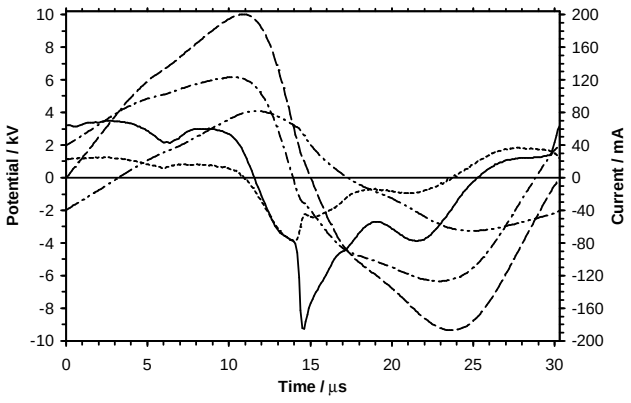

Figure 3. Measured and calculated potentials and currents for one cycle of the discharge in the reactor with pure helium working gas. Measured current (I_d, solid line), measured applied potential (V_a, dash), calculated gas potential (V_g, dash-dot), calculated memory potential (V_m, dash-dot-dot), and calculated reactance current (I_r, dot).