Deposition of thin film transition metal oxides (TMO) on glass by combustion chemical vapour deposition (C-CVD).

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Combustion CVD is a relative new technique. Recently it has been used for TMO but, in most of the cases, there is no description of the films or the conditions used (1). The materials chosen for the present investigation were tungsten oxide, molybdenum oxide and vanadium oxide thin films on glass. The tungsten and molybdenum oxides are interesting due to their electrochromic properties while vanadium oxide is a thermochromic material.

Aqueous precursors were deliver to the burner head as an aerosol. The substrate was held on a moving platform to simulate an on-line process. A detail description of the reactor has previously been given by *Davis et al.* (2).

The deposition was performed using a flame with an equivalence ratio of 1.0. This is in contrast to coatings of MoO_x and WO_x produced previously (2) where a less oxygen rich flame was used.

Scanning electron microscopy (SEM) of the sample WO_x showed a random columnar structure (Fig. 1). SEM of the sample MoO_x was uniform and apparently dense with no holes observed. The VO_x sample showed a relatively uniform film.

X-ray photoelectron spectroscopy (XPS) of WO_x indicated showed tungsten(VI) at the surface but lower oxidation states after argon ion beam etching (Fig. 2). XPS analysis of the coating of MoO_x showed similar results. XPS of the VO_x coating showed some molybdenum contamination. The surface of the VO_x film was vanadium(V), but etching revealed vanadium(IV) and vanadium(III). Rutherford backscattering (RBS) analysis (Fig. 3) confirmed the molybdenum contamination and also revealed traces of tungsten. The overall stochiometry estimated from the RBS was $VO_{1.93}$, which is consistent with the mixed oxidation states indicated by XPS.

It has been demonstrated that Combustion CVD can be used to deposit transition metal oxides from very cheap aqueous precursors. Higher oxidation state were found on the surface with lower states in the internal layers. It was also found that film morphology appears to be dependent on the flame condition used.

1. S. Shanmugham, A. Hunt, D. Motley *American Ceramic Society Bulletin,* **81,** 36, (2002).

2. M.J. Davis, G. Benito, S.J. Hurst, D.W. Sheel, M.E. Pemble, submitted to *Advanced Materials.*

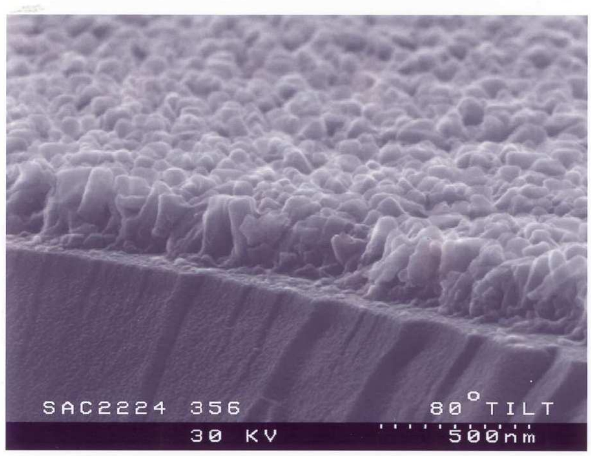

Figure 1. SEM of a WO_x film

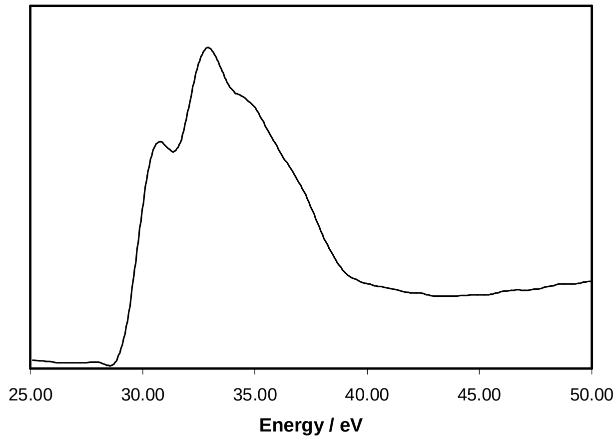

Figure 2. XPS of a WO_x after 4 minutes etching.

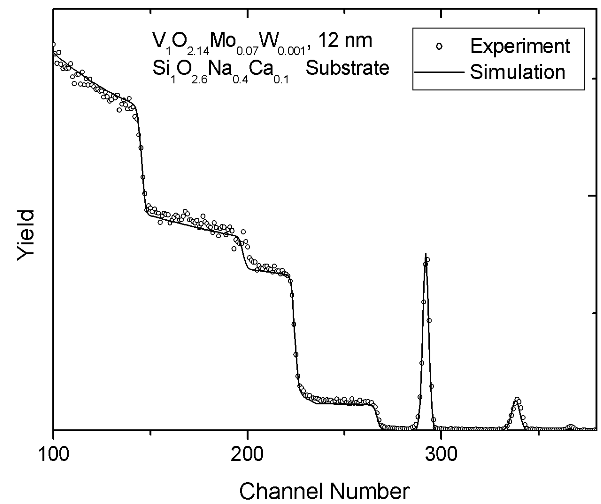

Figure 3. RBS of a VO_x film on glass.