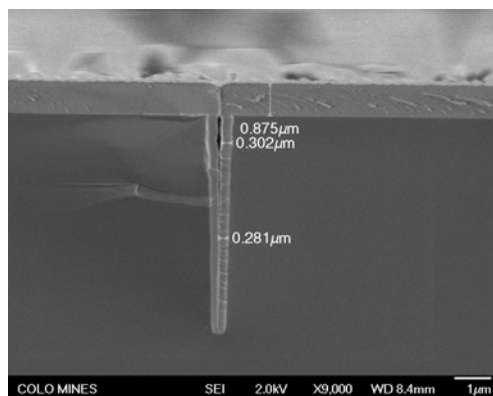


PULSED PECVD SYNTHESIS OF FUNCTIONAL OXIDES FOR SOLAR APPLICATIONS

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Oxide thin films play a number of critical roles in photovoltaics including transparent contacts, buffer layers, and permeation barriers for oxygen and water. Metal oxides are also the leading photocatalysts for both carbon reduction and water splitting. In most cases mixed metal oxides are employed, and control of composition and thickness is critical to achieve optimum performance. Atomic layer deposition (ALD) is a leading technique that produces conformal, pinhole-free films, with nanoscale control over film thickness and composition. However, ALD's low net rates make it prohibitively expensive for solar energy applications, where relatively thick (100- 1000 nm) coatings are often employed. We have recently develop pulsed plasma-enhanced chemical vapor deposition (PECVD) as an alternative to ALD for self-limiting growth of metal oxides.¹⁻³ The technique retains the nanoscale control and high quality of ALD, but with net deposition rates that are an order of magnitude greater (>30 nm/min). In addition, the deposition technique produces highly conformal coatings. The SEM on this page shows an image of a high aspect ratio trench that was completely filled by pulsed PECVD, demonstrating the unique combination of high rate and conformality afforded by this technique. Note that the film thickness approaches 1 μm .



The technique has great versatility as we have successfully demonstrated it for a number of oxides of interest to the solar energy community (TiO_2 , ZnO , Al_2O_3 , Ta_2O_5). In this poster we will review the basic principles of self-limiting film growth by pulsed PECVD. The deposition mechanism will be illustrated through measurements of growth rate, conformality, and comparisons with plasma-enhanced ALD. A distinct advantage of pulsed PECVD is that the deposition rate ($\text{\AA}/\text{pulse}$) may be tuned over a broad range using parameters such as precursor density, plasma power, and pressure. Film quality from the various material systems we have examined will be quantified through an array of techniques including FTIR spectroscopy, X-ray photoelectron spectroscopy (XPS), X-ray diffraction (XRD), photoluminescence, spectroscopic ellipsometry, and dielectric performance. In this poster we will also show some of our current work on using pulsed PECVD for the formation of mixed metal oxides, including nanolaminates and homogenous alloys.

References

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