PLASMA-ENHANCED AND THERMAL ALD OF Al_2O_3 FROM DIMETHYLALUMINIUM ISOPROPOXIDE, $[Al(CH_3)_2(O^iPr)]_2$

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Ultra-thin Al_2O_3 films deposited using atomic layer deposition (ALD) have many prominent applications, not only as high-*k* dielectrics, but also as passivation layers in solar cells and moisture barriers for organic electronics. For some of these applications, ALD at relatively low deposition temperatures is also preferred or, in some cases, required. $[Al(CH_3)_3]$ (TMA) is a popular Al precursor as it exhibits "ideal" ALD growth characteristics, even down to room temperature. However, its main drawback is its highly pyrophoric nature. The search for safer precursors for use in industrial-scale high-volume manufacturing is ongoing; therefore, we have been investigating the use of $[Al(CH_3)_2(O^iPr)]_2$ (DMAi) as an alternative Al precursor for plasma-enhanced and thermal ALD over wide temperature ranges of 25-400 and 100-400 °C, respectively.

The growth per cycle (GPC) obtained using *in situ* spectroscopic ellipsometry for plasma-enhanced ALD was 0.7-0.9 Å/cycle, generally lower than the >0.9 Å/cycle afforded by TMA[1] (Fig. 1). In contrast, the thermal process gave a higher GPC than TMA above 250 °C, but below this temperature, the GPC decreased rapidly with decreasing temperature, suggesting that O^iPr groups are difficult to remove at lower temperatures. *In situ* quadrupole mass spectrometry data confirmed that both CH_4 and HO^iPr were formed during the DMAi dose. Rutherford backscattering spectroscopy showed that, for temperatures >100 °C and >200 °C for plasma-enhanced and thermal ALD, respectively, the films were of a comparable composition to those deposited by TMA in the same reactor:[1] the films from DMAi had an O/Al ratio of 1.5-1.6, a H content of ~5 at.% and mass densities of 2.7-3.0 g cm^{-3}. For the thermal ALD at 100 °C, ~8 at.% C was detected, which is attributed to incorporation of the O^iPr ligand at this temperature, as alcohols are known to bond strongly to metal oxide surfaces.[2] For plasma-enhanced ALD, ~9 at.% C was detected at 25 °C, which is attributed to the presence of CO_x groups. However, C was not detected at higher temperatures for both ALD methods. Using these results, the film properties obtained using DMAi and TMA will be compared and the mechanisms for the plasma-enhanced and thermal ALD using DMAi will be discussed.

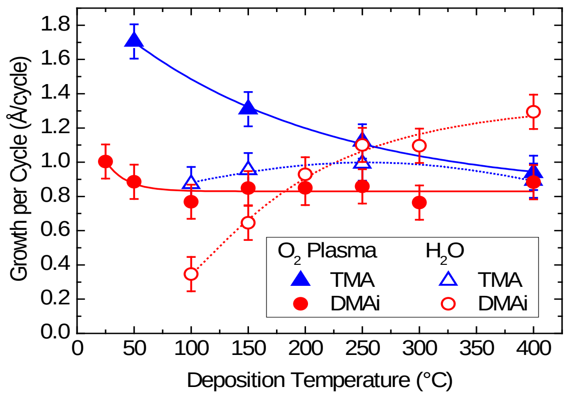

Fig. 1. GPC as a function of temperature for the ALD of TMA[1] and DMAi with an O_2 plasma and H_2O; deposited using an Oxford Instruments OpAL reactor. Lines serve as a guide to the eye.

[1]S. E. Potts *et al.*, *J. Electrochem. Soc.*, **157**, 7, 2010, P66-P74.
[2]A. Yanguas-Gil and J. W. Elam, *Proc. 10th Int. Conf. on ALD*, 2010, 36.