LOW TEMPERATURE PLASMA-ENHANCED ATOMIC LAYER DEPOSITION OF METAL OXIDE THIN FILMS

S. E. Potts, L. van den Elzen, G. Dingemans, E. Langereis, W. Keuning, M. C. M. van de Sanden, and W. M. M. Kessels
Department of Applied Physics, Eindhoven University of Technology, P.O. Box 513, 5600 MB Eindhoven, The Netherlands
Email: s.e.potts@tue.nl

Atomic layer deposition (ALD) processes have a temperature window governed by the reactivity and stability of the precursors and the surface groups involved in precursor adsorption. Few processes have been reported at considerably low temperatures, which are a necessity for temperature-sensitive substrates, such as polymers\textsuperscript{1,2} or metals\textsuperscript{3}, the mechanical properties of which may be altered by higher temperatures. Although films grown at lower temperatures generally contain more impurities, plasma-enhanced ALD may reduce these\textsuperscript{4}. As such, this project aims to develop and optimise the plasma-enhanced ALD of Al\textsubscript{2}O\textsubscript{3}, TiO\textsubscript{2} and Ta\textsubscript{2}O\textsubscript{5} at 25-250 °C as an alternative to thermal processes.

The precursors were [AlMe\textsubscript{3}], [Ti(O\textsubscript{i}Pr)\textsubscript{4}], [Ti(CpMe)(O\textsubscript{i}Pr)\textsubscript{3}] and [Ta(NMe\textsubscript{2})\textsubscript{5}] respectively and an O\textsubscript{2} plasma was employed as the oxygen source. The substrate temperature had a notable effect on the growth per cycle for [AlMe\textsubscript{3}] (Fig. 1), which was reduced with increasing temperature. However, the growth per cycle values remained almost constant for the titanium and tantalum systems. For Al\textsubscript{2}O\textsubscript{3}, the [O]/[Al] ratio was always higher than the desired 1.5 at temperatures below 200 °C. Hydrogen was the most significant impurity, which was reduced by higher substrate temperatures. For TiO\textsubscript{2} and Ta\textsubscript{2}O\textsubscript{5} the [O]/[Ti] and [O]/[Ta] ratios were more consistent at 2.0 and 2.5 respectively although hydrogen concentrations of ~5 at.% were present in both cases.

This presentation assesses whether plasma-enhanced ALD can produce films of sufficient quality for the desired applications\textsuperscript{1-3} and how the films compare with those deposited by thermal ALD at similar temperatures.


Figure 1. Variation of growth per cycle with substrate temperature.