Atomic Layer Deposition of Yttrium Oxide from Bis(Methylcyclopentadienyl) (MethylPentyl Pyrazolato) Yttrium (III)

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Yttrium Oxide (Y_2O_3) is a promising dielectric material due to its relatively wide band gap (~5.5 eV), high permittivity (>10), and high thermal stability. As semiconductor fabrication processes move toward high-aspect-ratio structures, highly conformal deposition methods for Y_2O_3 are required. Herein, we report the atomic layer deposition (ALD) of Y_2O_3 thin films based on a newly developed liquid precursor, Bis(Methylcyclopentadienyl) (MethylPentyl Pyrazolato) Yttrium (III), with ozone or water as co-reactants. The ozone process was tested in the range of 150 - 250 ^oC. The best uniformity and lowest thermal decomposition are achieved at 180 - 225 ^oC substrate temperature window, where the saturated growth rate is ~0.5 Å/cycle and refractive index is 1.69. Using H_2O as the co-reactant tested in the range of 125 - 250 ^oC, the optimum growth window is 135 - 180 ^oC, with a growth rate of 0.5 - 0.6 Å/cycle and refractive index of 1.73. However, due to the reactivity between Y_2O_3 and water to form hydroxides, higher purging gas flow and extra-long purging time are required to obtain dense Y_2O_3 films. For the films deposited under different conditions, we performed XPS study for compositional information, as well as AFM study for surface morphology and roughness. Our Y_2O_3 ALD processes offer the material fundamentals to enable future high-performance electronic devices, especially those with three-dimensional frameworks that require dielectric coatings in high-aspect-ratio structures.