

Figure 1. External pulsed fluidised bed system for in-situ precursor synthesis through ALE for ALD deposition of fluorine doped aluminium oxide. **1.** Mass flow controller. **2.** ALD valve. **3.** ALD valve. **4.** Three-way ALD valve. **5.** Manual bellows valve. **6.** Precursor bubbler. **7.** Lower VCR sealing gasket with metal frit. **8.** Heated powder bed. **9.** Upper VCR sealing gasket with metal frit. **10.** ALD valve. **11.** Manifold (see methodology) **12.** Heated reaction chamber. **13.** Stop valve.

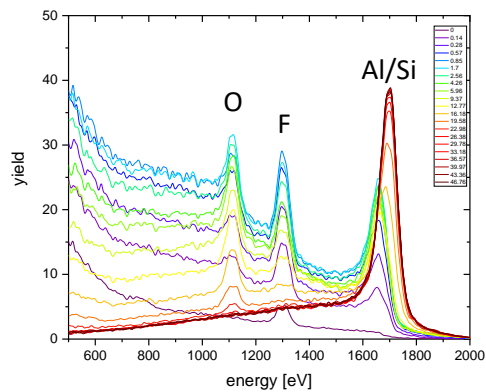


Figure 2. LEIS energy depth profile of F:Al<sub>2</sub>O<sub>3</sub> sample. Legend shows total sputter ion dose. 0 represents the top surface of the sample and each subsequent line is the surface after sputtering.

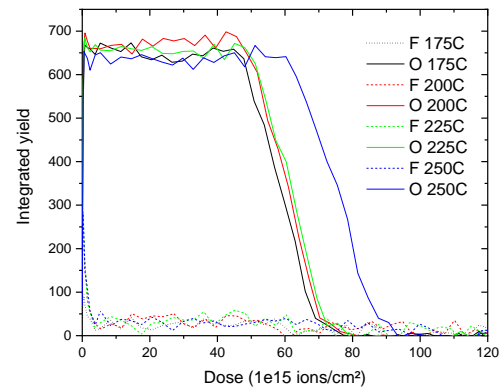


Figure 3. LEIS composition profile of thin films deposited using 200 cycles of TMA and H<sub>2</sub>O with TMA passed through the AlF<sub>3</sub> powder canister. Each film analysed was deposited at a different substrate temperature ranging from 175 °C to 250 °C. For all films, the canister temperature was set to 150 °C. Sputter dose is relative and corresponds to film thickness. F represents the fluorine content and O represents the oxygen content.

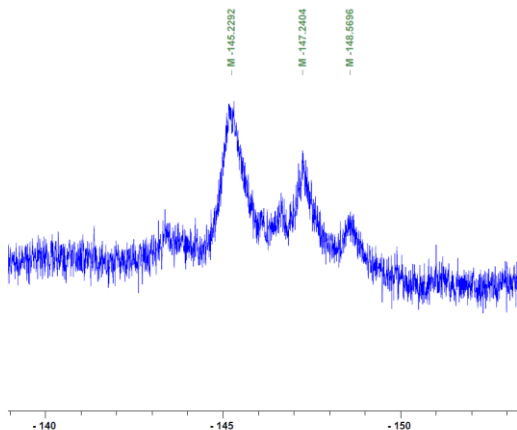


Figure 4. <sup>19</sup>F spectrum of species captured after TMA is passed through AlF<sub>3</sub> powder bed (376.50MHz, benzene-d<sub>6</sub>, 298K)