Yttria-stabilized cubic zirconia (YSZ) is the most-common electrolyte material for solid oxide fuel cells due to its reasonable oxygen-ion conductivity and chemical stability. To achieve suitable ionic conductivities, YSZ ceramics must be near theoretical density, requiring sintering temperatures around 1450°C. In 2011, it was demonstrated that flash sintering densifies YSZ in a few seconds at 750°C.\(^1\) During flash sintering, an electric field is applied across the sample and at a certain threshold temperature, the sample conductivity and power dissipation rapidly increase causing densification. Since densification occurs in just a few seconds, grain growth can be difficult to control. During conventional sintering of YSZ ceramics, researchers have demonstrated that the addition of a small quantity of aluminum oxide (Al\(_2\)O\(_3\)) pins grain boundaries, reducing YSZ grain size.\(^2\) However, the effect of small quantities of Al\(_2\)O\(_3\) addition on the grain growth of flash sintered YSZ has not been studied.

In this work, atomic layer deposition (ALD) was used to deposit a conformal film of amorphous Al\(_2\)O\(_3\) on the surface of YSZ particles. Particle ALD is a gas-phase deposition technique that homogeneously disperses a small quantity of Al\(_2\)O\(_3\) throughout the green body to control grain growth during flash sintering. Flash sintering experiments showed that the addition of 2.2 wt% Al\(_2\)O\(_3\) by Particle ALD increased the flash temperature of YSZ from 760°C to 880°C at an electric field of 300 Vcm\(^{-1}\) (Figure 1). Scanning electron microscopy was used to determine the effects of the Al\(_2\)O\(_3\) films on grain growth and microstructural evolution during flash and conventional sintering. Transmission electron microscopy and energy dispersive X-ray spectroscopy were used to characterize the as-deposited Al\(_2\)O\(_3\) films.


![Figure 1 – Power dissipation for samples with 0, 0.7, and 2.2 wt% Al\(_2\)O\(_3\) addition.](image-url)