Electronic Supplementary Information:

Tunable high-κ ZrₓAl₁₋ₓOᵧ thin film dielectrics from all-inorganic aqueous precursor solutions


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Figure S1: Fourier transform infrared spectroscopy (FTIR) for ZAO films annealed at 300 and 400 °C

Fig. S1  FTIR spectra of two-coat ZAO films annealed at (a) 300 °C and (b) 400 °C.
Figure S2: X-ray reflectivity (XRR) spectra and best fit models for ZAO films annealed at 500 °C

Fig. S2 Representative XRR spectra for single-coat ZAO films annealed at 500 °C (solid, colored) and overlaid best fit models (dashed, black). Best fit models were generated using a two-layer model consisting of a thin (~1-3 nm) capping layer over an underlying bulk layer of different density, consistent with models employed in previous XRR studies on aqueous-derived metal oxides.\(^\text{1,2}\)
Figure S3: Film thickness and density of ZAO films extracted from XRR best fit models

Fig. S3 (a) Film thickness \([t]\) and (b) density \([D]\) of single-coat ZAO films extracted from XRR best fit, two-layer models. Small differences in film thickness between compositions are attributed to small differences in the humidity of the spin-coating chamber during deposition.\(^3\) Density values are calculated from a weighted average of the capping and bulk layer densities.
Figure S4: Dielectric constant dispersion

Fig. S4  (a) Dielectric constants [κ] as a function of frequency [f] for ZAO-based MIS devices and (b) corresponding loss tangents [loss δ] as a function of f. MIS devices were fabricated from two-coat (~100 nm) ZAO films annealed at 500 °C. Error bars were determined using measurements taken from three separate batches of MIS devices.
References
