

Supporting information

Comparative study of the growth characteristics and electrical properties of atomic-layer-deposited HfO₂ films obtained from metal halide and amide precursors

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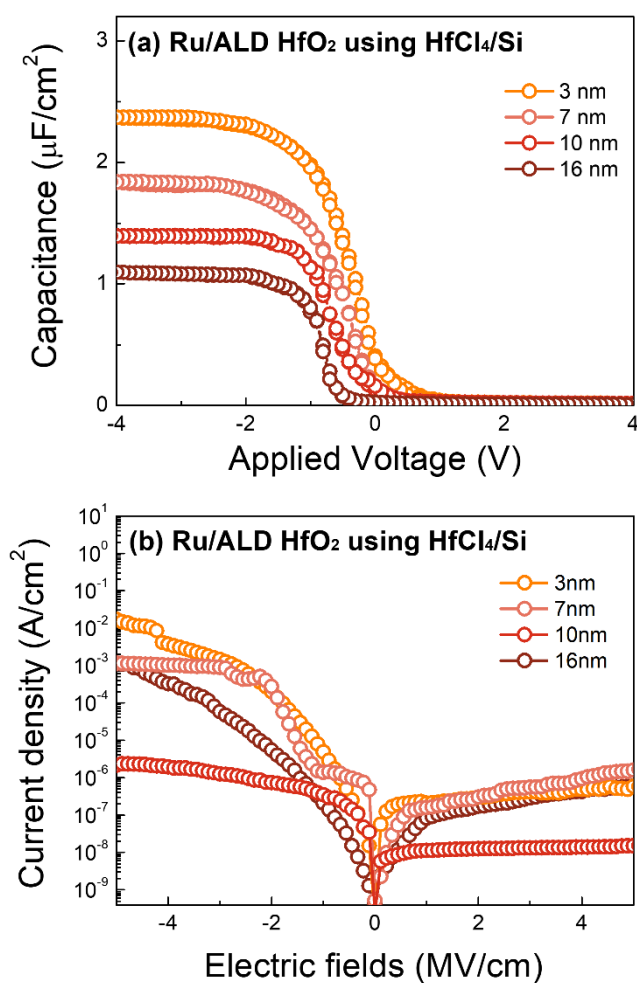


Figure S1. (a) *C-V* curves and (b) *I-V* curves of metal-oxide-semiconductor (MOS) capacitors using HfCl₄-based atomic layer deposited (ALD) HfO₂ with varying thicknesses.

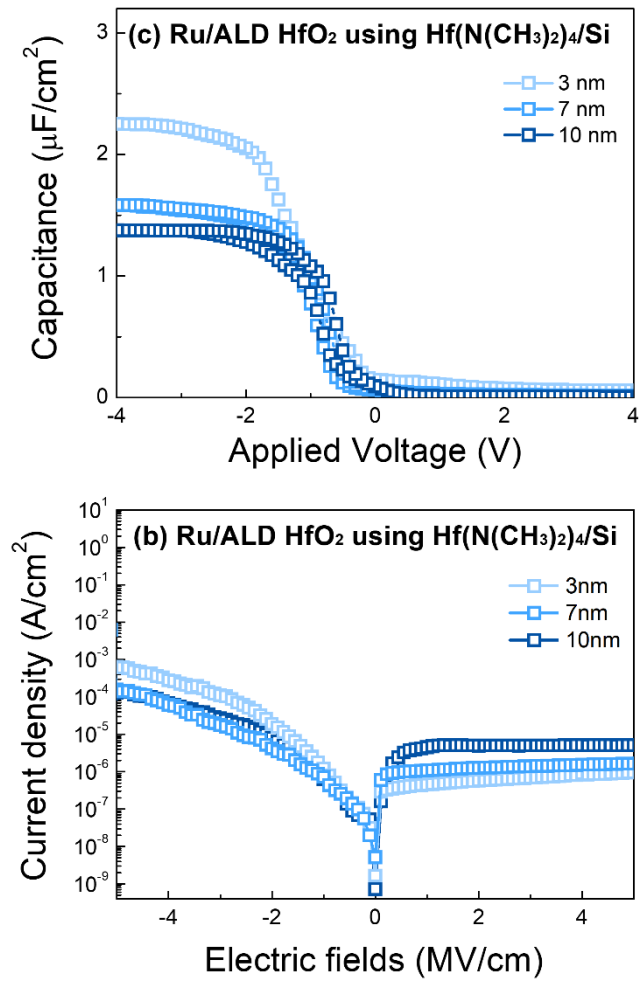


Figure S2. (a) C-V curves and (b) I-V curves of MOS capacitors using Hf(N(CH₃)₂)₄-based ALD HfO₂ with varying thicknesses.

Table S1. Electrical properties of MOS capacitors based on ALD HfO₂ with varying thicknesses

| Precursor | Thickness (nm) | Dielectric constant | EOT (nm) | D_{it} ($10^{11} \text{ cm}^{-2} \text{ eV}^{-1}$) | N_{ot} (10^8 cm^{-2}) | J_g at V_{FB} of -1V (A/cm^2) |
|--|----------------|---------------------|----------|--|-------------------------------------|--|
| HfCl ₄ | 3 | 8.04 | 1.44 | 1.85 | ~ 0 | 1.95×10^{-5} |
| | 7 | 14.9 | 1.57 | 2.85 | ~ 0 | 5.99×10^{-6} |
| | 10 | 15.7 | 2.48 | 1.86 | ~ 0 | 3.94×10^{-7} |
| | 16 | 20.1 | 2.98 | 2.87 | ~ 0 | 2.10×10^{-7} |
| Hf(N(CH ₃) ₂) ₄ | 3 | 7.65 | 1.53 | 46.3 | ~ 0 | 2.63×10^{-4} |
| | 7 | 12.5 | 2.18 | 43.2 | - 1.98 | 7.14×10^{-6} |
| | 10 | 15.9 | 2.45 | 8.96 | - 2.58 | 2.25×10^{-6} |