**ALD Oxides for Higher Performance Power Transistors**

**Scientific Achievement**
Successfully grew single-crystalline (Mg,Ca)O films epitaxially on InAlN transistors with unprecedentedly low density of defects and electron traps at the oxide/semiconductor interface.

**Significance and Impact**
The performance of transistors using these epitaxial (Mg,Ca)O insulators was dramatically improved relative to the many non-epitaxial insulators (SiO$_2$, Al$_2$O$_3$, Si$_3$N$_4$, HfO$_2$, La$_2$O$_3$, LaLuO$_3$, and AlN) tested previously in similar devices. These new transistors will improve the efficiency of electric power transmission and use.

**Research Details**
- New volatile, thermally stable, and highly reactive magnesium and calcium amidinate precursors were synthesized and demonstrated to make metastable epitaxial (Mg,Ca)O layers by atomic layer deposition (ALD).
- The leakage current in the off-state was reduced by between 2 and 5 orders of magnitude relative to non-epitaxial devices.
- The noise generated by the transistors was reduced by more than an order of magnitude relative to non-epitaxial devices.
- The sharpness of the turn-on voltage was found to be near the ideal limit.


![Schematic cross-section of a high-power nitride-based transistor.](image)

![Transmission electron micrograph of epitaxial Mg$_{0.25}$Ca$_{0.75}$O on indium aluminum nitride.](image)