Department of Chemical Engineering
Presents:

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Thin Films and High Quality Devices by Open Air ALD

Wednesday, March 7, 2012
2:15 p.m.
101 Goergen Hall

Atomic Layer Deposition (ALD) is a film growth process in which material is deposited by exposing a substrate to reactants one at a time, building an inorganic film atomic layer by atomic layer. The process leads to dense, conformal, pinhole-free films. Typical ALD processes are performed under vacuum with reactants repeatedly introduced and withdrawn from a vacuum chamber. An alternative process is to localize gases spatially to specific regions of a coating head, and to accomplish the growth by relative motion of a substrate to the coating head. A main advantage of such a spatial ALD process is the potential for processing large and ultimately continuous roll substrates in an open (chamberless) process.

While spatial ALD systems have been attempted, we have developed a new approach which is the first to demonstrate extremely fast reactant exposures, as short as 10 milliseconds, as well as sufficient isolation between reactants to yield true ALD films. The process and its underlying physics will be discussed.

We obtain high-quality films with characteristics typical of standard ALD processes. These can find application in electronics and energy harvesting. Insulating films based upon aluminum oxide show leakage and breakdown comparable to standard ALD films. In addition, transparent conductors such as aluminum-doped zinc oxide (AZO) with resistivity approaching that of the more expensive ITO are feasible with this system.

We have used our spatial ALD process to produce complete thin-film transistors (TFT) using zinc oxide as the semiconductor. Current methods for producing TFTs include the industrially mature amorphous silicon (a-Si) process, vacuum processes employing polycrystalline silicon- or zinc-based oxides, and organic semiconductors. Our approach has the potential to produce semiconductor films with mobility and stability that exceed that of a-Si while in an open process that can lead to manufacturing benefits relative to other methods. The performance of TFTs produced from the system will be discussed, as well as useful methods to pattern these devices based upon selective area deposition.