

The Department of Chemical Engineering Presents:



## J E F F E R Y E L A M

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Argonne National Laboratory

Zoom meeting link: <https://rochester.zoom.us/j/98875611576> 87849

**ABSTRACT:** Atomic Layer Deposition (ALD) provides exquisite control over film thickness and composition and yields excellent conformality over large areas and within nanostructures. These desirable attributes derive from self-limiting surface chemistry, and can disappear if the self-limitation is removed. Understanding the surface chemical reactions, i.e. the ALD mechanism, can provide insight into the limits of self-limitation allowing better control, successful scale up, and the invention of new processes. In situ measurements are very effective for elucidating ALD growth mechanisms. In this presentation, I will describe investigations into the growth mechanisms of ALD nanocomposite films comprised of conducting (e.g. W, Mo and Re) and insulating (e.g.  $\text{Al}_2\text{O}_3$ ,  $\text{ZrO}_2$  and  $\text{TiO}_2$ ) components using in situ measurements. These ALD nanocomposites have applications in particle detection, energy storage, and solar power. We have performed extensive in situ studies using quartz crystal microbalance (QCM), quadrupole mass spectrometry (QMS), Fourier transform infrared (FTIR) absorption spectroscopy, and current-voltage measurements. These measurements reveal unusual ALD chemistry occurring upon transitioning between the ALD processes for the two components. This results in unique reaction products that affect the properties of the films in beneficial ways. The knowledge gained from our in situ studies of the ALD nanocomposite films has helped us to overcome problems encountered when we scaled up the ALD processes to large area substrates. Beyond fundamental understanding, in situ measurements are extremely effective in ALD process development and process monitoring. I will end my talk by describing our recent work combining in situ measurements and machine learning to accelerate ALD process development.

**BIO:** Jeffrey Elam is an Argonne chemist who founded and directs Argonne's atomic layer deposition (ALD) research program. He leads Argonne National Laboratory's Functional Coatings Group in the Applied Materials division. The group develops coating technologies for a diverse range of applications including energy storage, photodetectors, and water purification. He has won five R&D 100 Awards and holds numerous patents.

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**Via Zoom:**

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