Emma Rocco, SUNY Poly PhD Candidate
Title: Impurity incorporation and diffusion from regrowth interfaces in N-polar photocathodes and the impact on quantum efficiency

Abstract:
III-nitride photocathodes provide single photon detection with low noise and picosecond response times, across a broad spectrum spanning from IR to UV wavelengths. N-polar III-nitride photocathodes have shown experimental and theoretical promise compared to the III-polar orientation. However, the atomic arrangement of the N-polar surface leads to an increased incorporation of oxygen and other impurities. Growth interruption between layers results in degradation of device performance due to the incorporation of unintentional impurities at interfaces and disruption of the intended electrostatic profile. To identify the impact of impurity incorporation and diffusion from regrowth interfaces in N-polar GaN photocathodes, structures consisting of a p-GaN active layer and a thin unintentionally doped (u-GaN) cap layer were grown by metal organic chemical vapor deposition with varied growth interruptions at interfaces. Spikes in oxygen and silicon concentration are observed at all regrowth interfaces, measured by secondary ion mass spectrometry (SIMS). Pipe and bulk diffusion of oxygen impurities is observed from regrowth interfaces when the overgrown layer required higher temperature growth, whereas only bulk diffusion is seen otherwise. The distribution of impurities is observed to have a significant impact on photocathode quantum efficiency (QE). Understanding of impurity incorporation at regrowth interfaces, dominating driving mechanisms behind diffusion of these species, and their impact on material properties are critical elements in designing high performing devices.