# Materials Science & Engineering Dissertation Defense

## Detailed Balance Analysis of Experimental High-Reflectance Back Contacts for Photovoltaics

**School for Engineering of Matter, Transport and Energy**

## Chris Gregory

**Advisor:** Richard King

## Abstract

Highly reflective rear surfaces are critical for reaching the detailed balance efficiency limits of photovoltaics. In addition to being highly reflective, the rear surface and contact of the cell must have low resistance. A traditional approach to balance reflectance and contact resistance has been to use point contact geometries, which are process intensive. This work considers using a transparent conductive oxide and metal mirror, which, due to being two planar layers, can be fabricated much more easily. To study the tradeoff between resistance and absorptance for this contact, the oxide doping concentration is varied. Test structures to measure the doping concentration, contact resistance, and parasitic absorptance were fabricated. Using measured parameters, the performance of high-quality GaAs photonic power converters is modeled. Measurements show that although the contact resistance is comparatively high, it can be controlled through doping in the oxide and semiconductor composition. Furthermore, modeling shows the contact resistance is not prohibitively high for one-sun or lower illumination level devices. The hemispheric reflectance of the experimental oxide/metal back contact is modeled to be 96.7%, which is quite high considering that it is a conductive back contact. Although the oxide/metal contact structure does not perform electrically or optically as well as more complex point contact structures, this work indicates the advantages of the planar transparent conductive oxide/metal contact structure near one-sun equivalent current densities for solar cells and photonic power converters, where it is desirable to avoid the device fabrication costs of back contact patterning.

April 2, 2024; 10:00 AM; ERC 593

Arizona State University