**<u>Announcing the Final Examination of Evan Smith for the Degree of Doctor of Philosophy in Physics</u>**

**Date:** Monday, 10/19/2015
**Time:** 1:00 p.m.
**Room:** Physical Science 160
**Dissertation title:**
VANADIUM OXIDE MICROBOLOMETERS WITH PATTERNED GOLD BLACK OR PLASMONIC RESONANT ABSORBERS

**Abstract:**
High sensitivity uncooled microbolometers are necessary to meet the needs of the next generation of infrared detectors, which seek low power consumption and production cost without sacrificing performance. Presented here is the design, fabrication, and characterization of a microbolometer with responsivity enhanced by novel highly absorptive coatings. The device utilizes a gold-doped vanadium oxide film in a standard air bridge design. Performance estimations are calculated from current theory, and efforts to maximize signal to noise ratio are shown and evaluated. Most notably, presented are the experimental results and analysis from the integration of two different absorptive coatings: a patterned gold black film and a plasmonic resonant structure.

Infrared-absorbing gold black was selectively patterned onto the active surfaces of the detector. Patterning by metal lift-off relies on protection of the fragile gold black with an evaporated oxide, which preserves gold black's near unity absorptance. This patterned gold black also survives the dry-etch removal of the sacrificial polyimide used to fabricate the air-bridge bolometers. Infrared responsivity is improved 70% for mid-wave IR and 22% for long-wave IR. The increase in the thermal time constant caused by the additional mass of gold black is a modest 15%. However, this film is sensitive to thermal processing; experimental results indicate a decrease in absorptance upon device heating.

Sub-wavelength resonant structures designed for long-wave infrared (LWIR) absorption have also been investigated. Dispersion of the dielectric refractive index provides for multiple overlapping resonances that span the 8-12 □m LWIR wavelength band, a broader range than can be achieved using the usual resonance quarter-wave cavity engineered into the air-bridge structures. Experimental measurements show an increase in responsivity of 96% for mid-wave IR and 48% for long-wave IR, while thermal response time only increases by 16% due to the increased heat capacity. The resonant structures are not as susceptible to thermal processing as are the gold black films. This work suggests that plasmonic resonant structures can be an ideal method to improve detector performance for microbolometers.

**Outline of Studies:**
Major: Physics

**Educational Career:**
B.A. Physics, Drew University, 2007
M.S. Physics, University of Central Florida, 2011

**Committee in Charge:**
Dr. Robert Peale (Chair)
Dr. Saiful Khondaker
Dr. Adrienne Dove
Dr. Glenn Boreman (External Committee Member)

Approved for distribution by Dr. Robert Peale, Committee Chair, on October 9, 2015.

The public is welcome to attend.