Received the B.S. and M.S.N.E. degrees in nuclear engineering from Purdue University, West Lafayette, IN, USA, in 2013 and 2016, respectively. He is currently a Pathways Fellow with the Air Force Research Laboratory, Wright-Patterson Air Force Base, Dayton, OH, USA. His current research interests include experimental plasma and electron emission physics.

Agricultural & Biological ENGINEERING

Dissertation Defense

Speaker: **Russell S. Brayfield II**

Title: **ELECTRODE EFFECTS ON ELECTRON EMISSION AND GAS BREAKDOWN FROM NANO TO MICROSCALE**

Major Professor(s): **Allen Garner**

Date: **Friday, July 10, 2020**

Time: **1pm EDT**

Location or link to join: **Webex**

Abstract:

Developments in modern electronics drive device design to small scale and higher electric fields and currents. Device size reductions to microscale and smaller have invalidated the assumption of avalanche formation for the traditional Paschen's law for predicting gas breakdown. Under these conditions, the stronger electric fields induce field emission driven microscale gas breakdown; however, these theories often rely upon semi-empirical models to account for surface effects and the dependence of gas ionization on electric field, making them difficult to use for predicting device behavior *a priori.*

This dissertation hypothesizes that one may predict *a priori* how to tune emission physics and breakdown conditions by altering electrode conditions (sharpness and surface roughness), gap size, and pressure. Specifically, it focuses on experiments demonstrating the implications of surface roughness and emitter shape on gas breakdown for microscale and nanoscale devices at atmospheric pressure and simulations to extend traditional semi-empirical representations of the ionization coefficient to electric fields relevant for these operating conditions.

Application:

This dissertation provides the first comprehensive assessment of the implications of surface roughness on microscale gas breakdown, experimental measurements of the transition in gas breakdown and electron emission mechanisms at nanoscale, and extension of semi-empirical laws for ionization coefficient. These results will be valuable in developing theories for predicting emission and breakdown to guide nanoscale device design.