

## **Opportunities in Cathode Research Enabled by Advanced Nanoscale Material Control and Understanding**

Cathode research is very challenging due to the complexity of the electron emission process. In particular, cathode performance is extremely sensitive to atomic-scale surface and bulk properties that determine the emission barrier and electron supply at the surface. At the same time, the emission mechanisms used to liberate electrons from the cathode place extreme demands on the material which can become modified or damaged under sustained operation. It is critical, therefore, to understand how the surface and bulk properties change under practical operating conditions in order to control and optimize the cathode performance.

While previous advances in cathode technology were realized through extensive characterization and modeling efforts, cathode development has remained somewhat stagnant in recent years due, in part, to the limited capabilities of established fabrication and characterization techniques. However, recent advances in materials growth and processing technology provide an important opportunity for cathode researchers to better control and tailor the nano/micro-scale structure and composition of emitter materials. Equally important, advanced characterization and analysis techniques are now able to probe the material properties on a nanoscale level, thereby providing critical insight into the cathode/emission dynamics.

In this talk, I will highlight several examples of cathode technology that demonstrate the importance of nanoscale control of the material and device properties and that represent significant opportunities for vacuum electronic device technology.