

# Plasma Physics Seminar

Location: BaPSF Auditorium (Rehab Building Room 15-70)

Tuesday, March 12, 2019

11:00AM

## Introduction to Thermionic Energy Conversion

**Eric S. Clark** (Modern Electron)

Modern Electron is a startup based in the greater Seattle area that is researching thermionic energy conversion in an effort to bring this technology to the mass market. It is a promising energy conversion technique that does not require large moving parts (e.g. boilers and turbines) and can convert heat directly into electricity with efficiencies greater than that of thermoelectric devices and accept much higher temperatures than traditional energy generation techniques. The basic principle is that a hot cathode is heated up such that it emits electrons into a vacuum or vapor filled cavity that can be collected upon another electrode. Depending on the work functions of the electrodes useful work can be done by the electrons collected by the anode as they pass through a load while returning to the cathode. One of the primary reasons this technology is not widespread is that typically the current traversing the gap between the anode and cathode obey the Child-Langmuir law, which characterized the space charge limited current that can be extracted from a hot cathode. This space charge limitation seriously impacts the current that can be extracted via thermionic and field emission from a cathode. One way to mitigate space charge is via electron beam optics using multiple biased electrodes, and the other is by using a plasma that is ignited within the gap of the converter to supply ions that mitigate the space charge and allow the current to flow. This talk will discuss possible applications of this technology in the near term as well as recent progress in research done at Modern Electron to mitigate space charge effectively using electron optics. Particle-in-Cell simulations of electron optical devices will be presented, as well calculations of plasma thermionic converters. Electron effects while interacting with low work function electrodes will also be discussed. Thermionic energy conversion scales down well and is an exciting technology that can be used for home scale combined heat and power cogeneration, where other technologies have failed to gain widespread acceptance due to maintenance requirements and system cost.