Characterization of Temperature-dependent Radiative Properties of Narrow-Bandgap Semiconductor Selective Emitters with High-Temperature Fourier-Transform Spectrometry

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Understanding the thermal emission from different materials is crucial to many important applications, among which thermophotovoltaic (TPV) desires spectrally selective emitters to achieve high conversion efficiency by minimizing the sub-bandgap photons. While previous studies have been focused on micro/nanostructure based metamaterial selective emitters made of refractory oxides or metals, a few percents of sub-bandgap emissivity still reduce the TPV efficiency significantly. On the other hand, intrinsic semiconductors, which have nearly zero emission below the bandgap except for weak optical phonon absorption in the mid-infrared, could be a promising selective emitter to improve TPV performance. This work will experimentally study the temperature-dependent radiative properties of narrow-bandgap undoped semiconductors such as Ge and InAs to understand the temperature effect on optical constants and energy bandgap. A home-built Fourier-transform spectrometry platform will be used to measure spectral reflectance and transmittance from visible to mid-infrared regime by heating the semiconductors up to 800 K inside a vacuum cryostat optically coupled with the spectrometer. The spectral-normal emissivity of the semiconductors will be measured by a home-built high-temperature emissometer with a vacuum heating chamber from 600 K to 1100 K. Optical modeling will also be performed to design high-efficiency TPV emitters based on narrow-bandgap semiconductors.