EXPERIMENTAL INVESTIGATION OF NEAR-FIELD RADIATIVE HEAT TRANSFER

Taehoon Kim (Keunhan Park, PhD)
Department of Mechanical Engineering

The total energy consumption of the United States is about 24% of the world's energy whereas the U.S. only constitutes 5% of the world's population. The amount of energy that the U.S. consumes for one year is almost 100×10^{15} BTU which is equivalent to 29.3×10^{15} Wh. However, about 20 to 50 % of the total energy is rejected as waste heat according to the U.S. Department of Energy.

This research is focused on waste heat recovery by direct conversion of heat to electricity using Near-Field Thermophotovoltaic (NTPV) power generation systems. This method is fundamentally very similar to the well-known photovoltaics (PV) where the solar radiation is converted into electricity using PV panels. However, in this new concept, sun is replaced with a high temperature source (thermal emitter) in order to observe nanoscale thermal radiation.

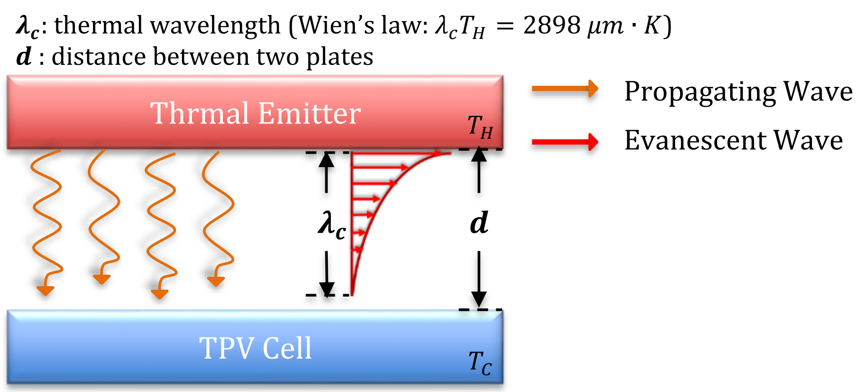

Figure 1. *Far-Field and Near-Field Radiation*

One key to maximize the thermal radiation between the thermal emitter and TPV cell (*Fig. 1*) is to minimize the gap distance between them. If the gap ($\boldsymbol{d}$) is smaller than the thermal wavelength ($\boldsymbol{\lambda_c}$), we will see the contribution of evanescent waves in addition to propagating waves in radiative heat transfer between the two plates. This will result in a drastically high heat transfer rate because the contribution of evanescent waves increases as the gap decreases.

The goal of this research is to develop an experimental setup and technique to achieve a sub-wavelength gap distance between large parallel plates with high temperature gradient. In order to accomplish the goal, the proper experimental investigation had to be prepared which includes preparing samples and achieving sub-wavelength gap between two samples using a nano-scale positioning system while maintaining high temperature gradient.