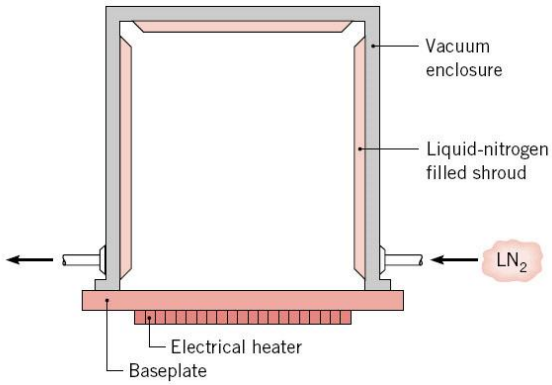
MEAM 333: Heat and Mass Transfer
Assignment 3
Due Date: 1/26/2012

Homework Guidelines:

- All papers must be stapled (No dog eared pages!).
- Solutions must proceed in a step-by-step fashion so that it is easy for the grader to follow and the method is well explained.
- Handwriting should be neat and presentation should be professional.
- Final answers for each part should be boxed or double underlined.
- Failure to do the above will result in point deductions.

Problem 1 [Solution]:

A vacuum sputtering system used to deposit thin metal films on microelectronic chips is comprised of a baseplate maintained by an electrical heater at 300 K and a shroud within the enclosure maintained at 77 K by a liquid nitrogen coolant loop. The circular baseplate, insulated on the lower side, is 0.3 m in diameter and has an emissivity of 0.25. How much electrical power must be provided to the baseplate heater to maintain these conditions?



Problem 2 [Solution]:

A potato is being cooked in an oven (conventional oven, not microwave). It is surrounded by high temperature walls at temperature T_w that emit radiant energy and also by hot air at T_∞. The potato sits on a metal oven rack but assume for the purposes of this problem that it is 'suspended' inside the oven (i.e. completely surrounded by air and not sitting on anything).

a. Write an expression for the rate of energy storage $\dot{E}_{stored}$ in the potato as a function of potato temperature T, potato volume V, density and specific heat. Assume that the entire volume of the potato is at the same temperature ('lumped' assumption).
b. Write an expression for the rate of volumetric energy generation inside the potato $\dot{E}_g$.
c. Write an expression (in terms of emissivity ε, potato surface area A_s, and air heat transfer coefficient h) for the *net* rate of energy flow into the potato $\dot{E}_{in} - \dot{E}_{out}$, assuming that the walls and the air are both hotter than the potato.
d. Write a differential equation that describes the time-dependent temperature of the potato
e. How is $\dot{E}_g$ (part b) different from the $\dot{E}_g$ for the microwave oven example discussed in class?