MAE 3314: Heat Transfer
Design Assignment #1 Cooling Solution for a Computer Chip
(Due 11:59 pm 10/16/2023 via Canvas) This is a **Key Assignment**. Passing Score: 70/100

You are a thermal engineer designing cooling solutions for computer chips. A typical cooling solution of chip packaging is shown in Figure 1a. In a simplified model, a heat sink (fins) is attached on a CPU chip as shown in Figure 1b. All surfaces of the system are convectively cooled. The dimension of CPU chip is 35.5 mm x 35.5 mm x 4 mm. Each heat sink fin has dimension of 1.5 mm x 1.5 m x 6.4 mm and total 121 fins (11 x 11 fins) are placed. The chip is silicon (Si) and the heat sink is aluminum (Al). Under steady operation, electric power dissipation in the CPU provides for uniform volumetric heating at rate of $\dot{q} = 5.0 \times 10^6$ W/m^3. Currently, the air convection is set with h = 50 W/m^2·K and T_∞ = 40 ºC. The bottom surface of the chip is thermally insulated. For the circuitry within the chip to survive, the chip temperature should not rise above 85 ºC.

(a) Create a CPU/Heat sink model in ANSYS (See Figure 1(b) &(c)).
(b) Apply proper material properties, thermal parameters, and boundary conditions to the model.
(c) Run the ANSYS model to find the steady-state temperature distribution in the system. Plot the temperature distribution:
    (i) 3-D color map for both the chip and the heat sink
    (ii) T-x plot for the temperature within the chip only. Find the maximum temperature within the chip and see if this temperature is within the safe range (< 85 ºC).
(d) Using the ANSYS model, check the effects of various thermal parameters on the temperature distribution in the chip. Write a brief report of your observations on temperature distribution when you vary following parameters:

Parametric study for **part (d)**
1) Increasing (and decreasing) the convection coefficient h of air
2) Increasing (and decreasing) air temperature T_∞
3) Increasing (and decreasing) the chip power generation density ($\dot{q}$)
4) Changing the heat sink materials (e.g., copper, silicon, and stainless steel).
5) [Optional] Changing the mesh sizes.

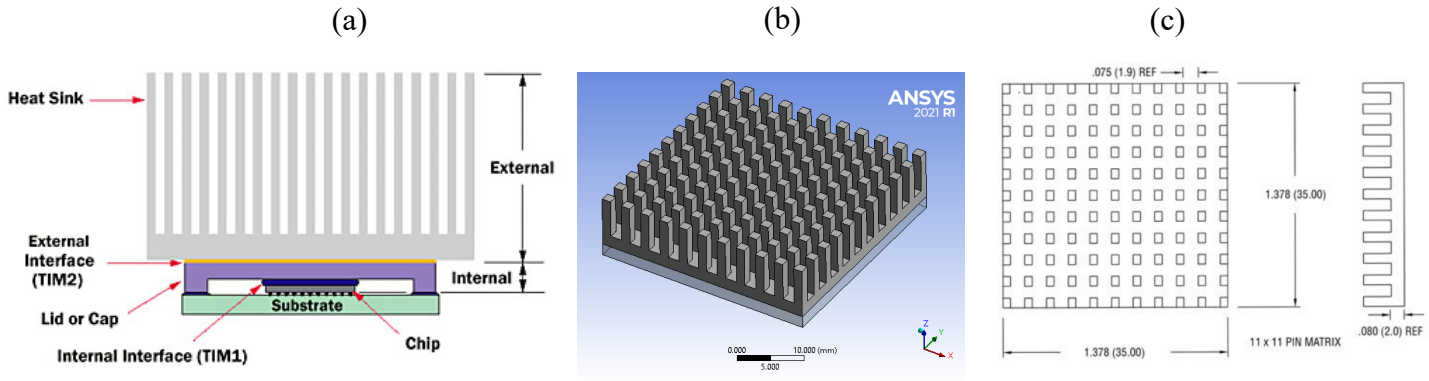
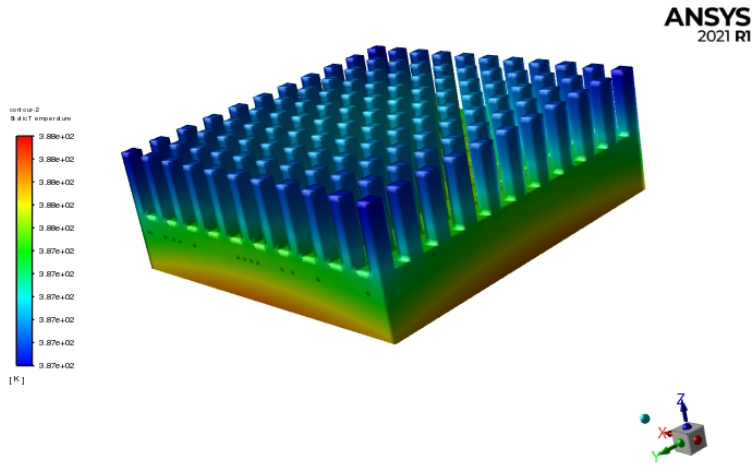
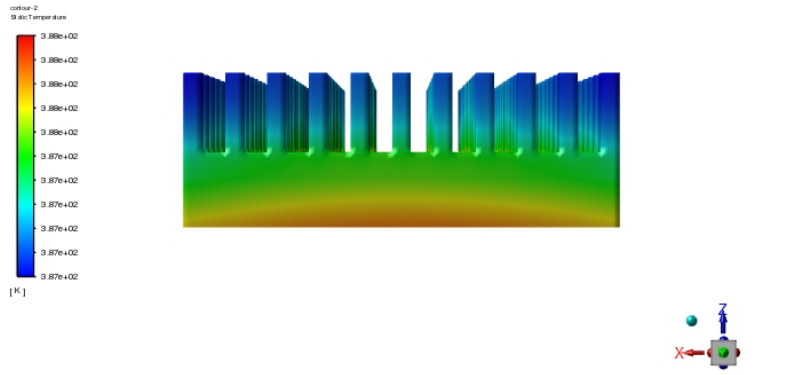


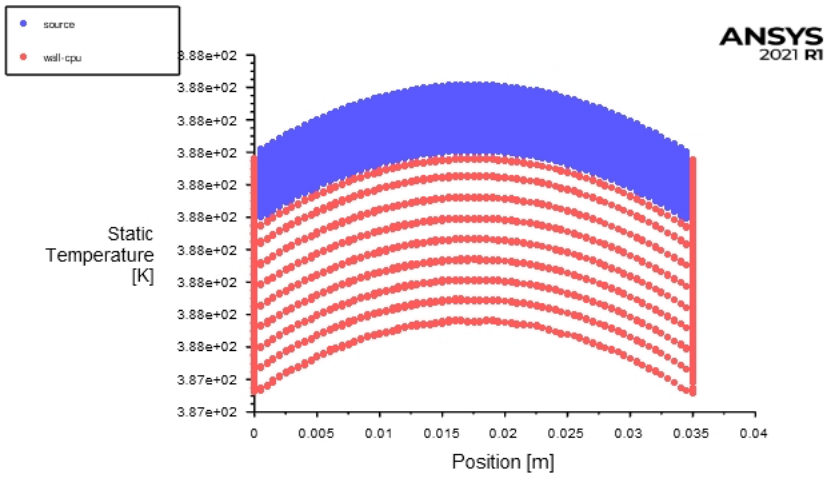
Figure 1. (a) A typical computer chip packaging with cooling solutions, (b) a simplified model, and (c) the dimension of the heat sink.

Hyejin Moon (Hyejin.moon@uta.edu)

Example results







Hyejin Moon (Hyejin.moon@uta.edu)