Exercise 17 - Multiphysics 1

In this exercise, the potential and the temperature distribution along a cylindrical cable will be investigated. The cable is made of a 1 m long cylinder of copper ($\sigma = 59.6\ \frac{MS}{m}$), has a cross section of 0.01 m. Its both ends are connected to a DC generator resulting in a electrical potential difference of 0.1 V between them. The cable stays in room temperature which results in a initial temperature value of 20 °C. Furthermore there are no heat dissipation from the lateral surface of the cable and both connecting areas are at constant temperature $T_0 = 20$ °C.

a) Solve the electrical part only by Comsol.

b) Solve the heat conduction part only by Comsol.

c) The copper conductivity is temperature dependent and defined as follows:

$$\sigma = \sigma_0 \left[1 + \alpha(T - T_0)\right],$$

where $\alpha = 0.0039 \frac{1}{K}$ denotes the thermal conduction constant, $T_0 = 293.15$ K describes the reference temperature and $\sigma_0 = 59.98\ \frac{MS}{m}$ represents the reference conductivity. Use Comsol's Electro-thermal interaction module to solve this Joule heating problem. What is different if you compare the result obtained here with the results from parts a) and b) ?

Note: The output of the heat equation (temperature distribution) will be used to update the (conductivity) Maxwell's equation and the output of the Maxwell's equation (current density) will be used as an input to the heat equation (heat source).

Exercise 18 - Multiphysics 2

A MEMS cantilever with a thickness of $20\mu m$. as shown in Fig.1 is to be simulated. The potential difference between the cantilever and the substrate under it is given by V_i. The specifications of poly-silica are: relative permittivity (4.5), Young's modulus $153e9$, Poisson's ratio 0.23, thermal expansion coefficient $4.15e-6$ and the density 2330.

a) Solve the problem by Comsol. Clearly determine the equations to be used together with the boundary conditions.

b) Plot the displacement of the tip of the cantilever as a function of applied voltage.

c) At which potential value does the tip touch the substrate.

d) Can you find an exact value for part c)? Why?

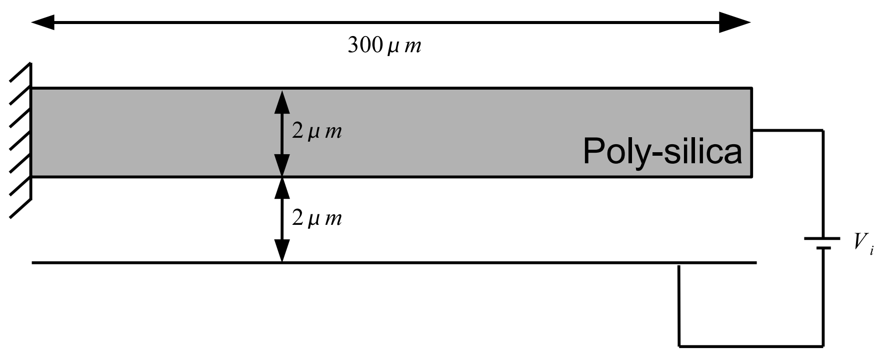

Figure 1: The Cantilever Beam.