

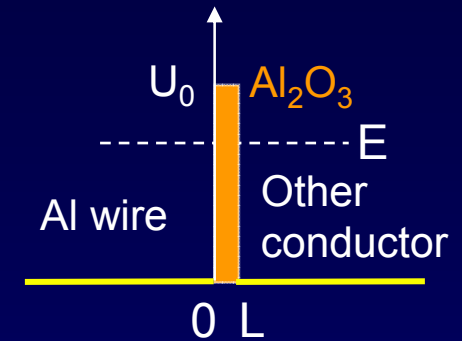
# Solution

Why household electrical wire is not aluminum:

Aluminum is cheap and a good conductor. However, aluminum tends to form an oxide surface layer ( $\text{Al}_2\text{O}_3$ ) which can be as much as **several nanometers thick**.

This layer could cause a problem in making electrical contacts, since it presents a barrier roughly **10 eV high** to the flow of electrons in and out of the Al.

Your requirement is that your transmission coefficient across any contact must be  $T > 10^{-10}$ , or else the resistance will be too high for the high currents you're using, causing a fire risk. Should you use aluminum wiring or not? (You can neglect  $G$  here.)



Compute the maximum  $L$ :

$$T \approx e^{-2KL} = 10^{-10}$$

$$L \approx -\frac{1}{2K} \ln(10^{-10}) \approx 0.72 \text{ nm}$$

$$K = 2\pi \sqrt{\frac{10\text{eV}}{1.505\text{eV}\cdot\text{nm}^2}} \approx 16\text{nm}^{-1}$$

Oxide is thicker than this, so go with copper!  
Al wiring in houses is illegal for this reason.