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Resistivity $\rho$ of select materials

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<th>Classification</th>
<th>Resistivity ((\Omega\cdot\text{cm}))</th>
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<tr>
<td>Silver</td>
<td>Conductor</td>
<td>$1.63 \times 10^{-6}$</td>
</tr>
<tr>
<td>Copper</td>
<td>Conductor</td>
<td>$1.72 \times 10^{-6}$</td>
</tr>
<tr>
<td>Aluminum</td>
<td>Conductor</td>
<td>$2.83 \times 10^{-6}$</td>
</tr>
<tr>
<td>Nickel</td>
<td>Conductor</td>
<td>$6.9 \times 10^{-6}$</td>
</tr>
<tr>
<td>Platinum</td>
<td>Conductor</td>
<td>$9.8 \times 10^{-6}$</td>
</tr>
<tr>
<td>Silicon</td>
<td>Semiconductor</td>
<td>$1.56 \times 10^{5}$</td>
</tr>
<tr>
<td>Aluminum oxide</td>
<td>Insulator</td>
<td>$1 \times 10^{15}$</td>
</tr>
<tr>
<td>Silicon oxide</td>
<td>Insulator</td>
<td>$1 \times 10^{14}$</td>
</tr>
<tr>
<td>Epoxy</td>
<td>Insulator</td>
<td>$1 \times 10^{15}$</td>
</tr>
<tr>
<td>Polyethylene</td>
<td>Insulator</td>
<td>$1 \times 10^{18}$</td>
</tr>
</tbody>
</table>

A PCB is given by:

$$R = \rho L / A \quad (2.1)$$

where $L$ is the length of the conductor (cm)

$A$ is the cross section area (cm$^2$)

$\rho$ is the resistivity (\(\Omega\cdot\text{cm}\))

The resistivity $\rho$ depends on the atomic structure of the element and if there are a large number of loosely bound electrons in the outer shell, the resistivity is low as indicated in Table 2.1. It is evident from the results shown here that the resistivity of different types of materials can vary over a very wide range. For metal conductors $\rho$ is of order $10^{-6}$ \(\Omega\cdot\text{cm}\) but for insulators $\rho$ is of order $10^{12}$ \(\Omega\cdot\text{cm}\) or higher.

The atomic structure of insulating materials clearly shows the reason for the large values of $\rho$. Consider the atomic structure of SiO$_2$ shown in Fig. 2.2. Silicon has a full K shell, a full L shell and four electrons in the outer M shell. Oxygen has a full K shell and six of eight electrons necessary to fill the L shell. The