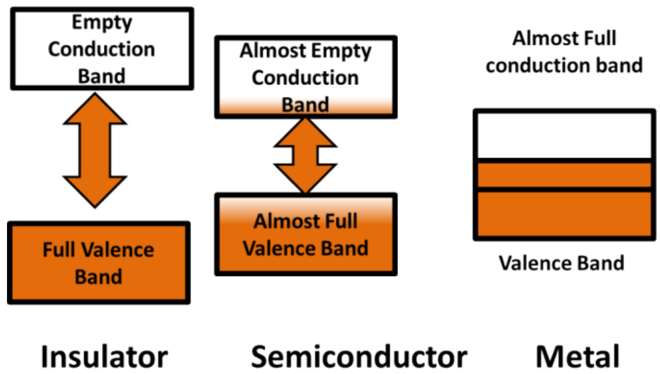
WHAT IS AN ELECTRICAL RESISTANCE?

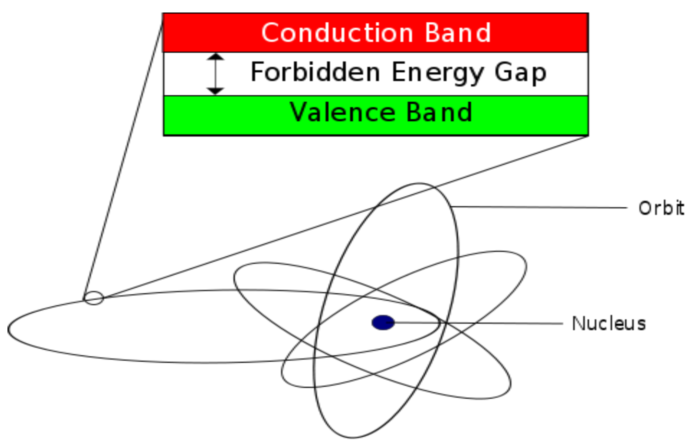
The electrical resistance is the measurement of the property of bodies to oppose to the passage of electric current.

As described above, the behavior of the material upon energy is directly related to its density, structure, elements of composition, and volume. The field interactions of an atom are directly related to the amount of energy that such atom can hold, limited by a fixed energy level.

When these energy fields are close together, they are called “energy band”, the most important are the “valence band” and the “conduction band” (usually the valence band is below the conduction band). Electrons move freely in the conduction band where material when an electric field affects the material.

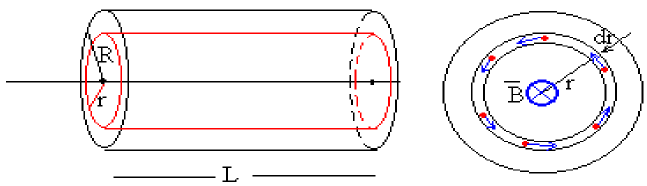


In materials as insulators and semiconductors there is an "energy band gap" between the "valence band" and the "conduction band" that electrons cannot occupy if they have enough energy to jump from the valence band to the conduction band.



This "forbidden energy gap", influenced by the electric field of the particles and by the vibrations caused by the heat therein, is the feature that gives the "resistivity" to the atom, if this band is greater, the greater the resistance of the atom to a passing electric current.

The resistance of a macroscopic material also depends on its geometry. If it is too long, it will require a greater number of collisions for transport the electricity current, creating more resistance, and if it is too thin, there will be less available to transport electrons energy, creating more resistance.

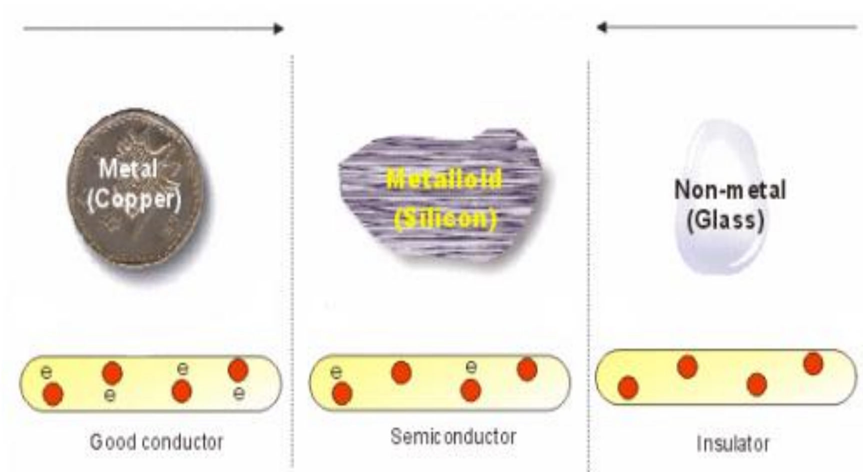


The unit of resistance can be measured mathematically, using the "ohm", which is defined as the resistance which opposes the passage of electrons.

The resistance dissipates the energy in a "phonon" generating heat.

Electricity is conducted in some materials better than others and in some physical conditions better than others.

According to its resistance, materials are classified as conductors (with little opposition to the exchange of electrons), insulators (which not allow the passage of electrons), semiconductors (which under certain conditions are conductive, and under certain conditions act as insulators).



The best electrical conductors are mostly metals like silver (15.9 ohm), copper (17.1), gold (22.1 ohm), aluminum (26.5 ohm), beryllium (highly toxic and expensive), tungsten (52.8 ohm) and zinc (59 ohm) and non-metals such as calcium (which is not very used in the industry due to its high reactivity with oxygen and water).

Material	ρ (Ω•m) at 20 °C	σ (S/m) at 20 °C
Silver	1.59×10−8	6.30×107
Copper	1.68×10−8	5.96×107
Annealed copper	1.72×10−8	5.80×107
Gold	2.44×10−8	4.10×107
Aluminium	2.82×10−8	3.5×107
Calcium	3.36×10−8	2.98×107
Carbon (diamond)	1×1012	~10−13
Germanium	4.6×10−1	2.17
Sea water	2×10−1	4.8
Silicon	6.40×102	1.56×10−3
Wood(oven dry)	1×1014 to 16	10−16 to -14
Sulfur	1×1015	10−16
Air	1.3×1016 to 3.3×1016	3×10−15 to 8×10−15
Paraffin wax	1×1017	10−18
Fused quartz	7.5×1017	1.3×10−18
PET	10×1020	10−21
Teflon	10×1022 to 10×1024	10−25 to 10−23

The best electrical insulators are Teflon, PET, quartz, paraffin, air, sulfur, rubber, diamond shaped carbon, glass and water without ions.

Semiconductors could be constituted of seawater, silicone or gallium and arsenic compounds. Generally the resistivity of semiconductors decreases with increasing temperature, since the electrons gain access to the conduction band due to thermal energy.

As the conductor temperature drops, the resistance decreases. In a superconductor, the resistance drops abruptly to zero when the material is cooled below its critical temperature.

Source: http://www.artinaid.com/2013/04/what-is-an-electrical-resistance/