MetalTek INTERNATIONAL
BECAUSE YOU DEMAND MORE THAN METAL

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Tek Bulletin

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Metals Tidbits:

- **Tungsten has a very high melting point, after carbon it has the second highest melting point of all elements.**
- **In the U.S, a five cent coin is called a "nickel" despite being 75% copper and only 25% nickel.**
- **Over 81,000 kgs (179,000 lbs) of copper was used to build The Statue of Liberty.**
- **Magnesium is the 11th most common element in the human body with around 60% found in the skeleton and 39% found in the muscle cells.**

Have a Metals Problem?
Call Us 1-262-544-7777
www.MetalTek.com

Conductivity in Metals

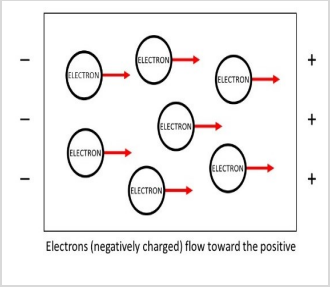
For a long while, parents can explain to their children that certain things just happen. Eventually, that answer is not good enough and the "Why?" question must also be fielded. So a simple statement that certain metals are more inclined or resistant to conducting heat or electricity than others will not long suffice. A short discussion as to why those materials offer varying ability to conduct heat or electricity provides another interesting glimpse into how metals work.

In our last TekBulletin issue, we went to the molecular level to discuss why certain metals inherently offer greater resistance to wear. This time, as we discuss conductivity, we will go smaller yet.

So what is conductivity? Conductivity is a measure of a material's ability to transmit heat, or electricity (or sound). The reciprocal of conductivity is resistance, or the ability to reduce the flow of those.

An understanding of a material's tendency to conduct may be a critical factor in the selection of that material for a given application. Clearly, some materials are chosen because they readily conduct electricity (as wire, for example) or heat (like fins or tubes in a radiator or heat exchanger). For other applications (like insulation), materials are selected because they specifically do not conduct very well.

Metals conduct electricity by allowing free electrons to move between the atoms. These electrons are not associated with a single atom or covalent bond. Since like charges repel each other, the movement of one free electron within the lattice dislodges those in the next atom, and the process repeats – moving in the direction of the current, toward the positively charged end.



Electrons (negatively charged) flow toward the positive

Pure metals will tend to provide the best conductivity. In most metals, the existence of impurities restricts the flow of electrons. Compared to pure metals, then, elements which are added as alloying agents could be considered "impurities". So alloys tend to offer less electrical conductivity than pure metal. If different properties provided by alloying are required (for additional hardness or strength, for example) it is important to choose the alloy additions that do not significantly affect conductivity if that is also important.

Thermal conductivity is similar to electrical in that exciting atoms in one section works to excite and vibrate adjacent atoms. That motion or kinetic energy – not unlike rubbing your hands together to get warm – allows heat to move through the metal. Alloys, which are a combination of different metallic elements, tend to offer a lower level of thermal conductivity than pure metals. Atoms of different size or atomic weight will vibrate at a different rate, which changes the pattern of thermal conductivity. If there is less energy transfer between atoms, there is less conductivity.

Pure silver and copper provide the highest thermal conductivity, with aluminum less so. Stainless steels provide low thermal conductivity. Some materials, including copper, will readily conduct both heat and electricity. While others, like glass, conduct heat but not electricity.

As we have noted before, the selection of the metal for any application probably involves tradeoffs. For example, consider the choice of metal in cookware. While aluminum is a decent conductor of heat, copper conducts better and would provide quicker and more even cooking performance - if you are looking for that quick meal. But copper is much more expensive. That is why all but the highest end cookware is made of aluminum, or aluminum with a coating or cladding (aluminum is reactive to salty and acidic foods), and not the more expensive copper. Copper with a stainless steel cladding would be yet another choice.

As with most of these applications, your neighborhood metallurgist can help make a cost-effective decision on alloy selection – for conductivity or almost any other desired performance.