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Technical Tidbits

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Go for the gold! This issue of Technical Tidbits is an overview on the use of gold as a electrical contact material.

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The next issue of Technical Tidbits will discuss the platinum group metals.

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Gold as a Contact Material

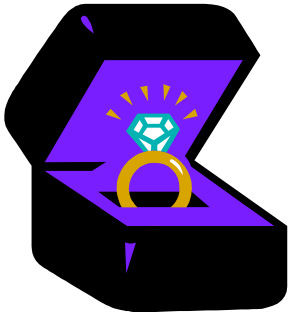
In the early nineteenth century, many prospectors journeyed to California, drawn by the prospect of finding gold, although few ever did. The early conquistadors searched vainly in Mexico and Central America for the mythical city of gold, El Dorado. The athletes who finish first in their competitions at the Olympic games receive gold medals. Governments around the world keep tons of gold bullion locked up in vaults. Many independently evolved cultures around the world view gold as a precious material. For ages, the pursuit of gold has sparked wars, changed history, and made otherwise reasonable people act silly. This prompts the question, why is there all this interest in gold?

Perhaps the main reason for the value of gold is its unparalleled corrosion resistance. It does not readily form oxides, sulfides, chlorides, or any other corrosion product that plagues most metals. This explains its widespread use in jewelry. (Human skin creates an assortment of corrosive agents found only in metallurgists' worst nightmares.)

Gold also has other advantages which make it an ideal material for electrical interfaces. It has excellent electrical and thermal conductivity, helping to ensure low contact resistance. Due to its softness, it requires very little normal force to make good electrical contact. (This becomes important in this age of connector miniaturization, since smaller contacts produce lower forces.) Its resistance to corrosion ensures that the electrical resistance of the contact interface will be stable for long periods of time. Given all of its favorable properties, one would think that gold would be used for every electrical contact. The most important reason for why it is not used in every connector application is the fact that it is very expensive.

Gold is classified as being either hard or soft. **Soft gold** is a high purity coating, ranging in hardness from approximately 20 to 90 KHN. It has an electrical conductivity of around 75% IACS. However, it is not a durable coating, and may have a tendency to wear off. For this reason, the normal force in soft gold plated contacts is best kept low, although a minimum of 25-35 grams is required.

Hard gold has a small amount of nickel or cobalt (usually up to 5%) added as a hardening agent. It is more durable and wear resistant than soft gold. It requires around 50





grams minimum contact force. However, the cobalt or nickel hardening agent may make the coating susceptible to oxidation.

Gold is usually used in low current, low voltage connectors that are not susceptible to arcing. It does not solder as well as most other plating materials. This is usually not a problem, since gold is usually not used as an overall plating.

Some other problems associated with gold have less to do with is properties than with how it is applied. Since it is usually applied in very thin layers, porosity in the gold can lead to creep corrosion. However, this is not a significant problem when there is a sufficient undercoat of nickel.

Due to its high price, gold is sometimes applied as a **flash** coating. This is a very thin layer on top of some less expensive, less noble coating. In this case, the gold is little more than an anti-oxidation layer. This very effectively enhances the corrosion resistance of the coating system. However, flash coatings are very susceptible to wear.

Another alternative to a gold flash is a gold **diffusion**. Here, a thin layer of gold is applied on top of another coating alloy. The component is then heated for a short time, which allows the gold to diffuse down into the surface of the undercoating below, enhancing its corrosion resistance and conductivity. At the same time, the outer gold surface becomes much less susceptible to wear. A gold diffusion into the surface is more mechanically stable than a gold flash.

Gold is most economical when it is **spot plated** (applied only to the areas of the connector that make electrical contact). An overall nickel underplate will provide most of the necessary corrosion resistance, and will prevent creep of corrosion products across the gold deposits. This way, no money is wasted by applying a very expensive metal to places where it is not needed. Spot plating works best through reel-reel electroplating of flat blanks. Any severe bending or forming must be done after the final plating, so the formability of the base metal and the undercoating become critical here.

In short, if gold were less expensive, it would be an almost ubiquitous coating material. It provides unparalleled corrosion resistance. It has very high conductivity, and does not require large normal forces in order to maintain electrical contact. It has very few drawbacks, and there are few situations where it absolutely cannot be used. Nonetheless, its price limits its use to applications that require the best electrical performance.

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