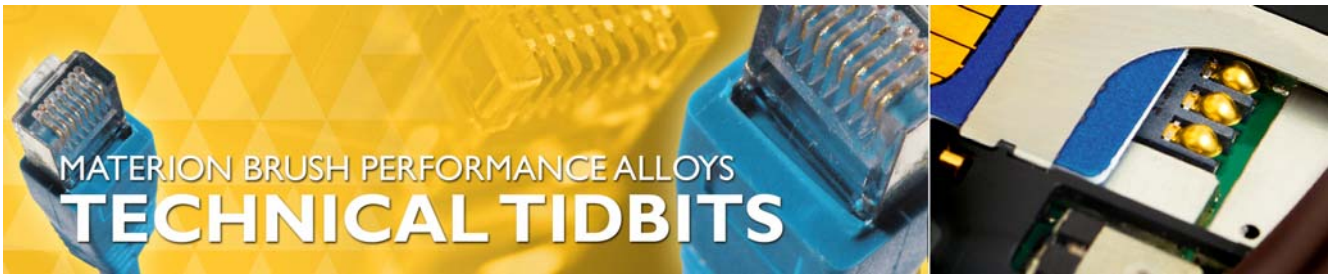

Issue No. 28 – April 2011 **Updated from Original October 2001 Publication**

Material Property Directionality

Going my way? – A discussion on ensuring that your spring contacts are properly oriented.

- **Transverse & Longitudinal Directions**
- **Directionality**
- **Anisotropy**
- **Prototype Orientation**

The next issue of Technical Tidbits will discuss the advantages and disadvantages of using strip vs. rod material.

Spring contacts for electronic connectors are usually stamped out of copper alloy strip. One of the most important decisions for the tool designer is how to lay out the part on the strip, knowing that the transverse and longitudinal formability of strip materials are typically different. Usually, contacts are stamped so that the main spring beam is laid out in the transverse direction. (See Figure 1.) This is why transverse, or bad way, formability is so important to the design process. Still, one must keep in mind that properties other than formability may vary with direction. Tensile properties may vary as well, and can show substantial difference between the longitudinal and transverse directions. This is a critical point, since most material certifications show only the longitudinal tensile properties.

For narrow width strip, it is impossible to create tensile samples long enough to measure the properties in the **transverse** direction. This is why the material's **longitudinal** properties are often specified on material certifications. However, one should never assume that the tensile properties are the same in both directions. Most strip material is manufactured in wide widths and is then slit to narrow widths per customer specification. Therefore, the copper alloy manufacturers should be able to perform transverse direction tensile tests if requested.

One might ask the question, "What other properties are affected by the orientation of the material?" The answer includes elastic modulus, elastic limit, yield strength, tensile strength, elongation, fatigue strength, and stress relaxation resistance. Once again, it is the amount of cold work in the finished product that influences the degree of **directionality,** also known as **anisotropy**. Heavy cold working imparts greater directionality than light cold working. Unfortunately, there is no equation that relates the ratio of L and T properties to the amount of cold work, or even to the formability ratios. It will vary depending on the individual alloy and temper.

Yield and fatigue strengths are often greater in the transverse direction than in the longitudinal direction, but this does not apply to all copper alloys. There are many alloys where the reverse is true, and others that show no directionality. Very little published data is available on transverse properties, so it is impossible to make any generalized statements. It is always good practice to ask the material supplier directly to provide information on the effect of orientation on tensile properties. This will help to avoid unexpected failures, when all design work indicates that the contacts should function properly. If the contacts will be used in situations where stress relaxation and fatigue are concerns, it is vital to obtain this information from the material supplier as well.

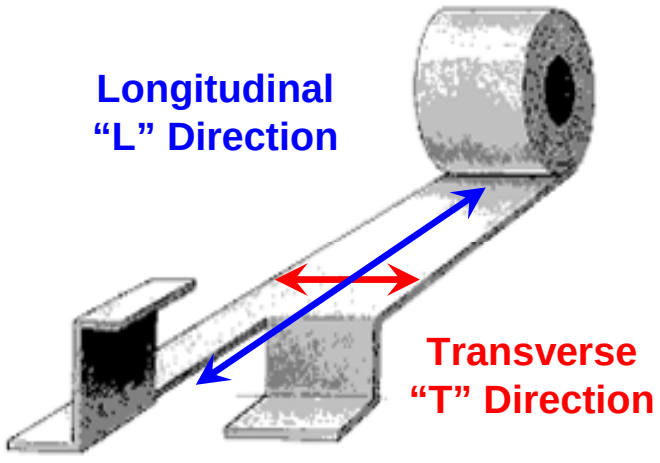

Figure 1. Longitudinal and Transverse Directions in Strip Material

Material Property Directionality (continued)

As an example, let us assume that there is an existing contact which performs perfectly in service. This contact is stamped from strip with its main spring beam oriented in the longitudinal direction. The tool designer correctly notices that there would be much less stamping scrap if the part were oriented in the transverse direction. In an effort to more efficiently manufacture the contact, the tooling is changed to stamp the part with a transverse orientation. Now let us suppose that the elastic modulus of the strip material is 20% higher in the transverse direction than the longitudinal direction, and that the yield strength is 3% higher. This creates a situation where the contact will experience 20% more stress, but it will only have 3% additional strength. If the initial design was close to an overstress condition, then the new part will certainly be overstressed. This could also result in increased stress relaxation as well, especially if material has greater potential for stress relaxation in this direction.

Prototypes are often made from etching flat pieces of strip, and are then formed by hand into the desired shape. When this happens, it is easy to lose track of the rolling direction of the strip sample. It is entirely possible that prototypes will be made with one orientation, and the production parts will be stamped in the perpendicular orientation. This would easily make possible a situation where the prototype parts work flawlessly, while the production parts fail in service. It is critical to keep track of the **orientation** of the parts, even in the **prototyping** phase.

We have seen that there can be considerable difference in strip material properties between the longitudinal and transverse directions. What about other orientations? One might expect that the properties in a 45 degree orientation would be approximately midway between the L and T properties. However, this would be wrong. Usually, formability and strength in this direction is worse than either the L or the T direction. Use extreme caution if designing a part in the 45 degree orientation, especially in a heavily cold worked material.

On the plus side, not every material shows directionality. Alloys hardened by thermal strengthening mechanisms like copper beryllium show very little directionality, particularly after heat treatment. Lightly cold worked tempers such as annealed or 1/4 hard show very little, if any directionality in almost all alloy systems. However, any spring hard, extra spring hard, or similar heavily cold-worked tempers can be expected to show significant directionality. Be certain to specify the strip orientation on any dimensioned drawings of designs, and be sure to obtain the transverse direction properties from the supplier to ensure that the part will work if oriented in that direction.

Written by Mike Gedeon of Brush Performance Alloys Customer Technical Service Department. Mr. Gedeon's primary focus is on electronic strip for the telecommunications and computer markets with emphasis on Finite Element Analysis (FEA) and material selection.

TECHNICAL TIDBITS

Brush Performance Alloys
6070 Parkland Blvd.
Mayfield Heights, OH 44124
(216) 486-4200
(216) 383-4005 Fax
(800) 375-4205 Technical Service

MATERION

Please contact your local sales representative for further information on directionality or other questions pertaining to Brush Performance Alloys or our products.

Health and Safety

Handling copper beryllium in solid form poses no special health risk. Like many industrial materials, beryllium-containing materials may pose a health risk if recommended safe handling practices are not followed. Inhalation of airborne beryllium may cause a serious lung disorder in susceptible individuals. The Occupational Safety and Health Administration (OSHA) has set mandatory limits on occupational respiratory exposures. Read and follow the guidance in the Material Safety Data Sheet (MSDS) before working with this material. For additional information on safe handling practices or technical data on copper beryllium, contact Brush Performance Alloys.