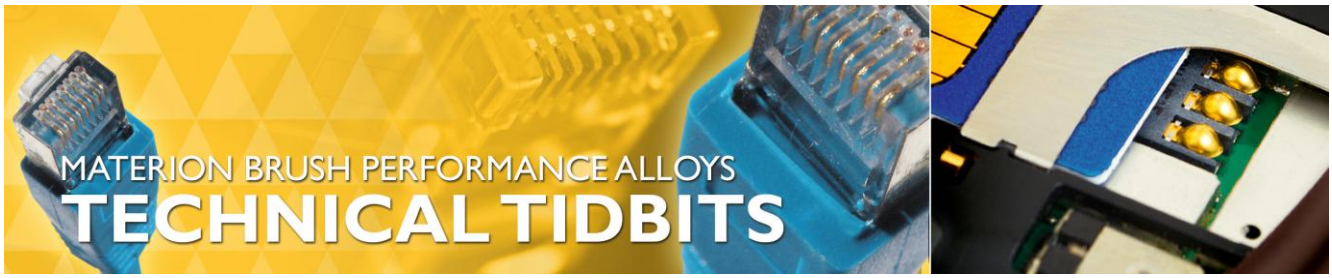

Issue No. 61 – January 2014 **New Publication**

Change is the only constant – Continuation of the discussion on how to modify the calculated fatigue strength value to account for real-world conditions.

- **Anisotropy**
- **Stress Life**
- **Strain Life**
- **Fracture Mechanics**

The next issue of Technical Tidbits will discuss more complicated loading scenarios

Other Variables Affecting Fatigue Perfomance

(This issue of Technical Tidbits continues the materials science refresher series on basic concepts of material properties.) Last month's edition of Technical Tidbits discussed how to modify the fatigue strength of a material to account for stress concentration. This month discusses some additional items to consider when calculating fatigue life.

Another factor to consider is the effect of platings or surface coatings. Nickel electroplates with high residual tensile stress can cause a reduction in fatigue strength (as well as reduction in formability). This is particularly a problem with bright nickel. More ductile nickel deposits, such as those deposited using sulfamate baths) would be preferred if fatigue may be an issue.

Another factor to consider would be **anisotropy** of properties. For example, strip materials with heavy amounts of cold work (such as extra hard, spring, extra spring, super spring tempers) might show significant differences in endurance limit between the longitudinal (down the length) and transverse (across the width) directions. You can see for the S-N curves in Figure 1 below, that the material has a fatigue strength that is higher in the transverse direction than the longitudinal direction. That is, at a given level of stress, a spring will last longer if laid out in the transverse direction than the longitudinal. Fortunately, most springs are stamped out in this direction.

One word of caution - if the fatigue properties are highly directional in a material, the elastic modulus may be as well. This would affect the total stress level experienced in the part laid out in a direction that is not reported on the material cert. Even if the fatigue strength is greater in one of the directions, the actual stress may be lower if the modulus is lower as well.

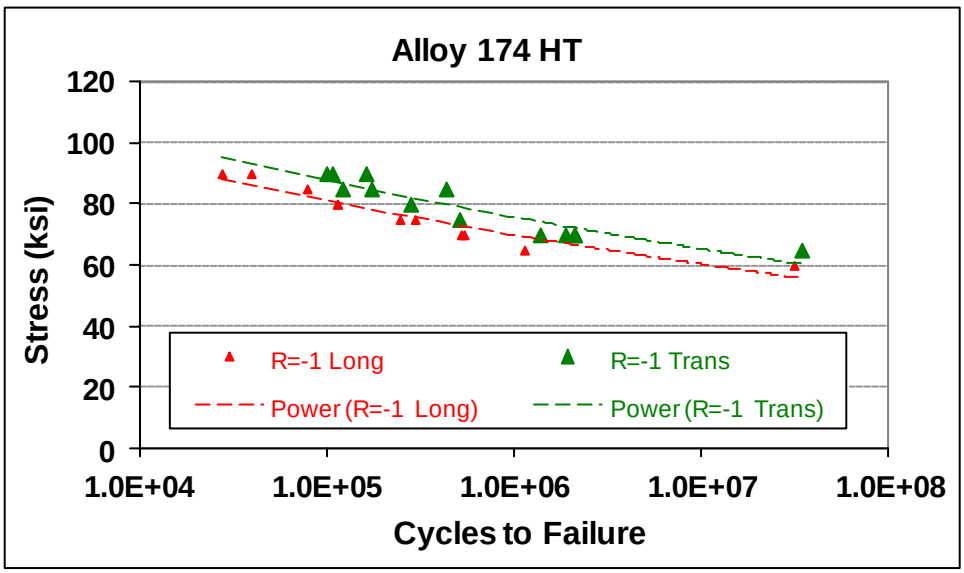

Figure 1. Effect of Direction on Fully Reversed Bending (R=-1) Fatigue Strength of a Copper Alloy. Even though the sample size is too small for a proper statistical analysis, it is apparent that the material has a greater fatigue strength in the transverse (across the width) than in the longitudinal (down the length direction.) Where possible, parts should be oriented so that the tensile stress is in the direction of greatest fatigue strength.

Other Variables Affecting Fatigue Performance (continued)

Another consideration, although data are limited, is the effect of strain rate. That is, if the loading cycles are considerably faster or slower than those used to generate the test data, fatigue cracks might propagate a greater or lesser amount during each cycle, which could affect the total cycle life.

The edge condition of the contact spring may also come into play. For example, the edge of the spring beam in the high stress area may be the slit edge of the input strip. It might be a cut edge blanked out during the stamping process. It may be laser cut, water jet cut, photochemically machined (PCM), or electrical discharge machined (EDM). The edges might be smooth (all shear, with some burr), or variable with a large amount of fracture. Edges that are EDM'ed or blanked/slit with high fracture tend to be irregular, with lots of potential crack initiation sites. Laser cut edges tend to be heat affected (softer than and weaker than the surrounding metal), which may affect the crack initiation time as well. Water jet cutting, slitting, and blanking can also work harden the edge and create residual stresses that may compromise fatigue life, or create potential for distortion during heat treatment.

By now, you will have an idea of how complicated fatigue calculations can be. Next month's addition of Technical Tidbits will put all of the concepts previously discussed together in one exciting issue. Next will come more complicated loading scenarios, where R>0 and <1. This will wrap up the discussion of simple fatigue analysis based on **stress life** methods. After that, the focus will shift to other types of fatigue analysis, such as **strain life** and **fracture mechanics**.

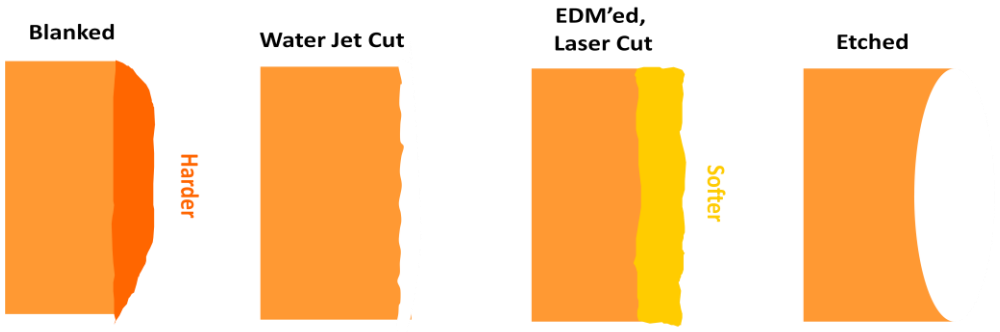

Figure 2. Effect of manufacturing on edge condition, most of which tend to affect the fatigue performance of a part in unpredictable ways. EDM'ing and laser cutting will produce heat affected zones that are softer than the surrounding metal. Blanking will create a work hardened zone at the edge. All methods will generate some irregular shapes on the edge, which may serve as crack initiation sites.

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