EFFECT OF YIELD-PROPERTIES ON PROBE TIP ANGLE

Differences in yield point and post-yield behavior of tungsten-rhenium (WRe) and tungsten (W) probe needles will result in significantly different tip angles when identical bending methodologies are applied.

The yield point and post-yield behavior of WRe- and W-probe needles are highly dependent on the material composition and drawing processes. For a given wire diameter, the addition of rhenium significantly increases the values of the stress and strain at the yield point.

	W	WRe
Elastic Modulus (GPa)	394.5±6.1	395.7±6.4
Yield Strength (GPa)	5.52 to 6.05	5.95 to 6.48
Yield Strain ($m/m \times 10^{-3}$)	13.4 to 14.9	15.0 to 15.9

• *Values are for APS supplied WRe- and W-probe needles*

These material property differences will be manifested during any production step that requires plastic deformation, e.g., probe needle bending.

Currently, the same methodologies are typically used when bending W and WRe-probe needle tips. The bending process can be described by the representative stress-strain curve shown in Figure 1.

It is important to note that the stress-strain curves are slightly exaggerated for emphasis, i.e., the differences between the plastic regions of the materials are not as extreme as they appear in the figure.

In order for a probe needle to be plastically deformed, the probe must be bent beyond the yield point. Once the yield point is exceeded, the deformation is permanent and non-recoverable. After the probe is released, the tip demonstrates elastic recovery according to Hooke's Law (i.e., it "springs back" slightly); however, since slip occurred some of the deformation remains.

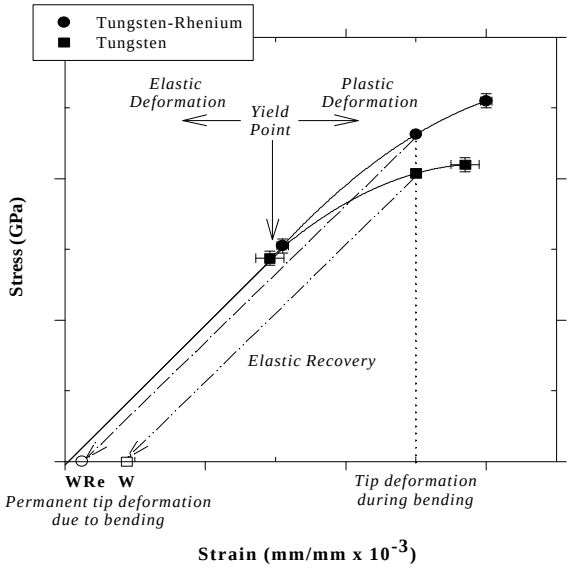

Figure 1. Representative bending stress-strain curve

If the same bend deformation is applied to identical W and WRe-probe needles, the amount of permanent deformation after the elastic recovery will be different for each material. In other words, the amount of permanent deformation of the W-probes will be greater than that of the WRe-probes (as shown in the figure). Thus, the tip angles of W and WRe-probe tips will be different.

Tip angle differences were observed in two populations of bent W and WRe isolinear probe needles. In both cases, the average tip angle measured at the inner bend of the WRe-probes was significantly greater ($p<0.001$) than that of the W-probes.

While small, these angular differences may affect probe wear behavior and may reduce the benefits of using WRe-probe needles.

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