



CONCEPTALLOYS

# Tungsten-Rhenium Alloy Thermocouple Wire

for Guaranteed Temperature Measurement to 2,315 °C



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## **Concept Alloys, Inc.**

Concept Alloys was formed in 2002 by former technical staff of Hoskins Manufacturing Company. The company manufactures its products in their facility located in Whitmore Lake, Michigan, USA. It specializes in the production of tungsten-rhenium alloys for temperature measurement using proprietary manufacturing and testing/calibration methods.

Knowledge and experience in the field allow Concept Alloys to provide unrivaled application support, failure analysis and laboratory testing.

## **Application Information for Tungsten Rhenium Alloys**

Tungsten-rhenium alloy combinations can be used over a wide temperature range that extends from  $-196^{\circ}\text{C}$  to over  $2,760^{\circ}\text{C}$ . Standard temperature tables (ASTM E230 and E1751) are available from  $0^{\circ}\text{C}$  to  $2315^{\circ}\text{C}$ . These alloy combinations are susceptible to rapid oxidation at high temperatures and are not recommended for use in oxidizing environments. They are very stable at high temperatures in reducing or inert atmospheres such as hydrogen, inert gases and vacuum. The cost of these materials is relatively low compared to noble metals.

Of the three common combinations of these alloys (pure W vs. W26Re, W3Re vs. W25Re and W5Re vs. W26Re) the W5/W26Re combination has received the widest acceptance by industry. Unless otherwise stated, all materials produced by Concept Alloys conform to ASTM E696, E230 and E1751.

The pure W vs. W26Re thermocouple was the earliest combination developed in this system. It suffers, however, from the brittle behavior of the pure tungsten positive leg. For this reason, the positive leg is generally shipped in the as-drawn condition. This results in an emf shift when the thermocouple is exposed to elevated temperatures (generally in excess of  $1,100^{\circ}\text{C}$ .) in use. The primary advantage in using this combination is the higher Seebeck coefficient obtained at temperatures in excess of about  $500^{\circ}\text{C}$ . Modern instrumentation minimizes the importance of this advantage.

Both the W5Re and W26Re thermoelements retain good room temperature ductility (in comparison to unalloyed tungsten) after heating to over  $1650^{\circ}\text{C}$  and are shipped in a stabilized condition. So long as use is restricted to  $1650^{\circ}\text{C}$  or lower this ductility is retained and handling problems are minimized.

W5Re/W26Re thermocouples may be used bare, with hard fired ceramic insulators or in mineral insulated, metal sheathed (MIMS) cable. At low temperatures common alumina or magnesia insulation is generally satisfactory. Their use is limited by the melting point of alumina ( $2010^{\circ}\text{C}$ ) and the low electrical resistivity of magnesia above  $1980^{\circ}\text{C}$ .

At temperatures over  $1650^{\circ}\text{C}$  insulators of beryllia, hafnia or thoria may be used. The most widely used is beryllia due to its higher electrical resistivity. Before selecting any insulator a thorough investigation should be conducted relative to material properties, chemical compatibility and necessary safety precautions. In MIMS constructions the selected sheath should be compatible with the insulators, wires and atmosphere. Materials that have been used successfully include tantalum, tungsten and some tungsten alloys, columbium, molybdenum and various ceramics.

## Tungsten-Rhenium Thermocouple Wire Alloy Types

Type C: Tungsten 5% Rhenium versus Tungsten 26% Rhenium wire  
 Type D\*: Tungsten 3% Rhenium versus Tungsten 25% Rhenium wire  
 Type G\*: Pure Tungsten versus Tungsten 26% Rhenium wire

\* "Type D" and "Type G" are industry terms and not official letter designated thermocouples.

### Stock sizes (mm/inches)

mm	inches
0.013	0.0005
0.020	0.0008
0.076	0.0030
0.127	0.0050
0.198	0.0078
0.254	0.0100
0.381	0.0150
0.406	0.0160
0.508	0.0200
0.813	0.0320
1.016	0.0400

Note: stock sizes for Type G are limited.



### Tungsten-Rhenium Accuracy Guarantee\*

<u>Wire Size, mm</u>	<u>Maximum Temperature, °C</u>	<u>Tolerance (whichever is greater)</u>
0.25 and larger	2315	±4.4°C or ±1%
<0.25 to 0.178	2090	±4.4°C or ±1%
<0.178 to 0.127	1980	±4.4°C or ±1%
<0.127 to 0.076	1870	±4.4°C or ±1%

\*These temperatures shall be the maximum reported and guaranteed temperatures for the wire sizes indicated unless otherwise agreed to between Concept Alloys and the customer. Sizes smaller than 0.076 mm diameter shall be tested at a larger breakdown size for reporting purposes, but no guarantee shall be in effect.

EMF tolerances refer to the deviations from the °C nominal temperature-emf relationships defined by ASTM E230 and E1751. The accuracy guarantee represents the initial calibration tolerance of the bare wire only. Factors that may affect accuracy in use include purity or quality of the atmosphere or vacuum, wire size, temperature gradient, thermocouple geometry and insulation type and purity.

The thermoelectric tolerance shall be the larger of ±4.4°C or ±1% of the temperature at each calibration point.

### Diameter Control

The diameter and roundness of all tungsten-rhenium wire is continuously measured using laser micrometer technology. This type of testing ensures that every coil of wire meets our rigid standards for dimensional uniformity.

## Mechanical Properties and Physical Properties

	Tungsten	W3Re	W5Re	W25/26 Re
Tensile Strength, ann. (x 10 <sup>3</sup> psi) 68°F 1832°F 3632°F	80 35 15	172 60 10	220 65 26	200 95 24
Elongation (% in 10") 68°F 1832°F 3632°F	0 10 23	15 18 23	20 24 24	11 19 27
Resistivity ( $\approx$ $\frac{39}{10^8}$ circ. mil / ft.) 68°F 1832°F 3632°F	33 199 398	57 228 420	70 235 434	170 331 524
Therm. Exp. Coef. (in./in./°F) 68°F 1832°F 3632°F	1.7x10 <sup>-6</sup> 2.3x10 <sup>-6</sup> 3.1x10 <sup>-6</sup>			2.9 x 10 <sup>-6</sup> 3.1 x 10 <sup>-6</sup> 3.9 x 10 <sup>-6</sup>
Density g./cm <sup>3</sup> lb./in <sup>3</sup>	19.3 0.697	19.4 0.700	19.4 0.701	19.7 0.714
Melting Point °C °F	3410 6170	3325 6017	3350 6062	3120 5648

## **The Concept Alloys Product Quality and Customer Service Philosophy**

Concept Alloys takes care every step of the way to produce the finest quality tungsten-rhenium thermocouple wire, and provide the best customer experience possible. Our experts can help guide you to make the best material selection by discussing your application and providing supporting technical information.

We understand that thermocouple wire accuracy and uniformity are important and we go to extremes to achieve it. Special, proprietary processes are employed for this purpose. Uniformity is routinely measured by calibrating each end of every coil produced. We go even further by requiring that every finished coil meet our own end-to-end uniformity tolerance. All of these tests are performed over the entire specified temperature range – usually 0°C to 2315°C depending on wire size - without extrapolation from lower temperature tests.

### **Further information regarding Concept Alloys' Tungsten-Rhenium thermocouple wire:**

**Manufactured and Calibrated On-Site** - We take pride in manufacturing and testing our product in Whitmore Lake, Michigan. Our in-house capabilities allow us to control quality to our own demanding standards, and meet your special requirements.

**Experienced Staff** - Our team has extensive experience in tungsten rhenium alloys, which allows us to provide unparalleled technical support and customer service.

**Complete Alloy Availability - W/W26%Re, W3%Re/W25%Re, and W5%Re/W26%Re.**

**Doped 3% and 5% Alloys** - Concept Alloys' doped 3% and 5% materials provide superior ductility to competitive un-doped materials.

**Calibration from 0°C to 2315°C** - Concept Alloys' innovative calibration system allows us to test materials to 2315°C or higher. Other manufactures simply extrapolate to these temperatures.

**Certified to NIST-traceable standards, deviations in mV, and either °F, or °C** - User-friendly certifications express deviations in both millivolts and °F or °C.

**Special EMF Tolerances and Sizes Available** - Special, tight tolerance wire is available for critical applications. We are fully capable of routinely providing any size wire from 0.0127 to 1 mm diameter. Larger diameters are available as special orders.

**End-to-End Calibrations** - Some customers prefer to use calibration data from both ends of long-length spools, rather than an average. This is available for a nominal fee.

**Volume Pricing** - Discounts from list price are available, and are based on annual usage rather than single buys.

**No Minimum Order** - Our goal is to meet your exact needs. No more, no less.

**Most Orders shipped same or next day** - Stock is maintained to support your just-in-time requirements. Our production and shipping systems allow for quick fulfillment of your rush orders.

**Customers Service** - In a culture of voice mail menus, faxes, e-mail, and unanswered calls, find out why Concept Alloys' customers rave about our personal service.