Issue No. 43 – July 2012 **Updated from Original January 2004 Publication**

Back in the saddle again! – A return of technical tidbits after a one year absence in 2003.

- **Elastic Modulus**
- **Yield Strength**
- **Elastic Resilience**
- **Electrical Conductivity**
- **Stress Relaxation Resistance**
- **Fatigue Strength**
- **Formability**

The next issue of Technical Tidbits will discuss connector insertion force.

Introducing Alloy 390®

Editor's note: This issue was originally released in early 2004, when Alloy 390® was a new alloy. For the sake of continuity, it is included in the current re-issuing of old editions.

Current trends in connectors point to smaller form factors and higher power. This requires materials with high strength in order to withstand the stress necessary to generate adequate contact force without yielding. The higher currents require materials with increased conductivity, as well as increased resistance to stress relaxation.

Burn-in and test sockets are seeing smaller pins with greater pin counts, higher currents, and higher test temperatures resulting in increased stress temperature exposures. Notebook computers and other devices are requiring even more power, which means that conductivity becomes critical in power connectors.

Alloy 390® is a new copper beryllium strip material. Its strength is comparable to the familiar high strength copper beryllium alloys such as 190 and 290. However, it has a conductivity of 45% IACS, which is comparable to the higher conductivity copper beryllium materials. This high strength/high conductivity combination is obtained without a dramatic loss of formability, making it ideal for use in many challenging high performance connector designs. Table 1 compares the properties of Alloy 390® with other common electrical contact/connector materials.

Elastic Modulus - Alloy 390® has an elastic modulus at the high end of the range for copper alloys. The elastic modulus is the most important material property for determining what the spring rate of a contact is. The high modulus also helps prevent buckling during compression loading and makes the connector more tolerant of vibration.

Yield Strength - As connectors become smaller, there is less mass available to provide the required spring force necessary for good electrical contact. The only way to increase the contact force is to increase the stress in the material. This increase in stress requires the use of higher yield strength materials such as Alloy 390®.

Alloy	Temper	Elastic Modulus	0.2% Off-set Yield Strength	Electrical Conductivity	Elastic Resilience	90° Bend Formability Ratio (R/t)		1000 Hour Percent Stress Remaining (initial stress=75% OYS)		10^8 Cycle Fatigue Strength
		10^6 psi	ksi	%IACS	10^{-3} psi/psi	L	T	150 C	200 C	ksi
390®	HT	20	135 - 153	44	6.8 - 7.7	2.0	2.0	88	67	42 - 45
Brush 60®	HT	20	105 - 125	50	5.3 - 6.3	1.5	1.5	89	75	42 - 45
190	XHM	19	135 - 170	17	7.1 - 8.9	4.0	5.0	86	69	50 - 57
174	HT	20	100 - 120	48	5.0 - 6.0	1.2	5.0	85	80	45 - 50
C70250	TM03	19	95 - 120	40	5.0 - 6.3	2.5	2.0	94	83	
C70260	S	19	95	40	5.0	0.5	1.0			
C72500	XS	20	95	11	4.8	2.0	3.0		40	38
C19900	EH	18	148	10	8.2	-	7.0	99	94	
C68800	H	17	101	18	5.9	2.0	2.0		10	37
C65400	H	17	109	7	6.4	2.0	3.5			34
C52100	S	16	100 - 113	13	6.3 - 7.1	2.0	7.0			33
C51000	S	16	92 - 108	15	5.8 - 6.8	3.0	8.0		20	30

Table 1. Properties of Alloy 390® and other common spring materials

Introducing Alloy 390® (continued)

Elastic Resilience - The total amount of deflection a contact can withstand without yielding is governed by the ratio of yield strength to elastic modulus, also known as elastic resilience. Materials with a high resilience are more tolerant of abuse than those with low resilience.

Electrical Conductivity - Consumer products such as cell phones, computers, automobiles, and even refrigerators are becoming increasingly complex. The amount of electrical and electronic devices in these products is continually increasing as well. This requires more electrical power to drive these devices. In order to provide more power to a device, one must raise either the voltage or the current supplied to it. There are practical limits to how much voltage one can run through a device. Arcing becomes a concern when the electrical potential exceeds 12 Volts. Higher voltages may also pose a potential safety risk to human beings. Automotive contacts are already operating near these limits. Therefore, an increase in current may be mandatory. The conductivity of Alloy 390® makes it ideal for applications which require high strength materials at increased power levels.

Stress Relaxation Resistance - The increased power seen in many devices means that there is an increase in temperature, both internally generated and experienced in the environment. This requires greater resistance to stress relaxation in order to maintain the normal force necessary for good electrical contact.

Fatigue Strength - Alloy 390® shows a fatigue strength similar to other copper beryllium alloys. This will allow for its use in highly cycled applications.

Formability - Alloy 390® has been engineered to make 90 degree bends in both the longitudinal and transverse orientations at a bend radius to material thickness ratio of 2.0. (Currently, this R/t ratio is valid for thicknesses of 0.002”-0.004”, those commonly used for high performance designs. Thicker sizes will show decreased formability.) This formability allows for the formation of complex shapes and miniaturized designs, while still retaining the strength and resilience to function as a spring contact material.

Alloy 390® is a new material that has an intriguing combination of strength, conductivity, and formability. This should make it a material of choice in highly demanding electrical contact applications.

Written by Mike Gedeon of Materion 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.

Please contact your local sales representative for further information on Alloy 390® or other questions pertaining to Materion 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 Materion Brush Performance Alloys

TECHNICAL TIDBITS

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

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