

## TIGER – INK <sup>(1)</sup>

### GENERAL DESCRIPTION

This proprietary product eliminates the need for molybdenum/manganese metallizing or other pre-metallizing treatments typically required in the joining of technical ceramics.

Tiger-Ink consists of Titanium metal powder, typically at –325 mesh (0.0017 in), that is held in suspension with a proprietary binder system. The product is currently available in several formulations suitable for brushing, spraying or screening onto ceramic components. This product enables the user to brush or screen this material directly on to the ceramic substrate and then braze with standard filler metals. The use of Tiger-Ink eliminates all traditional pre-metallization treatments, which can reduce component costs by as much as 50% in some large assemblies. Assemblies brazed with Tiger-Ink and traditional brazing alloys produce high strength, hermetic joints.

The product is fast drying, and while it doesn't require curing, a heating cycle of 300° F (149°C) for 10 to 20 minutes will cause the product to form a hard dry coating that is scratch resistant during subsequent assembly or shipping operations. The potential benefits of this product are as follows:

- Eliminate the moly-manganese or tungsten paint pre-metallization process which can reduce the cost of ceramic component by as much as 50%
- Enable brazing directly to lap ground or re-fired ceramics
- Increase material flow vs. currently available products – increased capillarity
- Enable brazing in dry atmosphere like Argon, Argon/Hydrogen as well as hard vacuum

Standard strength tests (tensile) have been conducted and the product has produced strong, leak-free joints. In all cases, the failure occurred in the ceramic before the braze joint.

	<u>Tensile Strength (lbs/in<sup>2</sup>) <sup>(2)</sup></u>
Alumina to Kovar	10,000 to 14,000

<sup>(2)</sup> Tensile calculations based on test washer with a .334" I.D. and .530" O.D. (surface area .133 sq. in.).

### TYPICAL BRAZE FILLER METALS USED WITH TIGER - INK

	<u>Silvaloy 616</u>	<u>Silvaloy 716</u>	<u>Silvaloy 721</u>
Silver	61.5% ± 1.0%	71.5% ± 1.0%	72.0% ± 1.0%
Copper	Remainder	Remainder	Remainder
Nickel	--	0.5% ± 0.2%	--
Indium	14.5% ± 0.5%	--	--

### PHYSICAL PROPERTIES OF BRAZE FILLER METALS

	<u>Silvaloy 616</u>	<u>Silvaloy 716</u>	<u>Silvaloy 721</u>
Melting Point(Solidus)	1155°F (620°C)	1435°F (780°C)	1435°F (780°C)
Flow Point (Liquidus)	1305°F (710°C)	1465°F (795°C)	1435°F (780°C)
Brazing Temperature Range	1400°F - 1500°F (760°C-816°C)	1575° F - 1625°F (795°C - 885°C)	1550°F - 1650°F (845°C - 899°C)

<sup>(1)</sup> U.S. Patent No.: 6,840,429 B2

## ***PRODUCT USES***

---

Tiger-Ink, when used with an appropriate brazing filler metal, is used for bonding or hermetically sealing a broad range of ceramic and non-metal components to themselves and to other ceramics or metals without the need for molybdenum/manganese metallizing or other pre-metallizing treatments. Tiger Ink may also be used for selectively coating the surfaces of these same materials through the use of silk-screening or brushing.

Heating to brazing temperatures in vacuum or under dry Argon atmosphere is required. During heating, the brazing filler metal will melt and subsequently flow only in relation to where the Tiger-Ink was applied. The ceramic bond results from an active metal reaction with the ceramic surface to form a fully bonded transition zone between the ceramic and the ductile filler metal. The compositions of the possible transition zones vary with the composition of the ceramic base and heating conditions. Joining to metal surfaces is accomplished through the metallic bonding expected in standard braze joints.

The proper use of Tiger-Ink has been shown to produce successful bonds in components manufactured from Alumina (up to 99% pure), silicon nitride, aluminum nitride and zirconia when these materials are bonded to themselves or appropriately selected metals and non-metals. Successful bonds would be expected in many higher strength “technical” ceramics and other strong non-metallic materials capable of withstanding the temperatures and vacuum conditions typically employed in joining.

Tiger – Ink has been used to produce bonds between varieties of dissimilar materials. The following list describes a number of technical ceramics and base metals joined in lab and production tests and provide examples of the manufacturing alternatives available.

- Alumina, Aluminum Nitride, Mullite, Zirconia, Silicon Nitride, Silicon Carbide
- Kovar, Steel, Stainless Steel and Copper

## ***PRODUCT APPLICATION***

---

Tiger-Ink is formulated in a consistency suitable for brushing or spraying or via application by silk-screen. The applied amount of active metal should equal between 2% and 10% of the total brazing alloy weight, but can also be dependant upon specific the joint configuration. For additional information, please contact the Lucas-Milhaupt Technical Services Department at 800-558-3856.

Brazing preforms may be applied directly between Tiger-Ink applied ceramic surfaces or to the exterior of joints where part design will direct alloy flow towards the joints. Success of the latter method will be dependent on base materials, joint gap, joint length and heating conditions. Reasonable flow and joint penetration are possible with gaps of 0.001 in. - 0.003 in. (0.025 mm - 0.076 mm). Proper brazing temperature varies with different families of alloys, but as a general rule brazing temperatures are recommended to be 100°F to 150°F (38°C - 66°C) higher than the liquidus temperature of the filler metal.

## ***HEATING METHODS & SURFACE CONDITIONS***

---

A vacuum furnace capable of maintaining  $10^{-4}$  Torr minimum vacuum or atmosphere furnace maintaining a high purity argon atmosphere is required.

A partial pressure backfill of argon entered into a vacuum furnace after initial heating will prevent evaporation of filler metal alloy when high brazing temperatures are employed. Though rapid heating has been used successfully, a ten-minute minimum hold time at brazing temperature is recommended for most applications.

## ***AVAILABLE FORMS***

---

Paste.

## ***SPECIFICATIONS***

---

Tiger-Ink conforms to the following specifications: N/A

## ***APPLICABLE PRODUCT CODE(S)***

---

The applicable Lucas-Milhaupt product code(s) for this technical data sheet:

<b><i>Brushable Tiger-Ink:</i></b>	HF600/69-037/35 <sup>(3)</sup> D1
<b><i>Screenable Tiger-Ink:</i></b>	HF660/69-037/35 <sup>(3)</sup> D1

<sup>(3)</sup> Can vary depending on application. For additional information, please contact the Lucas-Milhaupt Technical Services Department at 800-558-3856.

## ***SAFETY INFORMATION***

---

The operation and maintenance of brazing equipment or facility should conform to the provisions of American National Standard (ANSI) Z49.1, "Safety in Welding and Cutting". For more complete information refer to the Material Safety Data Sheet for Silvaloy Tiger Ink.

## ***WARRANTY CLAUSE***

---

Lucas-Milhaupt, Inc. believes the information contained herein to be reliable. However, the information is given by Lucas-Milhaupt, Inc. without charge and the user shall use such information at its own discretion and risk. This information is provided on an "AS IS" AND "AS AVAILABLE" basis and Lucas-Milhaupt, Inc. specifically disclaims warranties of any kind, either express or implied, including, but not limited to, warranties of title or implied warranties of merchantability or fitness for a particular purpose. No oral advice or written or electronically delivered information given by Lucas-Milhaupt, Inc. or any of its officers, directors, employees, or agents shall create any warranty. Lucas-Milhaupt, Inc. assumes no responsibility for results obtained or damages incurred from the use of such information in whole or in part.