



HANDY & HARMAN

850 THIRD AVENUE NEW YORK 22, N. Y.

AREA CODE 212 PL 2-3400

May 17, 1963

TO OUR CUSTOMERS:

Attached is a revised data sheet and specification covering our Consil 995 Silver-Magnesium-Nickel alloy.

The data sheet and specification reflects the latest laboratory data available on this product. However, there has not been any significant change in chemical or mechanical properties. We are simplifying the product line by eliminating the numerous suffixes which previously have been used to identify the product, i.e., Consil 995-A, Consil 995-B, etc. Effective June 15, 1963, we will produce one grade of Consil 995 which can be formed and subsequently oxidation hardened by the customer.

CONSIL 995

Temper: Annealed or fully hard rolled or drawn

Availability:

Strip - .003" to .024" thickness (see specification).
Other sizes subject to inquiry.
Thickness, ~~.014"~~ ^{8/32"} and below, will automatically be supplied as vacuum melt stock to insure optimum quality. An additional premium will be charged for this material.

Wire - .010" to .078" diameters.
Specification not available at this time. Wire will be supplied to chemical composition of Consil 995 Specification. Strength values for wire are similar to strip. However, wire ductility values will be considerably less.

Mill Prehardened Consil 995 is available in the following sizes for selected applications:

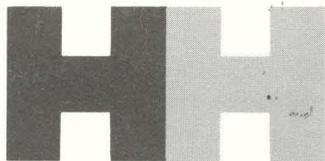
Wire - .010" to .625"

Strip - .003" to .014"

The attached specification does not apply to Mill Prehardened Consil 995. A specification for Prehardened Consil 995 will be issued shortly.

The Consil 995 data sheet and specification supersede our Technical Bulletin A-3. This revised information will become the basis for processing Consil 995 orders effective June 15, 1963.

HANDY & HARMAN



HANDY PRODUCT DATA SHEET

HANDY & HARMAN INDUSTRIAL PRODUCTS DIV.
850 THIRD AVENUE, NEW YORK 22, N. Y.

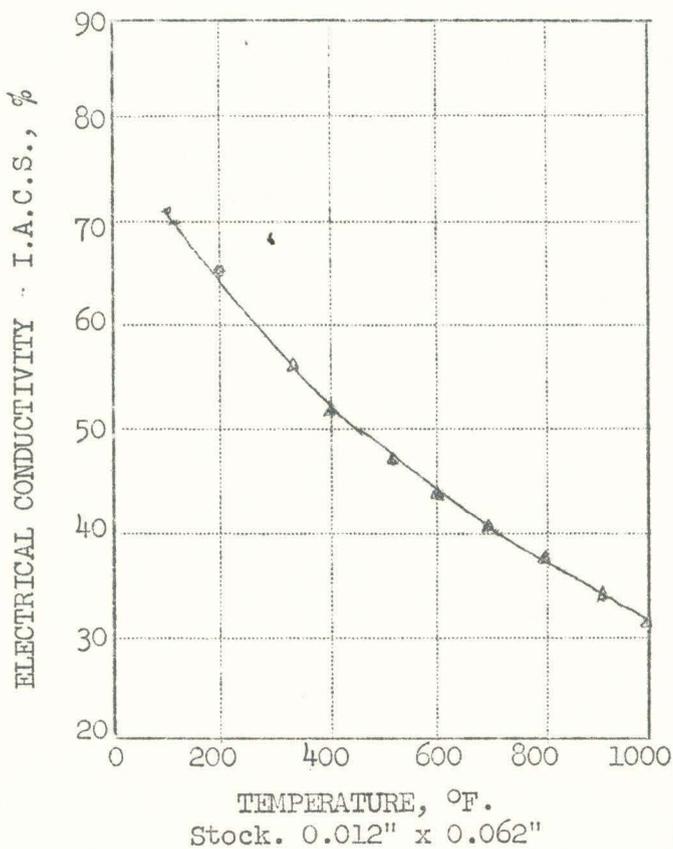
CONSIL
995

CONSIL 995

GENERAL INFORMATION

Consil 995 is a high strength, high conductivity alloy which, after oxidation hardening, does not soften as a result of being brazed. It normally is furnished in the full hard rolled condition, but it may be furnished in the annealed condition. After fabrication into the desired shape, it may be permanently hardened by a simple internal oxidation treatment that converts the Mg, which is in solid solution with Ag, into sub-microscopic particles of MgO. These particles which strengthen the alloy do not coalesce appreciably except after very long exposure to high temperatures.

ELECTRICAL CONDUCTIVITY (Typical values after oxidation hardening)



FORMABILITY

Before hardening the ability of Consil 995 to be formed depends upon the temper (hard rolled or annealed). After oxidation hardening major plastic deformation should be avoided, particularly for parts which are to withstand many cycles of stress. Minor correction in the shape of formed parts which have been hardened can be made, however, without significant impairment of performance.

Minimum Recommended Bending Diameter for 180° Bends
Made Perpendicular to Rolling Direction

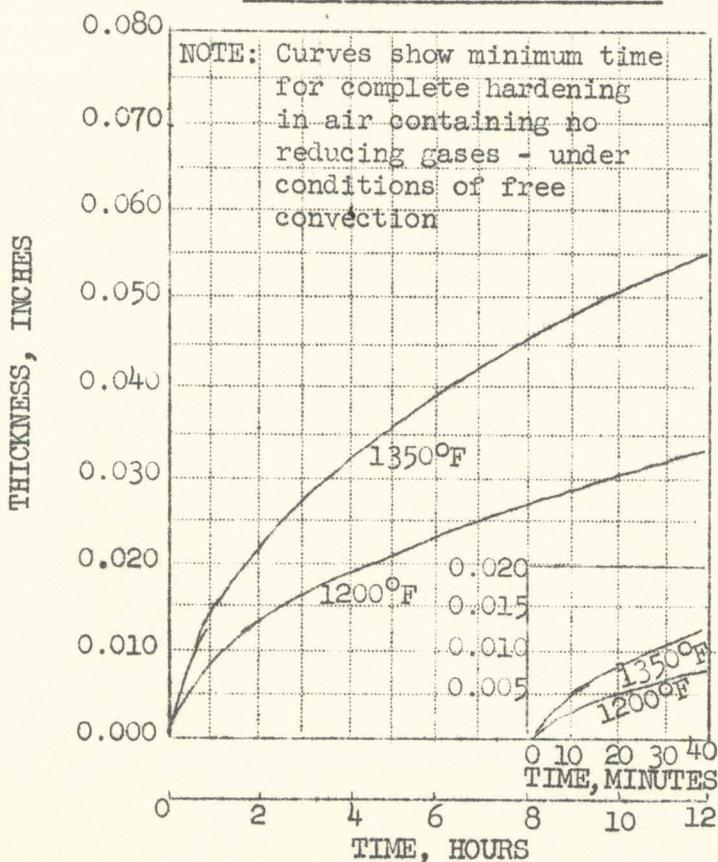
Full Hard Rolled	Annealed
4T	2T

Where T is thickness of stock

HARDENING DATA

The time required to oxidation harden Consil 995 is a function of the thickness of the section and temperature used for oxidation. These relationships are shown graphically below. If hardening is done in an environment of oxygen, the time required is 0.6 of that shown on the graph. Tensile Strength of strip hardened in an oxygen atmosphere will average 5% higher than strip hardened in air.

OXIDATION HARDENING CURVES



ELEVATED TEMPERATURE BEHAVIOR

In the temperature range 70°F. to 470°F., the short time strength of hardened Consil 995 decreases at the approximate rate of 6000 psi/100°F. Ductility also decreases with temperature, but more sharply reaching 4% elongation at 200°F. Above 300°F. elongation seldom exceeds 2%. The low ductility at elevated temperature can lead in time to brittle type fracture under conditions of excessive stress or applied strain.

CONSIL 995 SPECIFICATION

A. CHEMICAL COMPOSITION:

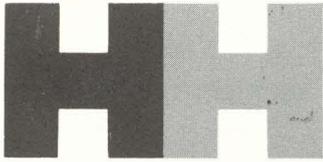
Element

Ag 99.4% min.
 Ni .2% max.
 Mg .3% max.

B. ROOM TEMPERATURE LONGITUDINAL MECHANICAL PROPERTIES*
 (Minimum Values After Oxidation Hardening)

Strip Thickness - (inches)	Up to .006	.007 to .011	.012 to .018	.019 to .024
Tensile Strength, PSI X 10 ³	62	60	58	56
Yield Strength, PSI X 10 ³ .2% Offset	55	52	49	47
Elongation, % in 2"	12	12	12	12
Elastic Modulus, PSI X 10 ⁶	12	12	12	12

*For material either rolled fully hard before oxidation or material rolled fully hard and then annealed at finish before oxidation.



HANDY PRODUCT DATA SHEET

HANDY & HARMAN INDUSTRIAL PRODUCTS DIV.
850 THIRD AVENUE, NEW YORK 22, N. Y.

SILVER
CONDUCTIVE
COATINGS

SILVER CONDUCTIVE COATINGS

Handy and Harman conductive coatings, called Silpaints, are pigmented with metallic silver together with bonding agents that are specially selected for the type of base material to which they are to be applied. These coatings are used to make conductive surfaces on such nonconductive materials as ceramics, glass, quartz, mica, plastics and paper. They can also be applied as conductive coatings on some metals.

There are two classes of Silpaints:

1. The fire-on types for base material that can withstand heating at temperatures in the range 800° to 1700°F.
2. The air-dry types for organic base or other materials that are usually force dried in the range of room temperature to 800°F.

FIRE-ON SILPAINTS

In this type of coating, the bonding agent is a powdered glass frit with a composition and melting point specifically selected for designated base materials. The composition and amount of glass used determine the adherence, electrical properties, solderability, plateability and the temperature required for firing.

The silver pigment and the glass powder are dispersed in an organic vehicle. Viscosity and drying rate are adjusted for the designated method of application, i.e. spraying, dipping, brushing, roller coating and screen stenciling.

The following general procedures are recommended for using fire-on Silpaints.

1. If thinning is necessary, it is important to use the recommended or similar thinners. Other type thinners may not be compatible.
2. After applying the Silpaint, it is desirable to predry by heating to drive off volatile solvents. This prevents entrapment of gases and subsequent bubbling or blistering during the fire cycle.
3. Fire at the designated temperature in an oxidizing atmosphere (air) to burn off the organic residue and fuse the glass. This bonds the silver in a tight adherent highly conductive layer to the ceramic, mica or other base surface. Underfiring can result in poor adherence. Overfiring will often leave a hard-to-solder surface.
4. Furnace or air cool. Avoid sudden shocks such as quenching.

The advantages of fire-on Silpaints over bake-on paints are their high adherence and good conductivity--50 to 75% of the conductivity of the equivalent weight and shape of solid silver.

Some compositions may be electroplated, others may be soldered directly. For capacitors, the glass binder is selected for high "Q" and direct soldering. Several examples of fire-on Silpaints are described on the following pages.

AIR-DRY AND BAKE-ON SILPAINTS

In this type of Silpaint the bonding agent is an organic resin and may be either thermoplastic or thermosetting. The viscosity and drying rate are adjusted for designated methods of application, as in the fire-on types. Some may be dried in air or force dried at higher temperatures. Thermosetting types require baking at temperatures of 300° to 400°F and in special cases up to 800°F. Hardness and flexibility can be regulated by resin and plasticizer choice.

The conductivity of air-dry Silpaints will vary from about 5 - 25% of the conductivity of the equivalent weight and shape of solid silver. Baking increases the conductivity of air dried coatings.

The air-dry and bake-on Silpaints are used to make conductive patterns, electrostatic shielding coats or plateable surfaces on such nonconductive materials as paper, plastic and deposited carbon resistors which cannot withstand firing temperatures.

GENERAL INFORMATION

Listed below are examples of various types of Silpaint now in use. Not all Silpaints are shown. It is usually necessary to determine experimentally the optimum treatment for each specific application under factory conditions. The masses involved and the rates of heating vary too widely from job to job to permit closer general specifications. In many cases special formulations not listed may be required and inquiries for such are invited.

FIRE-ON SILPAINTS

For Direct Soldering Ceramics--Fire Temperatures 1200°-1500°F (unless otherwise specified). High "Q" for Titanate Ceramics.

Methods	Silpaint No.	% Silver	Thinners	Recommended Use and Characteristics
Brush	L01-2165	65	Xylol, Turpentine	High conductivity, Excellent capacitance characteristics 1350°-1625°F for Alumina 1250°-1450°F for Other Substrates
Stencil	L05-1162	62	Butyl Carbitol Acetate, Cellosolves	Barium Titanate Steatite
Stencil	L06-1150	50	Butyl Carbitol Acetate, Carbitol Acetate, Cellosolves	1350°-1625°F for Alumina 1250°-1450°F for Other Substrates Four Hour Pot Life Minimum

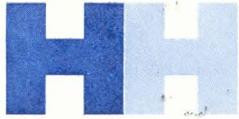
For Direct Soldering to Glass, Mica, Quartz and Semiconductor Bodies--
Fire Temperature 800° - 1000°F (unless otherwise specified)

Method	Silpaint No.	% Silver	Thinners	Recommended Use and Characteristics
Brush	2267-01	67	Xylol, Turpentine	1140°F Firing temperature.
Dip	102-3265	65	Xylol, Turpentine	Quartz, glass, mica.
Spray	4250-01	50	Ethyl Cellosolve Butyl Cellosolve	Prefire at 350°F ten minutes.
Spray	102-4250	50	Xylene, Toluene	Mica, quartz, glass.
Stencil	1250-04	50	Butyl Cellosolve	High "Q" for mica.
Stencil	1250-03	50	Pine Oil	Automatic Stencil, High "Q" for mica.

AIR-DRY AND LOW BAKE SILPAINTS
(For Plastics, Glass, Metals, Paper & Carbon)

Method	Silpaint No.	% Silver	Thinners	Recommended Use and Characteristics
Brush	102-1068	68	Ethyl Cellosolve	Thermosetting - low bake at 350°F deposited carbon resistor paint.
Brush *	2065-01	65	Ethyl Alcohol, Butyl Carbitol Acetate	General purpose - can be force dried at 210°-350°F
Brush	102-2060	60	Solvesso 150	For polystyrene - 300°F bake
Brush *	2060-01	60	Cellosolve, Ethyl Alcohol	General purpose - can be force dried at 210°-350°F
Stencil	101-1054	54	Water	8.1% Electrical conductivity.
Dip	3043-01	43	Ethyl Alcohol, Cellosolve	General purpose - can be force dried at 210°-350°F.
Spray *	4030-01	30	Ethyl Alcohol, Cellosolve	Low silver shielding paint -- can be force dried at 210°-350°F.

* NOTE: Air-dry coatings or may be force dried as indicated. (These coatings may be copper plated in an acid plating bath).



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CHEMICAL PRODUCTS

Handy & Harman produces a wide variety of chemical products of silver. These are briefly described below with more specific information available in the accompanying data sheets.

SILVER POWDER - Under the trade name Silpowder, small silver particles (0.5-10 microns) are produced by either the galvanic precipitation or the chemical reduction method.

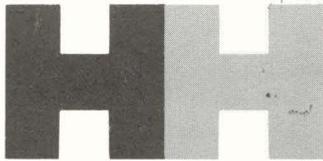
SILVER FLAKE - The trade name Silflake covers different flattened particles made from Silpowder. The silver is mechanically made somewhat leaf-shaped for better conductivity when used as a pigment.

SILVER PAINT - Known by our trade name, Silpaint, these conductive coatings are produced in air dry, bake-on or fire-on types for such uses as solderable terminals, capacitor plates, plateable coatings for irregularly shaped non-conductors, resistive elements corrosion, resistant thread coatings and similar applications.

SILVER OXIDE - Both monovalent (Ag_2O) and divalent (AgO) types are available with closely controlled mesh size and chemical purity for electrical and catalytic uses.

SILVER CHLORIDE - This can be produced in sheet form or blanks and cut pieces in various sizes against close physical and chemical specifications. The largest use is in battery plates for seawater activated batteries. No data sheet is available for this product since individual requirements are handled on a custom basis. Inquiries are invited.

HANDY & HARMAN



HANDY PRODUCT DATA SHEET

HANDY & HARMAN INDUSTRIAL PRODUCTS DIV.
850 THIRD AVENUE, NEW YORK 22, N. Y.

Chemical
Products

CHEMICALLY REDUCED PRECIPITATES

I. Specification:

	<u>Silpowder 130</u>	<u>Silpowder 132*</u>	<u>Silpowder 140**</u>
A. Physical Properties:			
1. Apparent Density; g/in ³ by Scott Volumeter	8 to 16	-----	-----
2. Weight Loss at 110°F; %	0.1 max.	0.1 max.	0.1 max.
3. Particle Size: by Fisher Sub-Sieve Sizer	0.6 to 3.0	0.6 to 4.0	0.6 to 3.5
B. Chemical Composition:			
1. Ag %	99.6 min.	99.6 min.	99.4** min.
2. Cu %	0.01 max.	0.01 max.	0.01 max.
3. Cl %	0.005 max.	0.005 max.	0.005 max.
4. Fe %	0.01 max.	0.01 max.	0.01 max.
5. Pb %	0.01 max.	0.01 max.	0.01 max.
6. NO ₃ %	0.01 max.	0.01 max.	0.01 max.

II. Typical Uses:

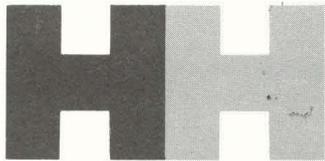
Powder Metal Contacts
Pigment for conductive coatings

III. Remarks:

Silpowder 130 and 132 have low apparent density and poor flow. However, compacted and sintered, for powder metallurgy, they give high strength and conductivity. Also, they are used as is or flattened into a flake for pigmenting purposes in vehicles for conductive coatings and adhesives.

* Formerly called Silpowder 131

**Includes 1.5% Ag₂O.



HANDY PRODUCT DATA SHEET

HANDY & HARMAN INDUSTRIAL PRODUCTS DIV.
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Chemical
Products

GALVANIC PRECIPITATES

I. Specification:	<u>Silpowder 120</u>	<u>Silpowder 150</u>	<u>Silpowder 160</u>
A. Physical Properties:			
1. Apparent Density; g/in ³ by Scott Volumeter	20 to 35	25 to 40	25 to 40
2. Moisture; %	0.10 max.	0.10 max.	0.10 max.
3. Flow by Rotary Orifice Gauge (P to S)	Good	Excellent (A to E)	Fair (Q to T)
4. Screen Analysis: *			
	+100 trace	0.5 max.	trace
	-325 85.0% min.	30.0% max.	85.0% max.
* 100 g. sample - 1/2 hour on Ro-tap Sieve Shaker			
B. Chemical Composition:			
1. % Ag	99.8 min.	99.8 min.	99.8 min.
2. % Cu	0.05 max.	0.05 max.	0.05 max.
3. % Fe	0.05 max.	0.05 max.	0.05 max.

II. Typical Uses:

Powder Metal Contacts
Battery Plates

III. Remarks:

Silpowders 120,150 and 160, galvanically precipitated, are chiefly used where good flow properties and apparent density from 20 to 40 g/in³ are required. Although generally sintered, these particles have been used as a pigment in greases, epoxy resins and other similar vehicles.



HANDY PRODUCT DATA SHEET

HANDY & HARMAN INDUSTRIAL PRODUCTS DIV.
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Chemical
Products

STANDARD DRY FLAKE

DESIGNATION: SILFLAKE 131

I. Specification:

A. Physical Properties:

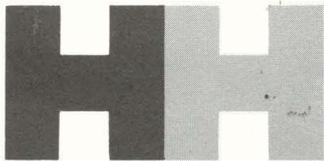
- | | |
|---|----------------------------|
| 1. Weight Loss at 1000° F | 0.8% |
| 2. Apparent Density
(by Scott Volumeter) | 16 to 25 g/in ³ |
| 3. Screen Analysis: | |
| -325 mesh | 90.0 min. |

B. Chemical Composition:

- | | |
|---------|-----------|
| 1. % Ag | 98.0 min. |
| 2. % Cu | 0.02 max. |
| 3. % Fe | 0.05 max. |

II. Typical uses:

Pigments for fire-on and bake-on conductive coatings.



HANDY PRODUCT DATA SHEET

HANDY & HARMAN INDUSTRIAL PRODUCTS DIV.
850 THIRD AVENUE, NEW YORK 22, N. Y.

Chemical
Products

SPECIAL FLAKES FOR AIR DRY CONDUCTIVE COATINGS

I. Specification:

	<u>Silflake 135 (Dry)</u>	<u>Silflake 850 (Wet)</u>
A. Physical Properties:		
1. Weight Loss at 230°F.	-----	15.5% max.
2. Weight Loss at 1000°F.	0.8% ± .2	0.8% max.
3. Screen Analysis:		
-325 mesh	90% min.	-----
B. Chemical Composition:		
1. % Ag	98.5 min.	85.0 ± 0.5
2. % Cu	0.02 max.	0.02 max.
3. % Fe	0.05 max.	0.05 max.

II. Typical Uses:

High reflectivity air dry coating.
Conductive adhesives.

III. Remarks:

Silflake 850 is supplied in 15% by weight denatured alcohol.