

Micromax™ 3993

Electronic Inks & Pastes

PRODUCT DESCRIPTION

Lead Free Series - Heated Glass Compositions

Micromax™ 399X Series Defogger Silver conductor compositions are provided for use in production of electrically heated glass. The Micromax™ 399X series will provide excellent printability and high print definition. Series members can be blended with each other to obtain a wide range of electrical resistance. These compositions have been designed to provide a robust fired layer that is resistant to environmental and chemical influences.

Product benefits

- Low laydown
- Wide range of electrical resistance
- Enhanced Green Strength
- Wide process window when co-firing over enamels
- Cadmium, Lead, Nickel and Phthalate free*
- Robust printing performance
- Supplied ready to print

*Cadmium, Lead, Nickel and Phthalate 'free' as used herein means that cadmium, lead, nickel, and phthalate are not intentional ingredients in and are not intentionally added to the referenced product. Trace amounts however may be present.

READ ENTIRE TECHNICAL DATA SHEET BEFORE USING THIS PRODUCT

PRODUCT INFORMATION

General Properties	Value Unit
Application	Heated window / Heated glass
Solvent or thinner	Micromax™ 9450
Solid content ¹	64 to 66 %
Blend member or series	399X Series

TECHNICAL DATA

Rheological Properties		Value	Unit
Viscosity ²		35 to 50	Pa.s
Application Technique		Value	Unit
Mask mesh ³		150 to 280	
Mask emulsion		12 to 25	µm
Drying temperature		125 to 150	°C
Recommended film thickness		8 to 10	µm
Electrical Properties		Value	Unit
Resistivity ⁴		8.24 to 12.36	mOhm per square
Storage and Stability		Value	Unit
Shelf life ⁵		6	months

¹750°C

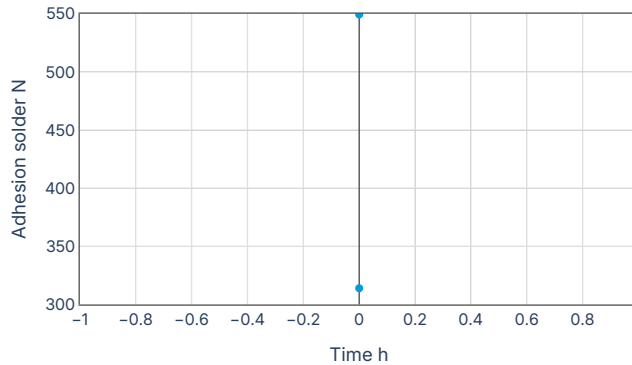
²Brookfield RVT, #14 at 10 rpm

³Screen Types: Stainless steel

⁴at 8µm fired thickness

⁵in unopened containers, from date of shipment, stable environment at room temperature between 5°C - 30°C

Adhesion solder after heat ageing



PROCESSING GUIDELINES

Blendability

In order to obtain a specific resistance value, the pastes can be blended with each other. A table showing sheet Resistivity vs. paste density (g/cc) is attached. A computer program or semi logarithmic graphs can be used to determine blend recipes for specific heated window designs.

Printing

Screen mesh size

150 - 280 per inch

Stainless steel screens are used in laboratory testing

Emulsion thickness

12 - 25 μm

Emulsion types

Terpene resistant

Enamel compatibility

Air dried and some UV

Drying

Allow printed paste to dry to desired green strength at between 125-150°C, if drying is needed.

Firing

Average glass surface temp.

600 - 670°C over enamel

600 - 700°C over glass

Furnace atmosphere

Sulphite free

Soldering

Burnish

Steel wool or fiberglass

Flux

Type R - rosin

Connector

Copper clip or braid pref, pre-tinned

Typical Fired Properties

Test	Properties
Line Width (µm)	350 - 800
Air side color	Light Brown / Yellow
Tin side color	Dark Brown
Solder metallurgy	Pb and Pb-free

Typical properties are based on laboratory tests, using the following conditions:

- Printing : 200 mesh stainless steel screen, 12µm emulsion
- Firing : 30 minute cycle, 11 zone belt furnace, peak temperature of 640°C
- Adhesion Test : Soldered copper clip, 70Pb/27Sn/3Ag, and Pb-free (In content) reflowed with flame
- Substrate : 2"x4" soda lime silicate glass, 4 mm thick

Information in this datasheet shows anticipated typical physical properties for Micromax™ 399X series based on specific controlled experiments in our labs and are not intended to represent the product specifications, details of which are available upon request.

399X Pb Free Blend Densities and Rs

	Gardco WG-SS-83.2 Cup Wgt (g)	Gardco WG-SS-8.32 Cup Wgt (g)	Paste Density	Ag%	Nominal R (Ω/ft)	Nominal R ($\text{m}\Omega/\text{sq}/8\mu\text{m}$)	Nominal SR ($\mu\Omega\text{-cm}$)
3991	323.0	32.3	3.88	78.8	0.72	3.12	2.50
90:10	310.3	31.0	3.73	77.1	0.82	3.15	2.52
80:20	297.5	29.8	3.58	75.3	0.92	3.18	2.55
70:30	284.8	28.5	3.42	73.6	1.02	3.21	2.57
60:40	272.0	27.2	3.27	71.9	1.12	3.25	2.60
50:50	259.3	25.9	3.12	70.2	1.22	3.28	2.62
40:60	246.6	24.7	2.96	68.4	1.32	3.31	2.65
30:70	233.8	23.4	2.81	66.7	1.41	3.34	2.67
20:80	221.1	22.1	2.66	65.0	1.51	3.37	2.70
10:90	208.4	20.8	2.50	63.2	1.61	3.40	2.72
3992	195.6	19.6	2.35	61.5	1.71	3.43	2.75
90:10	195.6	19.6	2.35	61.31	1.80	4.12	3.06
80:20	195.2	19.5	2.34	61.12	1.89	4.80	3.36
70:30	194.8	19.5	2.34	60.93	1.98	5.49	3.67
60:40	194.4	19.4	2.33	60.74	2.07	6.18	3.97
50:50	194.0	19.4	2.33	60.55	2.16	6.87	4.28
40:60	193.6	19.4	2.33	60.36	2.24	7.55	4.58
30:70	193.2	19.3	2.32	60.17	2.33	8.24	4.89
20:80	192.8	19.3	2.32	59.98	2.42	8.93	5.19
10:90	192.4	19.2	2.31	59.79	2.51	9.61	5.50
3993	192.0	19.2	2.31	59.6	2.60	10.30	5.80
3991	323.0	32.3	3.88	78.80	0.72	3.10	2.50
90:10	309.9	31.0	3.72	76.88	0.91	3.82	2.83
80:20	296.8	29.7	3.57	74.96	1.10	4.54	3.16
70:30	283.7	28.4	3.41	73.04	1.28	5.26	3.49
60:40	270.6	27.1	3.25	71.12	1.47	5.98	3.82
50:50	257.5	25.8	3.10	69.20	1.66	6.70	4.15
40:60	244.4	24.4	2.94	67.28	1.85	7.42	4.48
30:70	231.3	23.1	2.78	65.36	2.04	8.14	4.81
20:80	218.2	21.8	2.62	63.44	2.22	8.86	5.14
10:90	205.1	20.5	2.47	61.52	2.41	9.58	5.47
3993	192.0	19.2	2.31	59.60	2.60	10.30	5.80

Storage and shelf life

Containers should be stored, tightly sealed, in a clean, stable environment at room temperature between 5°C - 30°C. Shelf life of material in unopened containers is 6 months from date of shipment. Some settling of solids may occur and compositions should be thoroughly mixed prior to use.

Storage conditions on the product data sheets are intended to represent long-term material storage recommendations and not a shipping or temperature-at-receipt requirement.

Transportation: Under normal shipping conditions, without temperature control, Micromax™ products are not expected to exhibit a change in quality or fitness for use. Should extraordinary events result in extended transportation periods, Micromax™ recommends customers confirm products remain suitable for the intended application.

SAFETY & WARNING

It is recommended that the company/operator read and review the Safety Data Sheets for the appropriate health and safety warnings before use.
 Safety Data Sheets are available.

WASTE TREATMENT

Prior to using any recommendations or suggestions for waste treatment, the user is required to know the appropriate local/state/federal regulations for on-site or off-site treatment which may require permits. If there is any conflict regarding our recommendations, local/state/federal regulations take precedence.

CONTACT INFORMATION

www.macdermidalpha.com

North America	Europe	Asia
470 Research Drive Wilmington, DE, USA 855.622.7813	Bristol & Bath Science Park Dirac Crescent, Emersons Green, Bristol, BS16 7FR, United Kingdom 44.117.4769148	No. 45 Hsing-Point Road Taoyuan City, 330457 Taiwan 886.3.3773588

Also read carefully warning and safety information on the Safety Data Sheet. This data sheet contains technical information required for safe and economical operation of this product. READ IT THOROUGHLY PRIOR TO PRODUCT USE. Emergency safety directory assistance: US 1 202 464 2554, Europe + 44 1235 239 670, Asia + 65 3158 1074, Brazil 0800 707 7022 and 0800 172 020, Mexico 01800 002 1400 and (55) 5559 1588

DISCLAIMER: All statements, technical information and recommendations contained herein are based on tests we believe to be reliable, but the accuracy or completeness thereof is not guaranteed. No statement or recommendation shall constitute a representation unless set forth in an agreement signed by officers of seller and manufacturer. NO WARRANTY OF MERCHANTABILITY, WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE OR ANY IMPLIED WARRANTY IS MADE. The following warranty is made in lieu of such warranties and all other warranties, express, implied, or statutory. Products are warranted to be free from defects in material and workmanship at the time sold. The sole obligation of seller and manufacturer under this warranty shall be to replace any noncompliant product at the time sold. Under no circumstances shall manufacturer or seller be liable for any loss, damage or expense, direct, indirect, incidental or consequential, arising out of the inability to use the product. Notwithstanding the foregoing, if products are supplied in response to a customer request that specifies operating parameters beyond those stated above, or if products are used under conditions exceeding said parameters, the customer by acceptance or use thereof assumes all risk of product failure and of all direct, indirect, incidental and consequential damages that may result from use of the products under such conditions, and agrees to exonerate, indemnify, defend and hold harmless MacDermid, Incorporated and its affiliates therefrom. No suggestion for product use nor anything contained herein shall be construed as a recommendation to use any product in a manner that infringes any patent or other intellectual property rights, and seller and manufacturer assume no responsibility or liability for any such infringement.

© 2026 MacDermid, Inc. and its group of companies. All rights reserved. "(R)" and "TM" are registered trademarks or trademarks of MacDermid, Inc. and its group of companies in the United States and/or other countries.