TECHNICAL DATASHEET

ELECTRA WLP SH32-1-1

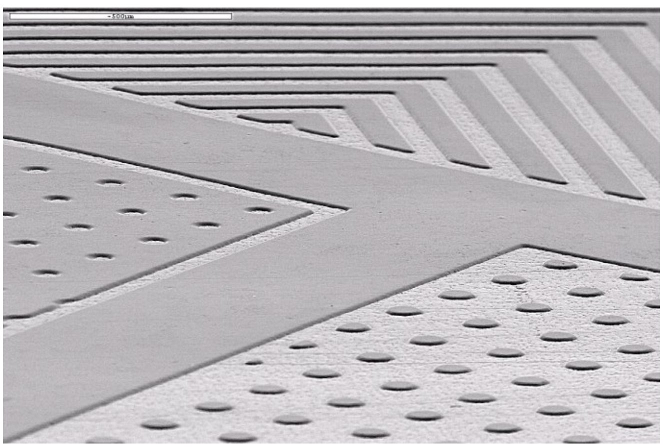
Aqueous Developable
WAFER-LEVEL PACKAGING
PHOTODIELECTRIC

PRODUCT SUMMARY

Electra WLP SH32-1-1 is a liquid, i-line photodielectric designed for wafer-level packaging applications. The product may be spin-coated onto glass and silicon wafers at thicknesses ranging from 5 – 40um.

Electra WLP SH32-1-1 performance properties include:

- Fast exposing – less than 250mJ/cm^2 for sub-10um layers
- Resolution capability to 15 um track and gap
- Optimum properties achieved by 150^{o}C cure
- Processed by aqueous chemistry
- Low Odour
- Ambient storage



PROCESSING REQUIREMENTS

Process Environment

Electra WLP SH32-1-1 is a high definition, negative-working photopolymer. It is sensitive to extraneous near-UV light, and excessive temperature and humidity. It is recommended that all application processing steps and inspection should be done in a controlled, clean-room environment:

Lighting:	Yellow Light, wavelength > 450nm
Temperature:	20 to 25°C
Relative Humidity:	30 - 70%

Product Description

WLP SH32-1-1 is a 2-part epoxy-acrylate system.

Part A is WLP SH32-1-1 Pt A.
Hardener is WLP SH32-1-1 Pt B
Mix ratio of Pt A to Pt B is 83 : 17 w/w

Product Mixing

To obtain optimum results, it is important that mixing of the components Parts A and B is done thoroughly. For quantities of less than approximately 200g, adequate mixing may be achieved manually, for example by rounded spatula, in 3 – 5 minutes.
Motor driven devices are strongly recommended for larger quantities, but are generally less efficient at mixing-in product from the sides of containers. A mixing period of 15 to 20 minutes is recommended.
High-shear mixers will cause air entrainment and should not be used.

Moderate vacuum may be used to remove micro-air bubbles prior to spin-coating; however, some solvent will be lost during vacuum-degassing which will result in viscosity increase. For example, a vacuum of 67 kPa (500mm Hg) can result in viscosity increase of 4% per hour for mixed product at 22°C.

Product Rheology

WLP SH32-1-1 is essentially a Newtonian fluid over a wide shear rate range, as demonstrated below. This property is important for even distribution of the photodielectric during spin-coating.

Shear Rate, 1/s	Viscosity*, mPa.s
0.2	5940
2.0	5940
20	5890
200	5710

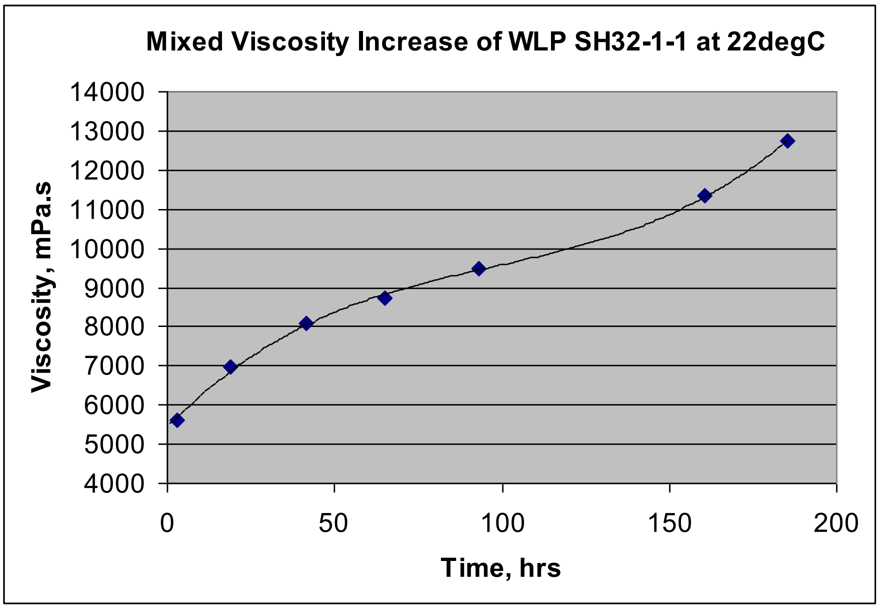
* *Viscosity measurement conditions:*
Cone and plate instrument, 40mm/4° truncated cone, operating in controlled shear rate mode at 22°C

Pot Life and Mixed Viscosity Increase

The viscosity of the mixed product increases with time (see below) but the product remains processable for up to 8 days when stored at a temperature no greater than 22°C. Generally, reducing storage temperature increases the mixed product pot life. The increasing viscosity of the mixed product as a function of time may be used to advantage when spin-coating.

Figure 1 shows the rate of increase of viscosity over eight days, for standard and high viscosity mixed products stored at 22-23°C:

Figure 1.



Viscosity measurement conditions:
Cone and plate instrument, 40mm/4° truncated cone, operating at controlled shear rate 2/s at 22°C

Surface Preparation

To obtain the optimum adhesion of Electra WLP SH32-1-1, the substrate should be free from surface contaminants such as grease, oxides and fingerprints.

1. Silicon and Glass Wafers

An adhesion promoter is generally necessary to ensure a reliable bond. A number of proprietary silane coatings are available for this purpose. The manufacturer's recommendations should be followed, including surface pre-treatment and method of application.
Typically, the wafer is flooded with a dilute (1-3%) solution of a compound such as aminopropyltriethoxysilane, methacryloxypropyltrimethoxysilane, or vinyltriethoxysilane. The wafer is then spun dry. A baking or other conditioning period may be advisable before applying the photodielectric.

2. Copper Laminate

An adhesion promoter is not normally required on copper, as long as the surface has been freshly prepared. Suitable techniques are:

a. Brush Pumice (grade 3F or 4F)
b. Jet Pumice (grade 3F or 4F)
c. Wet Brush (grade 320 grit)
d. Chemical (oxide preferred)

When using mechanical cleaning, surface roughness should be in the range of 2 to 4microns for optimum adhesion. For high resolution work, reduced surface roughness may be beneficial.

The metal surface should be dried before coating. Five minutes at 80°C is adequate for plain surfaces, but drilled or perforated surfaces may require a longer period.
Pre-cleaned copper panels should be coated within four hours, to minimize oxide build-up.

Coating
Spin Coating
The increasing viscosity of the mixed product on aging (see above), and the availability of the high viscosity Part B (WLP-SH32-1-1 Part B HV) enable the photodielectric to be spin-coated at a wide range of thicknesses. The values shown below may be used as a guide, for spin-coat periods of 1 - 2 minutes:

Viscosity, mPa.s	Spin Speed, rpm	Coating Thickness, um
6000	6000	5 - 6
10,500	2500	21
	3000	18
	3500	16
13,000	1500	40
	2000	30
	2500	24

Screen Printing
Printing conditions will vary depending upon the mode of use of the photodielectric. The conditions stated below are suitable where WLP SH32-1-1 is being used as a conventional soldermask and a deposit of approximately 25um is being applied. In this case, WLP-SH32-1-1 Part B HV should be used

Screen Printing Parameters

- Screen mesh: 34T Polyester
- Tension: 13-17N/cm^2
- Squeegee 60-80 Shore hardness, rounded edge
- Angle 75^o
- Printspeed <3 m/min
- Snap-off 4mm

Drying
Electra WLP SH32-1-1 can be dried by batch, conveyorised or IR convection ovens. Drying times will depend on the coated thickness and type of drying equipment.
For air convection ovens and coatings of 5 – 10um, a typical drying cycle is 10 minutes at a board surface temperature of 75°C.
20 – 40um coatings will typically require a drying period of 20-30 minutes at 75^{o}C.

Total drying period should not exceed 50 mins at 75^{o}C, or 35 mins at 80^{o}C.

Coatings should be cooled to room temperature (20°C) prior to exposure, to prevent variations in photosensitivity, and artwork marking / sticking.

Imaging
High resolution images may be achieved using a suitable phototool in conventional UV equipment.

The product is sensitive to light in the range of 340 to 420nm. Exposure units with iron-doped mercury lamps in the 3 to 10 KW range are recommended. Exposure frame temperatures in excess of 30^{o}C should be avoided, in order to prevent photo-tool sticking. Good vacuum (better than 0.6 bar recommended) is important during exposure for optimum cross linking of the soldermask, and for intimate contact between the phototool and resist.
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Exposure times will depend on the type of equipment used and the resist thickness and to some extent on the required resolution. Reducing exposure energy can significantly reduce line growth, particularly for thin films. Typical exposure energies are as follows:

Dried Coating Thickness, um	UV Exposure Energy Range, mJ/cm^2	Approx. Resolution (Track and Gap) Achievable
5 - 10	70 - 250	10-20um
10 - 20	180 - 350	20um
20 - 30	300 - 400	25um
30 - 40	350 - 450	35um

A Stouffer 21 Step Wedge will assist with UV- energy setting. For optimum film performance, a clear copper step 9 – 11 should be targeted. This should be achieved in combination with a developer breakpoint in the range 30 – 50% (see below).

Electra WLP SH32-1-1 contains a photofugitive dye which produces a visual contrast between exposed and non-exposed resist.

Developing

Hold time between exposing and developing should not exceed 24 hours. For highest resolution work, hold time should be minimised.

Electra WLP SH32-1-1 may be developed by sodium or potassium carbonate solutions in the range 1.0 – 1.3% w/v, at a temperature of 28 - 35°C.

Acceptable working pH range is 11.4 (fresh developer solution) to 10.6, although pH should be maintained, by carbonate solution replenishment, above pH 10.8 for high resolution work. Note however that a combination of high pH, high developing temperatures (35+°C) and solution concentrations in excess of 1.3% can degrade the surface of the coating.

Developing time will depend on the above parameters, on resist thickness and on the equipment used. A spray pressure of at least 2 bar is recommended to ensure clean developing.

A break point of 50% (ie, bare substrate revealed at half total developer dwell time) is generally recommended, although high resolution work may require a slightly longer developing time.

A water rinse at 10 - 20°C and spray pressures of 1.5 to 2.0 bar should be applied.
A deionized water rinse after mains water rinsing and the use of a hot air turbine drier will help to reduce drying marks..

Antifoam solution may be necessary in the developer to prevent frothing.

Thermal Curing

Maximum chemical and thermal resistance is obtained using a thermal curing time of **60 minutes at 150°C**. This will normally equate to a total curing cycle time of 75 to 90 minutes. There is some latitude to reduce the temperature at the expense of increased cure time, for temperature sensitive applications; but full cure is unlikely to be achieved below 135^{o}C.

There is a reduction of film thickness of between 5 – 10% when comparing developed-only and thermally cured coatings.

Electra WLP SH32-1-1 can also be cured using infra-red curing equipment. Temperature settings and lines speeds will depend on the type of equipment being used.

A blanket UV cure of 1.5 – 3.0 joules per cm^2 carried out after developing, will generally increase the hardness of the product. This increased hardness may be beneficial through soldering and defluxing.
Additionally, blanket UV cure will reduce resist thickness loss between developing and final (thermal) cure, and aid resist performance if a low imaging exposure had been used to obtain maximum resolution.

Resist Removal

Errors in the product application process may require the resist to be stripped. The imaged (but not fully-cured) resist can be removed in an aqueous solution of 5% potassium hydroxide at a temperature of 50 to 60 °C. Alternatively, the imaged resist may be removed by a variety of ketone, glycol and glycol ester solvents.

Fully cured resist has high chemical resistance, and is not readily attacked. However, soaking layers in hot organic base solution, or in an aggressive solvent mixture such as methylene chloride / butyrolactone, will soften the resist and facilitate its removal.
Always consult suppliers' MSDS, particularly when using aggressive chemistries.

Illumination of Working Areas

Electra WLP SH32-1-1 is sensitive to strong white light. It is recommended that the working areas be illuminated with yellow fluorescent lamps, such as Phillips type 1.2m TL-D36W-16. Windows should be coated with a non bleachable yellow film which is opaque to wave lengths below 450nm.
Plexiglas type yellow 303 is equally suitable.

Storage Conditions

For optimum long term storage, Electra WLP SH32-1-1 should be held in the unmixed state in a dry and cool environment (30 to 70% RH at a temperature of between 5 and 20°C).

The minimum shelf life of the Part A under these conditions is 12 months from date of manufacture.
The minimum shelf life of the Hardener (Pt B) under these conditions is 24 months from date of manufacture

Pot-life of mixed components A+B: 8 Days at a temperature of 22º C

Shipping Conditions

Electra WLP SH32-1-1 is a stable product in the unmixed state and does not require refrigeration for long-distance seafreight or trucking purposes but should be stored under recommended conditions once delivered.

Product Characteristics and Final Properties

The following product characteristics and performance levels are expected, but these data do not constitute a specification:

TEST	METHOD	RESULT
Non-volatile Content:	Compositional analysis	60 - 62% when Part A is mixed with standard Part B in ratio 83:17 62 - 64% when Part A is mixed with high viscosity Part B in ratio 86:14
Density (25ºC)	Electra method EPC620	Component A 1.06 g/cm³ Standard Part B 1.05 g/cm³ High viscosity Part B 1.15 g/cm³
Hardness (pencil)	SM-840B 2.4 27.2	6H
Hardness (acc Knoop)		24/26
Abrasion (Taber method)	SM-840B 4.8.3.1	Pass

TEST	METHOD	RESULT
Grid section	DIN 53152	GT 0
Wave-solder resistance	SM840B 4.8.9.2 MIL-Std 202F/210A	10s at 260 (± 5)°C 30s at 280 (± 5)°C
Hot-air-solder-level	255 (± 5)°C	Minimum 3 x 10s cycles
Chemical resistance 10% Sulphuric acid 5% Caustic soda Alcohols, e.g. Ethanol Ketones, e.g. Acetone Methylene chloride Fluoro-chloro-hydrocarbons	Room temp. 60 mins Room temp. 60 mins Room temp. 24 hours Room temp. 1 hour Room temp. 1 hour Room temp. 1 hour	Pass Pass Pass Pass Pass Pass
Thermal Shock Resistance	MIL-Std 202F/107D Siemens F12-F8089 (-65°C/15 min, 125°C 15 min – 100 cycles)	No Crack Formation Pass
Insulation resistance	Siemens F12-F9089 23°C/50% RH/100V DC After 4 days, 40°C/92% RH	2.0×10^{14} Ω 4.0×10^{10} Ω
Specific Insulation resistance After 4 days storage at 40°C/92% RH	DIN 53 482 VDE 0303, part 3	1.1×10^{15} Ω 2.2×10^{12} Ω
Surface resistance After 4 days storage at 40°C/92% RH	DIN 53 482 VDE 0303, part 3	4.2×10^{14} Ω 7.2×10^{11} Ω
Electrolytic corrosion 21 days 40°C/92% RH	Siemens F12-F9089	0
Creepage Current Strength Test solution A	DIN, IEC 112 VDE 0303, part 1	550
Break down Strength Mean value (kV/mm)	VDE 0303, part 2 DIN 53481	141
Dielectric Constant 23°C/50% RH	DIN 53483 VDE 0303, part 4	1 KHz 4.1 100 KHz 3.8 1 MHz 3.7

TEST	METHOD	RESULT
Dielectric Loss Factor 23°C/50% RH	DIN 53483 VDE 0303, part 4	1 KHz 3.3×10^{-2} 100 KHz 3.0×10^{-2} 1 MHz 2.1×10^{-2}
Tg, °C	TMA	121
CTE ppm/ °C Below Tg: Above Tg	TMA	78 158
Young's Modulus GPa 25°C 125°C	DMA	4.8 1.7

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