# TECHNICAL DATASHEET

# WLP60

## Aqueous Developable
## PHOTOIMAGEABLE DIELECTRIC

**PRODUCT DESCRIPTION**

**WLP60** is a negative-working photoimageable dielectric. It is supplied as two-component liquid, and may be applied by spin-coating, screen-printing, curtain coating or spray.
**WLP60** is an approved component of wafer-level chip-scale packaging devices, where it may be used as a soldermask - for example in precision soldered inter-connections (the fabrication of ball-grid arrays) – and as an inter-layer adhesive dielectric. It is also used in the fabrication of high resolution printed circuit boards.

**WLP60 performance features**:

- Photoimaged by industry-standard 360-380nm UV
- Better than 40um resolution at up to 40um finished thickness
- Rapid drying, typically 10-15mins at 75$^{o}$C
- Epoxy / acrylate chemistry giving exceptional chemical and thermal resistance
- Optimum properties achieved by 150$^{o}$C cure
- Processed by aqueous chemistry
- Low Odour
- Ambient temperature storage, 12 month shelf life
- RoHS and Sony Green Product compliant

## PROCESSING REQUIREMENTS

### Process Environment

WLP60 is a negative-working Dielectric, sensitive to ultraviolet light, excessive temperature and excessive humidity. It is recommended that all application processing steps and inspection should be done in a controlled environment:

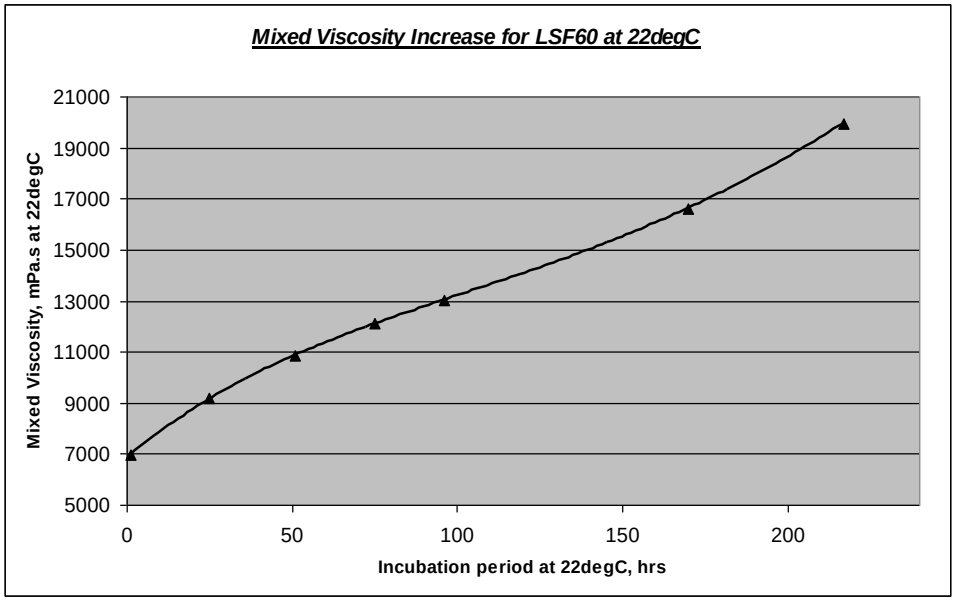
| | |
|---|---|
| Lighting: | Yellow Light, wavelength > 450nm |
| Temperature: | 20 to 25°C |
| Relative Humidity: | 30 - 70% |

### Product Mixing

To obtain the optimum results with the product it is important that mixing of the components A and B ( and C if necessary) is done thoroughly. A motor driven device is strongly advised. Adequate mixing will be achieved within 15 to 20 minutes.
The mixing ratio is 83 parts A to 17 Parts B as supplied in standard containers.

### Pot Life and Mixed Viscosity Increase:

The viscosity of the mixed product increases by approximately 80% over 4 days at 22°C. The product remains processable for up to 8 days when stored at a temperature no greater than 22°C.




Reducing the 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.

### Surface Preparation

To obtain the optimum adhesion of WLP60, the surface to be coated should be free from surface contaminants such as grease, oxides and fingerprints. Suitable treatments include the following:

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 4 microns for optimum adhesion.

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

### 1. Spin Coating

The increasing viscosity of the mixed product on aging (see above), enables the Dielectric 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 |

Vacuum de-gassing of the mixed product is recommended for critical spin-coat applications.

### 2. Screen Printing

- 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

After printing panels should be racked and dried horizontally. The recommended minimum dried resist thickness required over conductor edges is 12/15 microns.

(WLP60 may also be curtain coated).

## Drying

WLP60 can be dried by batch, conveyorised or IR convection ovens. The drying times will vary depending on the type of equipment used.
For air convection ovens a typical drying cycle is 10 to 15 minutes per side at a wafer or panel surface temperature of 75 - 80°C.
In conveyorised drying systems the drying time is dependant on the type of equipment and the volume of Dielectric being processed.

It is recommended that coatings be allowed to return to room temperature (20°C) prior to exposure

## Exposure

WLP60 is a negative-working Dielectric, and may be imaged using a conventional UV exposure source. The exposure time for the proper polymerisation of the product is a function of the type and intensity of the light source used.

WLP60 reacts with light in the spectral range of 340 to 420nm. Commercially available exposure units with mercury lamps in the 3 to 10 KW range which are doped with Fe are recommended. Units which have air or water-cooled exposure frames are preferred, to minimize artwork marking, and to reduce variability of exposure photostep.

Exposure times will depend on the type of equipment used and the resist thickness. The following UV exposure energies are recommended for general applications:

| Coating Thickness | Exposure Energy, mJ/cm$^2$ |
|---|---|
| 10 – 20um | 250 – 350 |
| 20 – 35um | 350 – 450 |
| 35 – 45um | 450 – 600 |

Increasing the exposure energy beyond these levels may cause slight image coarsening, and a more positive sidewall ‘foot’. The latter may improve chemical resistance of the layer in demanding applications.

A Stouffer 21 Step Wedge will assist UV- energy setting, helping to ensure consistent photodielectric performance

Good vacuum is important during exposure to obtain the optimum cross linking of the Dielectric.

## Developing

The hold time between exposing and developing should not exceed 24 hours
WLP60 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, 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. Excessive development can also increase undercut. For these reasons, developer breakpoint should be the minimum consistent with adequate image resolution and residue-free surfaces. A developer breakpoint of between 40 – 70% of total dwell time is generally recommended.

Actual 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 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. Ask your Electra representative for current recommendations

## Curing

Thermal curing is necessary to obtain optimum chemical, thermal and and physical properties of WLP60,. This is most readily achieved using a convection air oven.

The recommended curing time is 60 minutes at a temperature of 150°C, which normally equate to a total curing cycle time of 75 to 90 minutes.

WLP60 can also be cured using infra-red curing equipment. Temperature settings and lines speeds will depend on the type of equipment being used.

A UV cure of 2.5 to 3.0 joules per $cm^2$ carried out after developing will increase the pencil hardness of the product from 6H and 7H.

## Resist Removal

Errors in the product application process may require the resist to be stripped. The uncured resist can be removed in an aqueous solution of 5% potassium hydroxide at a temperature of 50 to 60 °C. Alternatively, polar organic solvents such as acetone may be used.

Cured WLP60 is very difficult to strip. A proprietary stripper such as ES108H can be used, contact your Electra representative for advice.

## Illumination of Working Areas

WLP60 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 not transparent to wave lengths below 450nm.
Alternatively Plexiglas type yellow 303 is equally suitable.

## Storage Conditions

For optimum long term storage, WLP60 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 product under these conditions is 12 months from date of manufacture.

## Shipping Conditions

WLP60 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 condition once delivered.

## Product Characteristics

| | | |
|---|---|---|
| Solid Content: | 67 - 68% | |
| Density (25ºC) | Component A | 1.25 g/cm³ |
| | Component B | 1.05 g/cm³ |
| | Mixture | 1.23 g/cm³ (before dilution) |
| Mixed Pot-life: | Mixed Components A+B | 8 Days at a temperature of 22º C |

## Product Final Properties

| TEST | METHOD | RESULT | CLASSIFICATION |
|---|---|---|---|
| **Hardness (pencil)** | SM-840B 2.4 27.2 | 6H | |
| **Hardness (acc Knoop)** | | 24/26 | |
| **Abrasion (Taber method)** | SM-840B 4.8.3.1 | Pass | |
| **Grid section** | DIN 53152 | GT 0 | |
| **Chemical resistance**<br>10% Sulphuric acid<br>5% Caustic soda<br>Alcohols, e.g. Ethanol<br>Ketones, e.g. Acetone<br>Methylene chloride<br>Fluoro-chloro-hydrocarbons | <br>Room temp. 60 mins<br>Room temp. 60 mins<br>Room temp. 24 hours<br>Room temp. 1 hour<br>Room temp. 1 hour<br>Room temp. 1 hour | <br>Pass<br>Pass<br>Pass<br>Pass<br>Pass<br>Pass | |
| **Tg, ºC** | DMA / TMA | 146(DMA), 125(TMA) | |
| **CTE** Below Tg<br>Above Tg | TMA | 55 ppm / ºC<br>123 ppm / ºC | |
| **Modulus,** GPa 25ºC<br>125 ºC | DMA | 4.6<br>2.2 | |
| **Stress ( = modulus at 25ºC x CTE below Tg)** | | 253 | |
| **Thermal Shock Resistance** | MIL-Std 202F/107D<br>Siemens F12-F8089<br>(-65°C/15 min, 125°C 15 min – 100 cycles) | No Crack Formation<br>Pass | Pass |
| **Insulation resistance** | Siemens F12-F9089<br>23°C/50% RH/100V DC<br>After 4 days, 40°C/92% RH | $2.0 \times 10^{14}\ \Omega$<br>$4.0 \times 10^{10}\ \Omega$ | |

| TEST | METHOD | RESULT | CLASSIFICATION |
|---|---|---|---|
| **Specific Insulation resistance**<br>After 4 days storage at 40°C/92% RH | DIN 53 482<br>VDE 0303, part 3 | $1.1 \times 10^{15}\ \Omega$<br>$2.2 \times 10^{12}\ \Omega$ | |
| **Surface resistance**<br>After 4 days storage at 40°C/92% RH | DIN 53 482<br>VDE 0303, part 3 | $4.2 \times 10^{14}\ \Omega$<br>$7.2 \times 10^{11}\ \Omega$ | |
| **Electrolytic corrosion**<br>21 days 40°C/92% RH | Siemens F12-F9089 | 0 | |
| **Creepage Current Strength**<br>Test solution A | DIN, IEC 112<br>VDE 0303, part 1 | 550 | |
| **Break down Strength**<br>Mean value (kV/mm) | VDE 0303, part 2<br>DIN 53481 | 141 | |
| **Dielectric Constant**<br>23°C/50% RH | DIN 53483<br>VDE 0303, part 4 | 1 KHz 4.1<br>100 KHz 3.8<br>1 MHz 3.7 | |
| **Dielectric Loss Factor**<br>23°C/50% RH | DIN 53483<br>VDE 0303, part 4 | 1 KHz $3.3 \times 10^{-2}$<br>100 KHz $3.0 \times 10^{-2}$<br>1 MHz $2.1 \times 10^{-2}$ | |
| **Wave-solder resistance** | SM840B 4.8.9.2<br>MIL-Std 202F/210A | 10s at 260 (± 5)°C<br>30s at 280 (± 5)°C | Pass<br>Pass |
| **Hot-air-solder-level** | 255 (± 5)°C | Minimum 3 x 10s cycles | Pass |
| **UL Flammability** | UL 94 V-O | V-0 | E 68935 |

For further information, contact:

Electra Polymers Ltd
Roughway Mill,
Dunk's Green
Tonbridge
Kent  TN11 9SG
UK

Tel: +44 (0)1732 811 118
info@electrapolymers.com

Or visit our Website for details of local offices and Distributors

**www.electrapolymers.com**