

## XV501T-4 Screen

From the ImagecureSMART™ family  
of Photoimageable Solder masks

### 1. Description

**imagecureSMART®** AQ XV501T-4 Screen is a two component thermal hardening liquid photoimageable solder resist that dries by solvent evaporation to give a film that can be processed in aqueous potassium or sodium carbonate solution, or solvent.

This Technical Information Leaflet (TIL) and the relevant Material Safety Data Sheet (MSDS) should be read carefully prior to using this product.

### 2. Product features

- RoHS & WEEE Directive Compliant
- Excellent adhesion to all clean copper surfaces
- Not recommended for use with reflow tin/lead and electrolytic gold plated conductors. For the processes the **imagecureSMART®** XV501T screen products are recommended
- A selection of products is available to suit a wide range of process conditions. The required colour and finish may be obtained by mixing the appropriate resist with the clear hardener
- Suitable for exposure with Laser Direct Imaging (LDI); please refer to Technical Information Leaflet (TIL) number T227 for further information
- Sony Green Partner Program Registered



**U.L. FILE NUMBER E83564**

® is a registered trade mark



### 3. Product Range

SAP No.

|          |          |                                                  |          |          |
|----------|----------|--------------------------------------------------|----------|----------|
| 90173614 | XV501T-4 | Matt Green Halogen Free Screen Resist            | 2.00 kg. | CAWN2220 |
| 90173619 | XV501T-4 | Semi Matt Green Halogen Free Screen Resist       | 2.00 kg. | CAWN2249 |
| 90173620 | XV501T-4 | Matt Green Halogen Free Screen Resist            | 2.00 kg. | CAWN2255 |
| 90173626 | XV501T-4 | Semi Matt Dark Green Screen Resist               | 2.00 kg. | CAWN2287 |
| 90173630 | XV501T-4 | Semi Matt Dark Green Screen Resist               | 2.00 kg. | CAWN2321 |
| 90173611 | XV501T-4 | Clear Screen Hardener                            | 1.00 kg. | CAWN2196 |
| 90173638 | XV501T-4 | Clear Screen Hardener                            | 1.00 kg. | CAWN2432 |
| 90173628 | XV501T-4 | Extra Matt Green Halogen Free Screen Resist      | 2.00 kg. | CAWN2292 |
| 90173636 | XV501T-4 | Extra Matt Dark Green Halogen Free Screen Resist | 2.00 kg. | CAWN2422 |
| 56215910 | XV501T-4 | Extra Matt Dark Green Screen Resist              | 2.00 kg. | CAWN2470 |
| 90173627 | XV501T-4 | Clear Screen Hardener                            | 1.00 kg. | CAWN2291 |
| 90173670 | XV501T-4 | Semi Matt Dark Green Screen Resist               | 0.67 kg. | CAWP2321 |
| 90173660 | XV501T-4 | Clear Screen Hardener                            | 0.33 kg. | CAWP2196 |
| 90173674 | XV501T-4 | Clear Screen Hardener                            | 0.33 kg. | CAWP2432 |
| 90160166 | XZ107    | Slow Thinner                                     | 5.00 L.  | CDSN4059 |
| 90160157 | XZ46     | Screen Cleaner                                   | 5.00 L.  | CDSN4008 |



## 4. General Handling

### 4.1 Storage and Shipping

When stored in sealed containers, in a cool place (20°C / 68°F), away from sources of direct heat and sunlight, **imagecureSMART®** XV501T-4 resist and hardener components have a minimum shelf life of 18 months.

**imagecureSMART®** XV501T-4 can withstand higher temperatures (40 - 60°C / 104 - 140°F), whilst in transit for up to periods of 1 month without any detrimental effect on its performance.

### 4.2 Waste disposal

Care should be exercised in the disposal of printing ink waste. This should be carried out in accordance with good industrial practice, observing all the appropriate regulations and guidelines.

For more specific handling advice refer to the detailed Safety Data Sheet (SDS), supplied by your local Sun Chemical Circuits representative.

## 5. Application / Processing Conditions

### 5.1 Processing Environment

The choice of printing and exposure environment has been found to have a direct effect on fine solder dam yield values. Every effort should be made to minimise the incidence of dust or fibres on the print room and exposure area.

It is therefore recommended that a Class 10,000 clean room be considered the minimum requirement for resolving features less than 100µm (4mil) at high yield.

Commercial, automated printing equipment may already contain some level of air filtration and the manufacturers or local Sun Chemical Circuits representatives can advise on its' suitability.

It is also recommended that the screen print area be fitted with UV screened illumination (yellow lights) due to the high photosensitivity of this particular product.

### 5.2 Mixing

The resist and hardener components must be mixed together in the correct mixing ratio of 2:1 w/w before use. The hardener component must be added to the resist component.

Mechanical mixing is recommended to ensure thorough mixing of the resist and hardener components. Recommended mixers include those with variable speed motors and paddle type mixing blades as well as the shaker or rotating type mixers. The use of such mixers should guarantee a consistent product mix for each mixed pack.

Mixing times will depend on the type of mixer or stirrer used but typical mix times of 10 - 15 minutes with stirrer speeds between 40 - 100 rpm can be expected. Avoid excessively fast speeds as this will entrap large volumes of air into the mixed resist.

It is recommended that attention be paid to ensuring that any resist at the sides of the container and on the bottom is completely mixed into the main body of the resist.



**NOTES ON RESIST / HARDENER COMPATIBILITY**

1. CAWN2292, 2422, and 2470, Extra Matt resists must only be used with CAWN2291 hardener; these components should not be mixed with other **imagecureSMART®** XV501T-4 products.
2. CAWN2432 is an alternative hardener that is recommended for use with CAWN2220, 2249, 2287, 2321 & 2255 resists only.

After the mixing operation is completed it is recommended to allow the mixed and thinned pack to debubble for ~ 30 min. before use.

Mixed pot life at 23 $\pm$  2°C (70 - 77°F) will be approximately 72 hours. Always ensure the lid is replaced on the container to avoid any contamination and excessive solvent evaporation.

**5.3 Thinning**

This product is supplied ready-to-use, and therefore further thinning is not generally recommended. However, should further thinning be deemed necessary, a maximum of 3% **imagecureSMART®** Slow Thinner XZ107 should be used.

**N.B. The mixed resist should be stirred thoroughly before reduction.**

**5.4 Pre-Clean**

Ensure that all copper surfaces are completely clean, tarnish free and dry prior to applying **imagecureSMART®**. For panels that are badly oxidised and tarnished then a micro-etch prior to mechanical pre-cleaning is recommended. The micro-etch should be capable of removing any oxide or tarnish staining and of thoroughly rinsing and drying the panel before being mechanically cleaned.

Mechanical pre-cleaning is recommended as follows: -

**Brushing** 280 - 400 grit silicon carbide brushes are recommended having a footprint on the copper of 8 - 15mm. (0.3 - 0.6 in). The water rinse and heater sections should be capable of thoroughly rinsing and drying the panels such that no water is left in the holes or between closely spaced conductors and that moisture or tarnish is not present on the freshly brushed panels.

It is important that each brush is regularly checked and dressed as necessary to ensure optimum efficiency during use. Please note that Nylon brushes of 600 - 800 grit can also be used.

**Pumice** Pumice or Aluminium oxide slurry of between 12 - 18% is recommended with an optimum of 15%. The water rinse and heater sections must be capable of rinsing and drying the panels such that residual pumice particles are completely removed and that no water is left in the holes or between closely spaced conductors and that moisture or tarnish is not present on the freshly cleaned panels.

**Microetch** Where panels have close track/gap configurations, which may not be suitable for mechanical precleaning, the use of a "deep etching" micro-etch chemistry is recommended. It is recommended that each user ensures that the Imagecure product is compatible with the particular micro-etch used and all subsequent metal finishing processes.



Surface roughness figures of:-

|           |              |
|-----------|--------------|
| Ra        | 0.2 - 0.4µm. |
| R delta q | 4 - 9º       |

would be considered to be optimum values for copper surfaces pre-cleaned as above. A minimum Ra of 0.2µm. with an R delta q value of >4º is recommended (optimum R delta q values 7 - 9º).

Please refer to separate technical document on surface roughness for a fuller explanation of the above roughness values.

NB. It is recommended that all freshly cleaned panels are coated with **imagecureSMART® XV501T-4** within a maximum time of 2 - 4 hours. The actual maximum time will vary depending upon ambient temperature and humidity. Panels left longer than 4 hours before coating should be pre-cleaned again.

### 5.5 Application

The **imagecureSMART® XV501T-4** series can be used with all types of vertical screen print units and horizontal screen print machines.

Typical polyester meshes will be 32 - 43T/cm. (80TPI - 110TPI), with a 65 - 70° shore squeegee with a square edge profile. The optimum mesh for printing is 43T/cm (110TPI) and this will be suitable for most 18µm. and 35µm. base copper board designs.

For boards with 70µm. base copper, or for boards requiring a specific withstand voltage the use of meshes with lower mesh counts 32 - 36T/cm. (80 - 90TPI) may be necessary.

Print tests with subsequent microsections are recommended to ensure adequate track encapsulation. Screens must be cleaned, thoroughly dried and free from cleaner or solder mask residues, before use.

### 5.6 Washing Up

Screen Cleaner XZ46 is recommended for washing up.

Alternative cleaners and screenwashes are available to suit customers' particular requirements. Your local Sun Chemical Circuits representative will be pleased to advise on product selection.

### 5.7 Pre-Dry

Good drying of the printed film is important so ovens with good temperature profiles and extraction are necessary. Specific drying parameters (time and temperature) will be dependent upon the specific oven used as well as the thermal mass and quantity of the panels being dried.

It is recommended that printed panels be allowed to debubble for approximately 5 - 10 minutes in still air at ambient temperature prior to being placed in the oven.

Air flow speeds of 1 - 2m/sec. are recommended to achieve sufficient removal of the volatile solvent. Drying is less efficient as the air velocity drops below 0.5m./sec.

For vertical screen print systems with a vertical drying oven a set air temperature of 75 - 85°C (167 - 185°F) for 30 - 50 min. is recommended. Optimum 80°C (176°F) for 45 minutes. Drying will depend on board thickness and **imagecureSMART®** thickness as printed, as well as air flow in the oven.



For printing processes that only print one side at a time the following is recommended for box ovens:-

|        |                                           |
|--------|-------------------------------------------|
| Side 1 | 10 - 15 min. at 75 - 80 °C (167 - 176 °F) |
| Side 2 | 25 - 35 min. at 75 - 80 °C (167 - 176 °F) |

The maximum drying time (Side 1 + 2) should not exceed 45 minutes at 80 °C (176 °F).

The **imagecureSMART®** XV501T-4 series can also be dried in IR ovens. Specific times and temperatures will depend on the specific Infra red oven used. Please discuss with your **imagecureSMART®** partner the specific settings before use.

Allow an adequate gap between panels. Spacing of 25 - 40 mm (1 - 1.6 in.) is recommended to ensure sufficient air flow between panels.

After drying it is recommended that panels be exposed and developed within 24 hours. The maximum storage time of boards before exposure/development is 72 hours. It is recommended that boards be stored in yellow light conditions with controlled temperature and humidity. If the humidity increases above 60% RH then the storage time of the dried panels will be reduced.

## 5.8 Exposure

All **imagecureSMART®** XV501T-4 systems are negative working and can be used with all exposure units using ferric doped mercury vapour lamps with UV wavelengths between 300 - 400nm.

Ferric doped lamps with power ratings of 5 - 10kW are recommended. It is recommended that to remove the infra red radiation the unit is either cooled or has an infra red filter to keep the temperature of the artwork < 30 °C (86 °F). Optimum working temperature 22 - 25 °C (72 - 77 °F).

Exposure readings of 200 - 300 mJ/cm<sup>2</sup> are typical\*.

\* Exposure readings taken with an IL390B radiometer from the International Light Co. Inc.

Stouffer values of 8 - 10 (solid resist) using a 21 step wedge are typical. For selective Ni/ Au and or immersion Sn exposure levels of 10/11 (solid resist) are recommended.

The artwork should have a Dmax > 4.0 and a Dmin < 0.15.

**imagecureSMART®** XV501T-4 (CAWN2220 / 2249 / 2196 and CAWN2292 / 2291 are also suitable for exposure with LDI equipment; please refer to TIL number T227 for further information.

Where panels are to be developed using solvent, a minimum Stouffer value of 10 should be considered.

## 5.9 Thermal Bump

If panels are to be developed in solvent, a thermal bump immediately after exposure may be necessary. Recommended conditions are 100 °C (212 °F) for 100 seconds.

Discussion with your **imagecureSMART®** partner is recommended in order to obtain optimum results.



## 5.10 Development

### Aqueous Developing

**imagecureSMART®** XV501T-4 will readily develop in either potassium or sodium carbonate solutions. The recommended carbonate concentration is  $10 \pm 2\text{g./lit.}$

The working pH range is 10.8 to 11.3 for aqueous carbonate solutions. To ensure the quality of development it is recommended that the pH of the developer solution does not drop below 10.8. At a pH <10.6 the efficiency of the developer solution may drop due to the increased loading of photopolymer.

Recommended temperature range is 30 - 40°C (86 - 104°F), optimum 35 - 38°C (95 - 100°F).

Spray pressures between 2 - 4 bar (30 - 60 PSI), optimum 2.5 bar (37.5 PSI).

Dwell times in the developing chambers of 45 - 80 seconds, optimum 60 seconds. For boards with small via holes (0.2 - 0.4mm) or with laminate thickness > 3mm, longer dwell times may be necessary to ensure complete development of the holes.

Water rinse pressures to be 2 -3 bar (30 - 45 PSI), with operating temperatures 15 - 30°C (59 - 86°F).

It is recommended that hard water (~200 ppm dissolved ions) be used where possible to give good rinsing, followed by a final rinse in deionised water.

Anti-foams will need to be added to the aqueous developing chambers to avoid foaming. The amount of anti-foam to be added may vary depending upon the type of anti-foam used, the size and number of developing chambers and spray bars, spray pressures and the loading of developed resist. In all cases it is recommended that the minimum amount of anti-foam be added.

### Solvent Developing

**imagecureSMART®** XV501T-4 will also develop in solvent (BDG, EDG or BLO). The developer temperature should be  $30 \pm 2^\circ\text{C}$  (82 - 90°F), with a dwell time between 120 and 160 seconds. Spray pressures of 4 - 5 bar (60 - 75 PSI) are normal. Optimum conditions will include a dwell of 150 seconds @ 30°C (86°F) with spray pressures of 4 - 5 bar.

It should be noted that Imagecure® films needing to be removed can be stripped by dipping in either a proprietary solder mask stripper or 5% sodium hydroxide solution at 50 - 70°C (122 - 158°F).

## 5.11 UV Bump

Generally **imagecureSMART®** does not require a UV bump. However there may be certain customer processes or requirements that render the use of a UV bump desirable or necessary.

If a UV bump is required then it is recommended that it be carried prior to post bake, and that a multi lamp double sided UV cure unit be used. Recommended UV energy is 1000 - 1500mJ/cm<sup>2</sup>.

A UV bump can also be carried out after post bake, recommended energy of 2500 - 3000mJ/cm<sup>2</sup>.

A UV bump will improve surface hardness, reduce volatile emissions, reduce ionic contamination and give increased resistance to OEM assembly cleaning processes.



### 5.12 Post Bake

It is important to ensure that all ovens have an independent thermal profile taken, as the set air temperature is not always reliable and the air flow in the oven or the door seals may give rise to either hot or cold spots.

The recommended bake cycle is 140 - 150°C (284 - 302°F) for 60 - 90 min. Optimum is 150°C for 60 min. Bake times should be taken when oven temperature reaches the pre-set point.

Sufficient air flow is necessary to ensure a consistent temperature gradient in the oven as well as a uniform degree of cure for the solder resist.

With respect to batch ovens boards should be racked 25 - 40mm. (1.0 - 1.6 in.) apart.

All exhaust ducting and extraction fans should be adequately insulated to avoid any volatile emissions condensing around the oven area.

### 5.13 Notation/ Legend Printing

All **imagecureSMART®** XV501T-4 products are compatible with a wide range of Sun Chemical UV curing, thermal curing and photoimageable notation inks.

Thermal curing inks can be applied prior to post bake to increase productivity.

## 6. Health and safety

Detailed material safety data sheets will be supplied by your local Sun Chemical Circuits representative.

The products detailed hereon have been tested in accordance with, and meet the requirements of, the RoHS Directive 2002/96/EC and the European Directive 2003/11/EC, regarding the presence of the metals - Pb (Lead / Lead compounds), Hexavalent Chromium, Cd (Cadmium), Hg (Mercury), and Poly Brominated Flame Retardants.

Conforms to Regulation (EC) No. 1907/2006 (REACH), Annex II – Europe.

Registered to the Sony Green Partner Program, Certificate Number 11490

Sony Green Book Number I8880002

As the world's foremost producer of inks, pigments and colour technology, Sun Chemical is leading our industry in developing and producing products which minimise our impact – and our customers' impact – on the environment and striving to maximise the use of renewable resources. We consider it our responsibility to be involved in the communities in which we live and work and to offer direction in meeting today's needs without compromising the ability of future generations to meet theirs.



## 7. Film Performance/ Technical Specification

### 7.1 Physical Properties of imagecureSMART® XV501T-4 Screen

| Pack Code       | Viscosity        | S.G. | Flash point     | Non volatile content |
|-----------------|------------------|------|-----------------|----------------------|
| CAWN2220        | 18.0 – 22.0 Pa.s | 1.30 | >70 °C (158 °F) | 67.5%                |
| CAWN2249        | 18.0 – 22.0 Pa.s | 1.32 | >70 °C (158 °F) | 68.1%                |
| CAWN2255        | 18.0 – 22.0 Pa.s | 1.30 | >70 °C (158 °F) | 67.5%                |
| CAWN/P2196      | 11.0 - 17.0 Pa.s | 1.29 | >70 °C (158 °F) | 80.8%                |
| CAWN / CAWP2432 | 11.0 - 15.0 Pa.s | 1.29 | >70 °C (158 °F) | 77.8%                |
| CAWN2292 / 2422 | 18.0 – 22.0 Pa.s | 1.25 | >70 °C (158 °F) | 66.5 – 68.1%         |
| CAWN2470        | 18.0 – 22.0 Pa.s | 1.25 | >70 °C (158 °F) | 67.7%                |
| CAWN2291        | 11.0 - 17.0 Pa.s | 1.20 | >70 °C (158 °F) | 79.8%                |
| CAWN2287        | 18.0 – 22.0 Pa.s | 1.32 | >70 °C (158 °F) | 68.5%                |
| CAWN / CAWP2321 | 18.0 – 22.0 Pa.s | 1.32 | >70 °C (158 °F) | 72.7%                |

\*Viscosity measured at 25 °C (77 °F). Please note viscosity can vary greatly depending on ink temperature, volume of ink tested, type of viscometer used and the test method.

|                                       |                |
|---------------------------------------|----------------|
| <b>Non Volatiles (as supplied)</b>    | 72 - 74%       |
| <b>Volatile Organic Content (VOC)</b> | 360 - 400g./L. |

### 7.2 Properties of imagecureSMART® XV501T-4 Cured Film

|                                            |                                                                                                                               |                                      |
|--------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|--------------------------------------|
| Solder Resistance                          | MIL-PRF-55110F<br>IPC SM840E                                                                                                  | 30 secs @ 288 °C (550 °F)            |
| Resistance to Fluxes                       | IPC SM840E                                                                                                                    | Pass                                 |
| Ni/Au Plating                              |                                                                                                                               | Pass                                 |
| Chemical Tin Plating                       |                                                                                                                               | Pass                                 |
| Immersion Silver Plating                   |                                                                                                                               | Pass                                 |
| Hydrolytic Stability                       | IPC SM840E Class H                                                                                                            | Pass                                 |
| Solvent, Cleaning Agent, & Flux Resistance | IPC SM840E Class H                                                                                                            | Pass                                 |
| Fungal Resistance                          | IPC SM840E Class H                                                                                                            | Pass                                 |
| Abrasion Pencil Hardness                   | IPC SM840E Class H                                                                                                            | Pass (7H)                            |
| Adhesion (Copper)                          | IPC SM840E Class H<br>EN ISO 2409                                                                                             | Pass<br>< GT1                        |
| Thermal Shock                              | IPC SM840E Class H<br>MIL-PRF-55110F<br>MIL-STD-202G<br>Bosch Y 273 R80 029 Class TC1 and TC6<br>Siemens 657539.49.60 Class C | Pass<br>Pass<br>Pass<br>Pass<br>Pass |



|                                                 |                                                                                             |                                                                |
|-------------------------------------------------|---------------------------------------------------------------------------------------------|----------------------------------------------------------------|
| Thermal Storage                                 | IPC SM840E Class H<br>Bosch Y 273 R80 029 Class TC1 and TC6<br>Siemens 657539.49.60 Class C | Pass<br>Pass<br>Pass                                           |
| Chemical Resistance                             | IPA<br>1,1,1 Trichloroethane<br>MEK<br>Methylene Chloride<br>Alkaline Detergent<br>Fluxes   | >1 hour<br>>1 hour<br>>1 hour<br>>1 hour<br>>1 hour<br>>1 hour |
| Ionic Contamination                             | MIL-PRF-55110F (Alpha Ionograph 500M)                                                       | <0.3µg. NaCl/cm²                                               |
| Flammability                                    | UL 94V0 Rating                                                                              | File No. E83564                                                |
| Bellcore                                        | TR-NWT000078                                                                                | Pass                                                           |
| Insulation Resistance                           | IPC SM840E Classes T & H                                                                    | Pass                                                           |
| Moisture & Insulation Resistance                | IPC SM840E Classes T & H                                                                    | Pass                                                           |
| Electromigration                                | IPC SM840E Classes T & H                                                                    | Pass                                                           |
| E-Corrosion                                     | Bosch Y 273 R80 029<br>Siemens 657539.49.60                                                 | Pass<br>Pass                                                   |
| Dielectric Constant Er (1 MHz)                  |                                                                                             | 3.9 – 4.0                                                      |
| Dielectric Loss Factor tangent (10² Hz - 10⁶Hz) |                                                                                             | 0.02                                                           |
| Dielectric Strength (50Hz.)                     | IPC SM840E Classes T & H<br>DIN53481                                                        | 120kV/mm.                                                      |

## 8. Disclaimers

This information has been carefully compiled from experience gained in field conditions and extensive laboratory testing. However the products' performance and its' suitability for the customers' purpose depend on the particular conditions of use and the material being printed. We recommend that customers satisfy themselves that each product meets their requirements in all respects before commencing a production run. Since we cannot anticipate or control the conditions under which our products are used, it is impossible to guarantee their performance. All sales are also subject to our standard terms and conditions.

## 9. Technical Assistance / Contacts

Sun Chemical Circuits are an international company, and as such can offer technical, engineering and sales support to our customers worldwide.

For further information regarding this product, or any of our extensive range of materials for PCB fabrication, please contact your local Sun Chemical team or visit the Technical Help Desk at website: <http://www.sunchemicalhelpdesk.com>

Our Products are intended for sale to professional users. The information herein is general information designed to assist customers in determining the suitability of our products for their applications. All recommendations are made without guarantee, since the application and conditions of use are beyond our control. We recommend that customers satisfy themselves that each product meets their requirements in all respects before commencing a print run. There is no implied warranty of merchantability or fitness for purpose of the product or products described herein. In no event shall Sun Chemical be liable for damages of any nature arising out of the use or reliance upon this information. Modifications of the product for reasons of improvements might be made without further notice.

