



# **Webinar**

## **Advanced UV Adhesive Chemistry**

*Note: The information in this document is  
subject to change without notice*

# Webinar Content

***Part 1: Domain Knowledge of UV Adhesives***

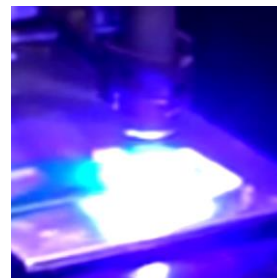
***Part 2: Free Radical Type***

***Part 3: Cationic Type***

***Part 4: Substrate Surface***

*Walk Away Message:*

- a. Users will carry away the know-how to select the right UV chemistry of adhesive for their product designs and applications.
- b. Users' precaution in handling the different chemistry types of adhesives;
- c. The adhesive technologies trend for now and future markets. .



# PART 1

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## Domain Knowledge of Adhesive



# Introduction

- The raw materials of UV adhesives are mainly polymeric materials, which are composed of multiple components, such as monomers, oligomers, photoinitiators and additives.
- When adhesives are illuminated by the **light sources from 320nm-420nm**, the adhesive will cure in just a couple of second, providing instant bonding.
- The component can be **positioned precisely** before adhesives harden; this gives a consistent high-quality output & increase process yield.
- Penchem can **customize** UV adhesives performances and curing mechanism according to customer requirements (product & process configuration, substrates and reliability).
- **Radical and cationic polymerization** are the two most popular mechanism for UV adhesives, both types offer their own advantages in different application scenarios.

# PART 2

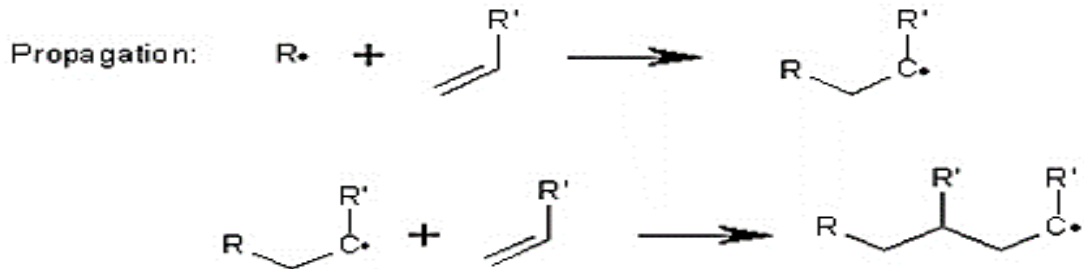
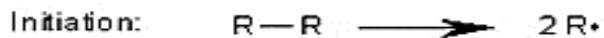
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## FREE RADICAL ADHESIVE



# Free Radical Polymerization **PENCHEM®**

- Free radicals are generated through hemolytic-cleavage of photo-initiators.



- General Features:

- ❑ Fast UV tacking, sealing and bonding performance;
- ❑ Lower reaction temperature
- ❑ Low to moderate hardness (Shore A 43 to D 80);

# Product Selection Guide

## Free Radical UV Curable Only

| Properties            | Unit                | UV767-3                                        | UV252-1                                               | UV252                                                 | UV200                                                    | UV772-5R2               | UV705-8         | UV768-9      | UV782-1                                                          |
|-----------------------|---------------------|------------------------------------------------|-------------------------------------------------------|-------------------------------------------------------|----------------------------------------------------------|-------------------------|-----------------|--------------|------------------------------------------------------------------|
| Special Feature       | -                   | Visible light Curable; Good Bonding to Plastic | Visible light Curable; Fast Cure High Tg yet Flexible | Visible light Curable; Fast Cure High Tg yet Flexible | Visible light Curable; Good Bonding to Plastic and metal | Good Bonding to Plastic | Flexible        | High Tg      | UV Radical Cure only Coating Heat Resistance, RI 1.6 after cured |
| Bonding Property      | -                   | FR4>PC>Glass>SS>PEI                            | Glass>>Nickel>Ceramic Aluminium>PC>PEI                | Nickel>Glass>Ceramic>Aluminium>PC>PEI                 | PMMA>Nylon>SS>PC>PVC>PP>PE>ABS>PU                        | PC>Glass>PVC>ABS        | Glass>PC>SS>PPS | FR4>Glass>SS | Glass                                                            |
| Appearance            | -                   | Greenish                                       | Light Yellow                                          | Light Yellow                                          | Light Yellow                                             | Clear                   | Clear           | Clear        | Clear                                                            |
| Chemistry             | -                   | Acrylate                                       | Acrylate                                              | Acrylate                                              | Acrylate                                                 | Acrylate                | Acrylate        | Acrylate     | Acrylate                                                         |
| UV Wavelength         | nm                  | 320-415                                        | 320-415                                               | 320-415                                               | 320-415                                                  | 365                     | 365             | 365          | 365                                                              |
| Min. Curing Intensity | W/cm2               | 0.5                                            | 0.5                                                   | 0.5                                                   | 0.5                                                      | 2                       | 2               | 2            | 2                                                                |
| Min. Curing Profile   | sec                 | 15                                             | 3                                                     | 3                                                     | 4-10                                                     | 10                      | 15              | 15           | 15                                                               |
| Viscosity             | cps                 | 5,000                                          | 6,000                                                 | 11,000                                                | 250                                                      | 500                     | 2,600           | 2,000        | 860                                                              |
| Hardness              | Shore D             | 58D                                            | 59D                                                   | 64D                                                   | 62D                                                      | 70D                     | 28D             | 80D          | 80D                                                              |
| Tg                    | °C                  | 52                                             | 115                                                   | 114                                                   | 78                                                       | 30                      | 50              | 108          | 107                                                              |
| Bonding               | Kgf/cm <sup>2</sup> | 75                                             | 105                                                   | 109                                                   | 280                                                      | 75                      | 42              | 89           | Coating                                                          |

# PART 4

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UV FREE RADICAL + HEAT CURABLE ADHESIVE



# UV Hybrid Product

| Properties            | Unit    | UV777-1                                             | UV777-5                                 | UV777-6                 | UV777-7                 | UV777-8                          |
|-----------------------|---------|-----------------------------------------------------|-----------------------------------------|-------------------------|-------------------------|----------------------------------|
| Special Feature       | -       | High Adhesion Strength to Many Substrates           | High Adhesion Strength to alumina       | Low Temperature Curable | Low Temperature Curable | Low Temperature Curable, low CTE |
| Bonding Property      | -       | Glass>Nickel>Kovar>LCP>Aluminium>Ceramic>Nylon>Gold | Glass>Alumina>Nylon> Glass>LCP> Ceramic | Glass>Ceramic>LCP       | Glass>Ceramic           | Glass>Ceramic                    |
| Appearance            | -       | Translucent Amber                                   | Translucent Amber                       | Translucent Amber       | Translucent White       | Milky Translucent                |
| Chemistry             | -       | Hybrid                                              | Hybrid                                  | Hybrid                  | Hybrid                  | Hybrid                           |
| UV Wavelength         | nm      | 365                                                 | 365                                     | 365                     | 365                     | 365                              |
| Min. UV Intensity     | W/cm2   | 2                                                   | 2                                       | 0.35                    | 0.35                    | 0.35                             |
| Min. UV Profile       | sec     | 15                                                  | 15                                      | 3                       | 3                       | 3                                |
| Heat Cure Temperature | °C      | 100                                                 | 100                                     | 80-100                  | 80-100                  | 80-100                           |
| Heat Cure Time        | Hour    | 1                                                   | 1                                       | 1                       | 1                       | 1                                |
| Viscosity             | cps     | 123,000                                             | 183,000                                 | 68,000                  | 67,500                  | 49,300                           |
| Storage Modulus -40C  | Mpa     | 2933                                                | 2761                                    | 3254                    | 1626                    | 5304                             |
| Storage Modulus 30C   | Mpa     | 1808                                                | 1920                                    | 2364                    | 1333                    | 3459                             |
| Storage Modulus 100C  | Mpa     | 18                                                  | 25                                      | 13                      | 270                     | 243                              |
| 45° Flow, 5mins       | mm      | -                                                   | -                                       | -                       | 18                      | 1                                |
| Tg                    | °C      | 53                                                  | 56                                      | 53                      | 110                     | 118                              |
| CTE                   | Ppm/K   | 38                                                  | 50                                      | 54                      | 40                      | 34                               |
| Die Shear Strength    | Kgf/cm2 | 276                                                 | 126                                     | 177                     | 97                      | 196                              |

# Free Radical Polymerization

## Assurance of Quality

| Role     | Caution – At Environment Control Level                                                               | Caution – At Product Level                                                          | Caution – At Method Level                                                                                                                    | Caution – At User Level |
|----------|------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------|-------------------------|
| End User | Environmental control to purge nitrogen during UV curing for open system module (exposed to oxygen). | Cure the dispensed material asap.<br><br>Enclosed with syringe tip when not in use. | Use plastic film to limit contact in between adhesives and oxygen.<br><br>Use the recommended UV curing profile to run DOE for optimum cure. | Wear PPE                |

# PART 3

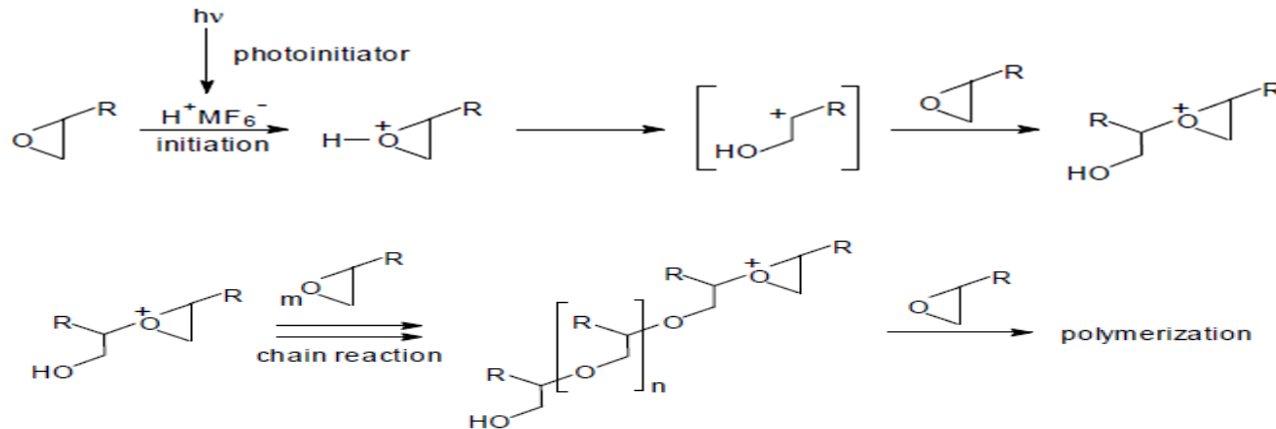
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## CATIONIC ADHESIVE



# Cationic Polymerization

- Once a cationic photoinitiator absorbs UV radiation the initiator molecules is converted into a strong acid species (cation), it **opens the epoxy ring structure causing polymerization**.



➤ General Feature:

- ❑ Shadow curable possible, delay cure based on system design.
- ❑ Reduced shrinkage
- ❑ No oxygen inhibition

# UV Cationic + Heat Curable Product

| Properties            | Unit    | UV788-2              | UV788-6                                          | UV799-2                                            | UV799-3                                 | UV799-4                                 | UV566-25                        | UV566-22                                | UV566-26               |
|-----------------------|---------|----------------------|--------------------------------------------------|----------------------------------------------------|-----------------------------------------|-----------------------------------------|---------------------------------|-----------------------------------------|------------------------|
| Special Feature       | -       | Low CTE<br>High Tg   | Extreme<br>Low CTE,<br>Shrinkage<br>High Tg      | Low CTE<br>High Tg                                 | Low CTE<br>High Tg                      | Low CTE                                 | Non-flow                        | Non-flow<br>Good<br>bonding to<br>Ultem | Slight flow<br>High Tg |
| Bonding<br>Property   | -       | Glass><br>SS>PCB     | Glass>SS><br>Gold><br>Nickel><br>Kovar><br>Ultem | Glass><br>Aluminium><br>Kovar><br>Nickel><br>Ultem | Glass>SS><br>Kovar><br>Nickel><br>Ultem | Glass>SS><br>Kovar><br>Nickel><br>Ultem | Glass>SS><br>FR4<br>Nickel>Gold | Glass>SS<br>>Nickel<br>>Ultem           | Glass>SS><br>FR4       |
| Appearance            | -       | Translucent<br>White | Translucent<br>White                             | Translucent<br>White                               | Translucent<br>White                    | Translucent<br>White                    | Translucent<br>White            | Translucent<br>White                    | Translucent<br>White   |
| Chemistry             | -       | Epoxy                | Epoxy                                            | Epoxy                                              | Epoxy                                   | Epoxy                                   | Epoxy                           | Epoxy                                   | Epoxy                  |
| UV Wavelength         | nm      | 365                  | 365                                              | 365                                                | 365                                     | 365                                     | 365                             | 320-380                                 | 365                    |
| Min. UV Intensity     | W/cm2   | 0.5                  | 0.5                                              | 2                                                  | 2                                       | 2                                       | 2                               | 0.2                                     | 0.3                    |
| Min. UV Profile       | sec     | 15                   | 15                                               | 15                                                 | 15                                      | 15                                      | 15                              | 15                                      | 90                     |
| Heat Cure Temp.       | °C      | 100-120              | 100-120                                          | 120-120                                            | 100-120                                 | 100-130                                 | 100-130                         | 120-130                                 | 100                    |
| Heat Cure Time        | Hour    | 1                    | 1                                                | 1                                                  | 1                                       | 1                                       | 1-1.5                           | 0.5                                     | 1                      |
| Viscosity             | cps     | 22,000               | 28,000                                           | 66,000                                             | 19,000                                  | 14,000                                  | 14,000                          | 4,400                                   | 1,500                  |
| Hardness              | Shore D | 85                   | 84                                               | 85                                                 | 85                                      | 85                                      | 86                              | 86                                      | 86                     |
| 90° Flow, 10mins      | mm      | 30                   | 45                                               | 42                                                 | 42                                      | 54                                      | 0                               | 0                                       | 5                      |
| Tg                    | °C      | 140                  | 203                                              | 120                                                | 134                                     | 113                                     | 108                             | 100                                     | 142                    |
| CTE                   | Ppm/K   | 23                   | 18                                               | 25                                                 | 29                                      | 28                                      | 37                              | 51                                      | 51                     |
| Die Shear<br>Strength | Kgf/cm2 | 180                  | 154                                              | 63                                                 | 176                                     | 195                                     | 159                             | 159                                     | 122                    |

# Cationic UV + Heat Curable Product

| Properties              | Unit    | UV784-12   | UV784-3    | UV784-11   | UV784-4    | UV784-5                      | UV773-6                          | UV781-2                                     | UV288*                |
|-------------------------|---------|------------|------------|------------|------------|------------------------------|----------------------------------|---------------------------------------------|-----------------------|
| Special Feature         | -       | Soft Epoxy | Soft Epoxy | Soft Epoxy | Soft Epoxy | Moderate Hardness<br>High RI | High Tg<br>Low intensity curable | Low RI Matching Epoxy Hybrid, Dk 3.2 @28Ghz | Low RI Matching Epoxy |
| Bonding Property        |         | Glass      | Glass      | Glass      | Glass      | Glass                        | Glass                            | Glass                                       | Glass                 |
| Appearance              | -       | Clear      | Clear      | Clear      | Clear      | Clear                        | Clear                            | Clear                                       | Clear                 |
| Chemistry               | -       | Epoxy      | Epoxy      | Epoxy      | Epoxy      | Epoxy                        | Epoxy                            | Hybrid                                      | Epoxy                 |
| UV Wavelength           | nm      | 365        | 365        | 365        | 365        | 365                          | 365                              | 365                                         | 365                   |
| Min. UV Intensity       | W/cm2   | 0.18-2     | 0.5-2      | 0.18-2     | 0.5-2      | 0.5-2                        | 0.3                              | 0.15                                        | 2                     |
| Min. UV Profile         | sec     | 60         | 15         | 60         | 15         | 15                           | 90                               | 200                                         | 360                   |
| Heat Cure Temp.         | °C      | 100        | 100        | 100        | 100        | 100                          | 85-100                           | 100                                         | 100                   |
| Heat Cure Time          | Hour    | 1          | 1          | 1          | 1          | 1                            | 1                                | 1                                           | 1                     |
| Viscosity               | cps     | 1000       | 750        | 2200       | 630        | 1200                         | 380                              | 6000                                        | <500                  |
| Refractive Index, 589nm | -       | 1.49       | 1.49       | 1.49       | 1.50       | 1.53                         | 1.51                             | 1.41                                        | 1.41                  |
| Hardness                | Shore D | 53 (A)     | 26         | 40         | 52         | 77                           | 80                               | 73                                          | -                     |
| Tg                      | °C      | 34         | 13         | 40         | 37         | 94                           | 168                              | 53                                          | -                     |
| Die Shear Strength      | Kgf/cm2 | 61         | 78         | 73         | 72         | 102                          | 150                              | 62                                          | 48                    |
| Storage modulus @ -40°C | -       | 749        | 870        | 744        | 870        | 1749                         | 2360                             | 718                                         | -                     |

\* Penchem's own synthesis of materials

# Shadow Curable UV and/or Heat Curable Product

| Properties            | Unit    | UV254                                   | UV254-1                                 | UV254-2                                 | UV739-1                                               |
|-----------------------|---------|-----------------------------------------|-----------------------------------------|-----------------------------------------|-------------------------------------------------------|
| Special Feature       | -       | UV or Heat Curable<br>Low Temp Curable  | UV or Heat Curable<br>Low Temp Curable  | UV or Heat Curable<br>Low Temp Curable  | UV or Heat Curable<br>Thermally Conductive<br>2.8W/mk |
| Bonding Property      | -       | Glass>Nickel>FR4><br>Kovar>Alumina>Gold | Glass>Nickel>FR4><br>Kovar>Alumina>Gold | Glass>Nickel>FR4><br>Kovar>Alumina>Gold | Alumina><br>Aluminium>SS>Glass                        |
| Appearance            | -       | Clear                                   | Translucent White                       | Translucent White                       | Off White                                             |
| Chemistry             | -       | Epoxy                                   | Epoxy                                   | Epoxy                                   | Epoxy                                                 |
| UV Wavelength         | nm      | 365                                     | 365                                     | 365                                     | 365                                                   |
| Min. UV Intensity     | W/cm2   | 2                                       | 2                                       | 2                                       | 0.5-2                                                 |
| Min. UV Profile       | S       | 15                                      | 15                                      | 15                                      | 30-60                                                 |
| Heat Cure Temperature | °C      | 100-120                                 | 80-120                                  | 80-110                                  | 125                                                   |
| Heat Cure Time        | Hour    | 1                                       | 1-2                                     | 1-2                                     | 1                                                     |
| Viscosity             | cps     | 500                                     | 8,000                                   | 15,000                                  | 70,500                                                |
| Storage Modulus -40c  | Mpa     | 6690                                    | 4227                                    | 6433                                    | 7972                                                  |
| Storage Modulus 30c   | Mpa     | 5287                                    | 3085                                    | 4962                                    | 6925                                                  |
| 90° Flow, 10mins      | mm      | >50                                     | 1                                       | 40                                      | 0                                                     |
| Tg                    | °C      | 165                                     | 111                                     | 96                                      | 159                                                   |
| CTE                   | Ppm/K   | 59                                      | 38                                      | 21                                      | 33                                                    |
| Die Shear Strength    | Kgf/cm2 | 57                                      | 105                                     | 57                                      | 271                                                   |

# Cationic Polymerization

## Assurance of Quality

| Role     | Caution – At Environment control                                 | Caution – Product                                                                                                                                                                         | Caution – At Method Level                                      | Caution – At User Level |
|----------|------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------|-------------------------|
| End User | Environmental control to reduce the moisture level below 70% RH. | <p>After thaw the product from the freezer, wipe off the moisture on the syringe before use.</p> <p>The combination use of this product on the same package must avoid base adhesives</p> | Avoid staging the adhesive >2hrs before further heat post-cure | Wear PPE                |

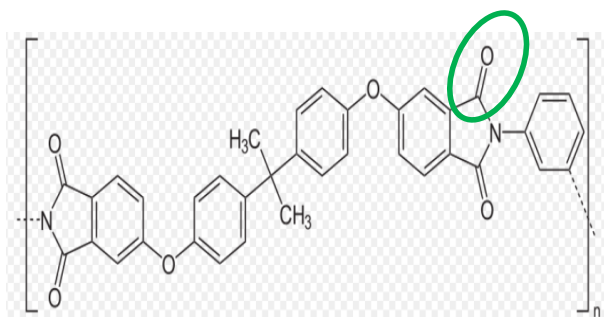
# **PART 5**

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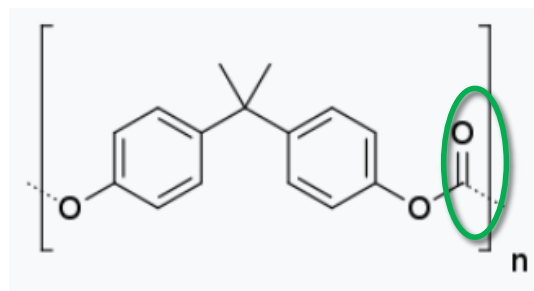
SUBSTRATE SURFACE

# Substrates for Light Curing Adhesives

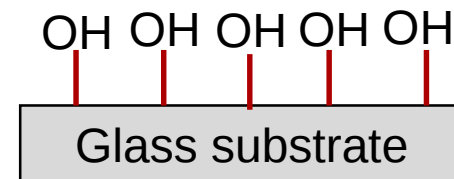
- The ideal case for the use of UV light curing adhesives for an application with at least one of the substrates must transmit the light **so that light can reach the adhesive bond line.**
- Transparent but UV blocking substrate: Ultem (Polyetherimide) and UV-absorbing PC : UV-Visible light Curable Adhesives (UV767, UV252, UV766 series)



Ultem



Polycarbonate



Glass

# Substrates for Light Curing Adhesives

Metal substrates: Aluminum, Stainless steels, Nickel, Kovar or Gold

- Low viscosity adhesives
- High curing temperature
- Need primer surface modification
- Additional surface modification (greater surface roughness → greater effective surface area for bonding)

# THANK YOU!

For more information, please contact our technical and commercial team, who will be always pleased to help.

**PENCHEM®**

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