NISSHINBO

# CARBODILITE™

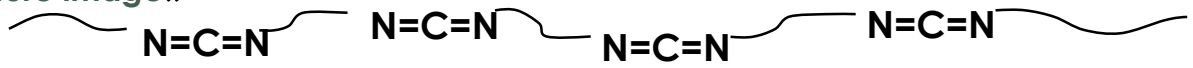
The next generation of crosslinking technology

Distributed by GSI Creos

# What is CARBODILITE?

- **Waterbone polycarbodiimide resin** which contains carbodiimide [ - N=C=N - ] group with hydrophilic segments

≪Structure image≫

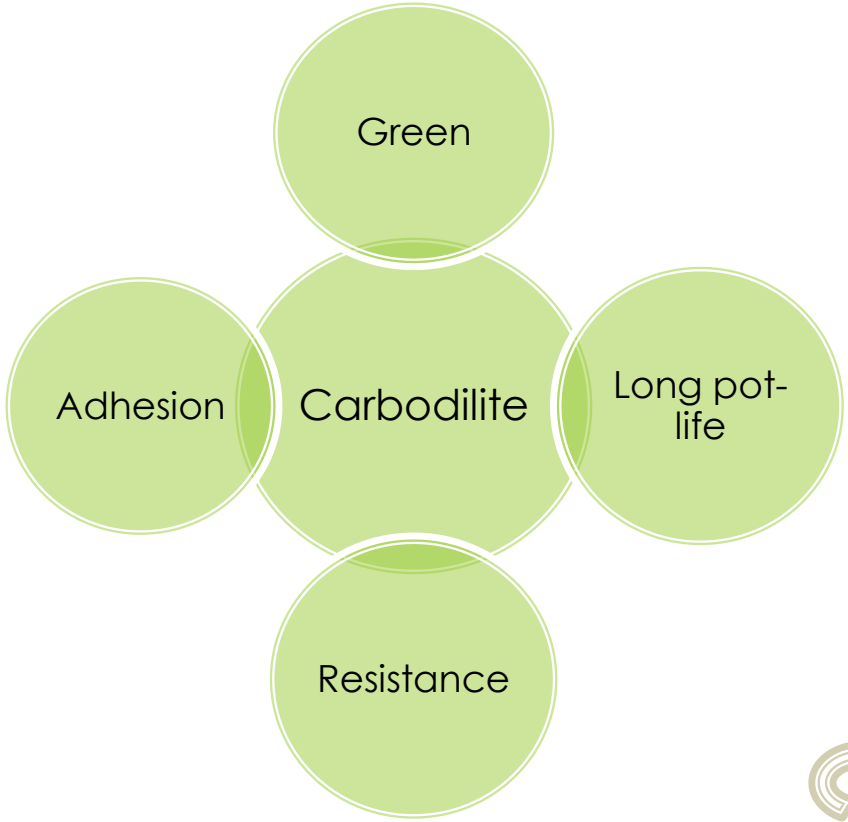



- **Very safe** for use and environment friendly crosslinker (Applicable for VOC regulatory compliance products)

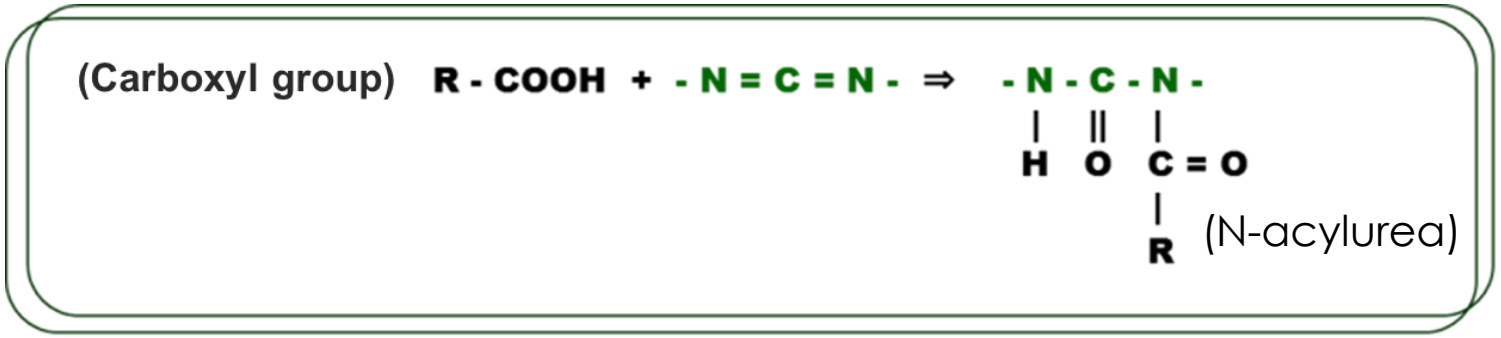
- **Wide range** of products (Customers can choose the most suitable ones)

# Features of CARBODILITE

- **Green (Safe and environmentally friendly)**
- **Long pot-life**
- **Good reactivity with carboxylic acid**
- **Reactive at room temperature**
- **Promotes adhesion**
- **Remains flexibility**
- **Easy to disperse**
- **Anti-hydrolysis (for resins containing ester bond)**



# Reaction of CARBODILITE



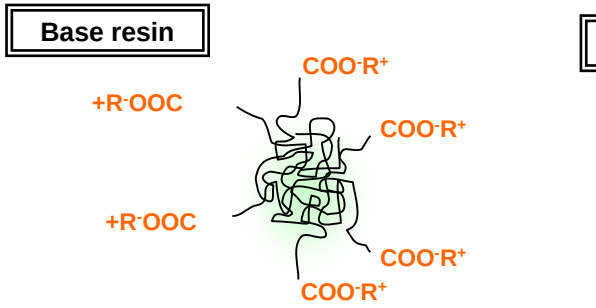

CARBODILITE is effective for crosslinking with carboxylic acid. Please check if base resin has carboxylic acid.

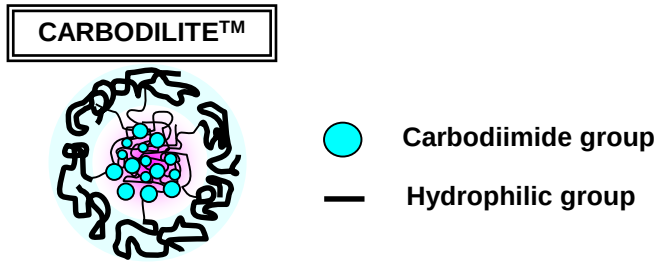
Carbodiimide groups in CARBODILITE react with carboxylic acids in a base resin (polymer) which forms 3-dimensional networks. This 3-dimensional network structures improve water resistance and solvent resistance property.

# Applicable resins

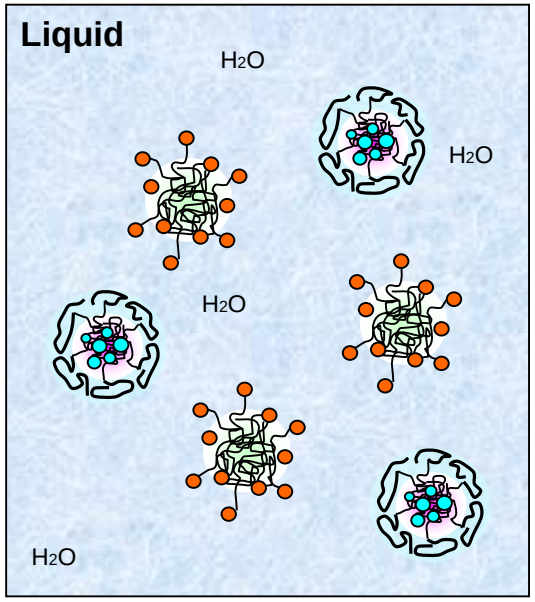
- PUD （Polyurethane dispersion）
- Acrylic emulsion
- Carboxylic acid-modified resins (SBR, NBR latex, etc)
- Water-dispersible polyester

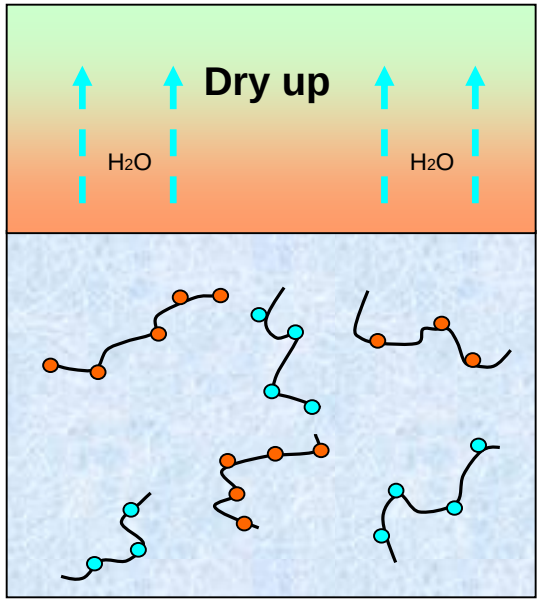
# Reaction mechanism

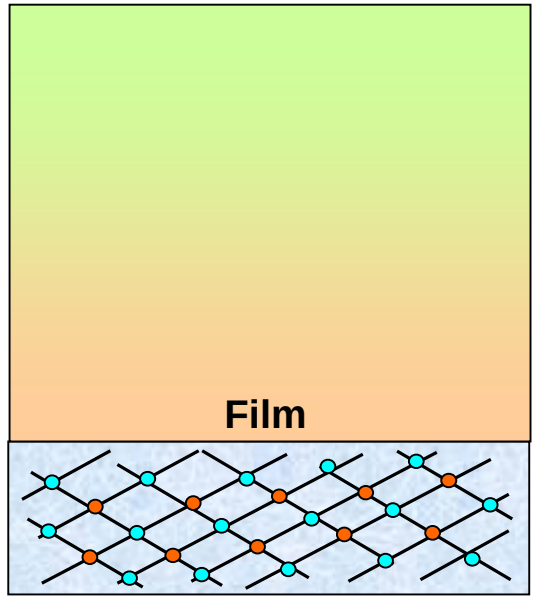



Although carbodiimide groups normally reacts carboxylic acids at room temperature, CARBODILITE obtained long pot-life by the mechanism below.



# Crosslinker Comparison

| Item | Toxicity | Reactivity | Pot-life | Reaction temp. |
|---|---|---|---|---|
| Aziridine | Poor | Excellent | Poor | Low |
| Block-isocyanate | Fair | Good | Excellent | 120 ℃(248°F) < |
| Water-dispersion isocyanate | Poor | Excellent | Poor | Low |
| Melamine | Poor | Fair | Excellent | 140 ℃(284°F) < |
| Waterborne epoxy | Poor | Fair | Fair | 80 ℃(176°F) < |
| Oxazoline | Excellent | Poor | Good | 80 ℃(176°F) < |
| ***CARBODILITE*** | ***Excellent*** | ***Good*** | ***Good*** | **20℃(68°F) <** |

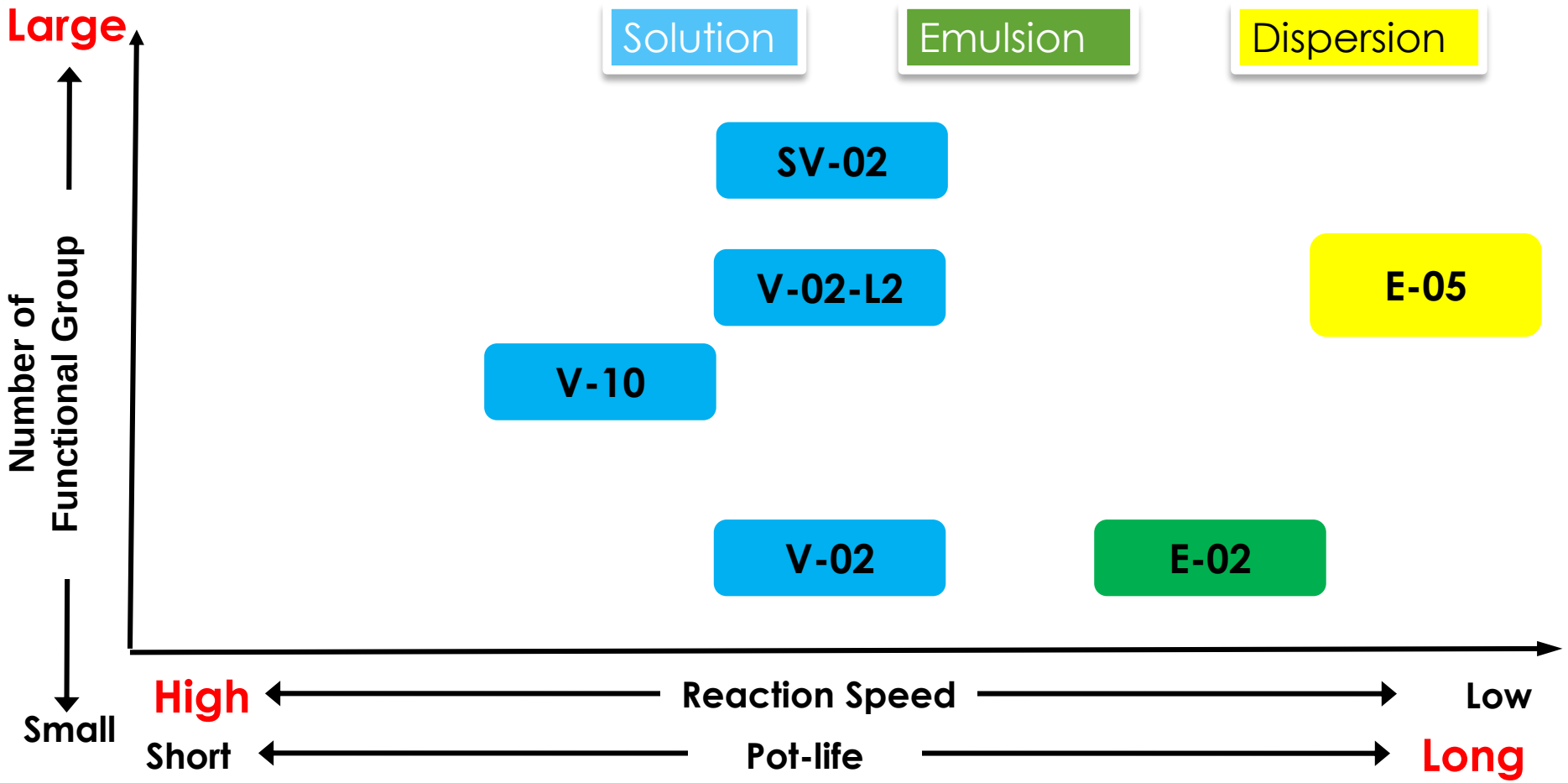
# Specifications

| Grade | V-02 | V-02-L2 | SV-02 | V-10 | E-02 | New E-05 |
|---|---|---|---|---|---|---|
| Apperrance | Water Solution (micro micell) | | | | Emulsion | Dispersion |
| | | | | | Soap-free | Incl. Soap |
| Solid Content | 40% | | | | 40% | 41.3% (Incl. Surfactant 1.3%) |
| Co-Solvent | None (60% Deionized-water) | | | | None (60% Deionized-water) | None (58.7% Deionized-water) |
| pH | 9-12 | 8-11 | 8-11 | 9-12 | 8-11 | 8.0-11.5 |
| Viscosity *1 (mPa・s) | 90 | 70 | 90 | 75 | 10 | ≦200 |
| – NCN – Equivalent *2 | 590 | 385 | 430 | 410 | 445 | 310 |
| Feature | Standard | High-NCN | High XL density | Fast cure | Long pot-life | High-NCN Exetra long pot-life |

*1 Measured value

*2 Calculated value  Calculated value (Smaller number generally means less required addition amount for the same effect. )

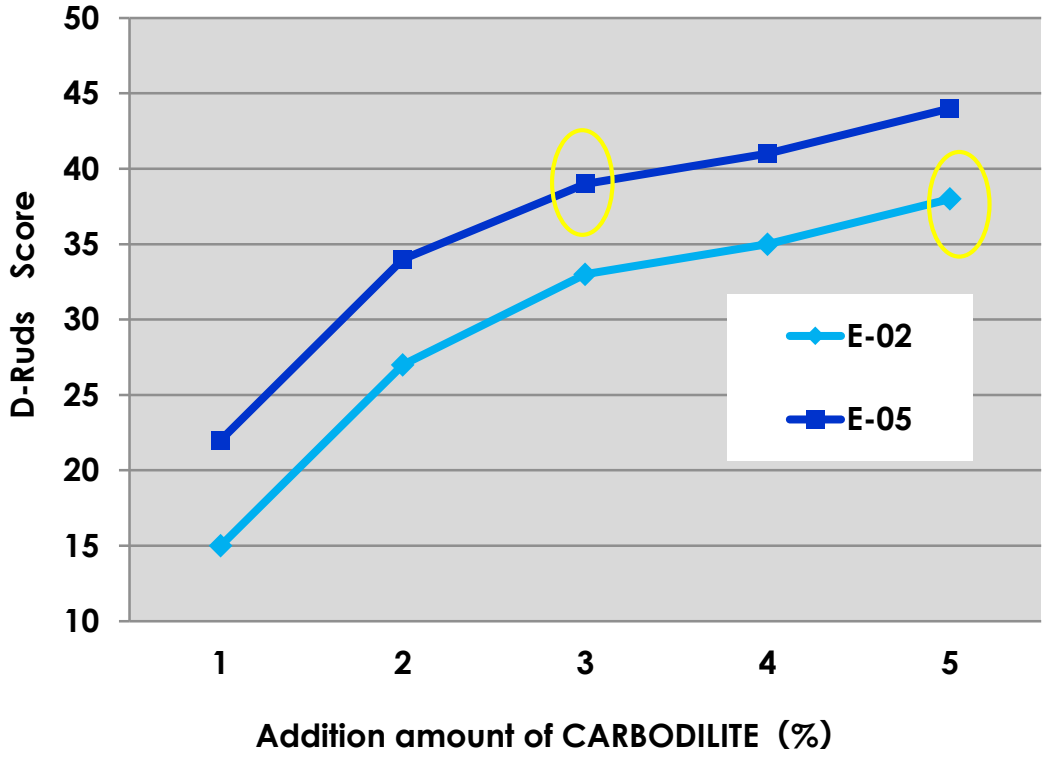
# Basic Product Difference (Functionality)



# Usage direction

- Suggested dosage level (CARBODILITE solid) ⇒ ca. **3～7%** by total formula
- For faster reaction: Increase curing temperature
- For extending pot-life: Increase pH with neutralizer (ammonia, amine )
  - Crosslinking reaction does not progress with neutralizer of hydroxide metal
  - Pot life may not be extended in case compound contains glycol-based solvents

# Reduction of dossage by E-05



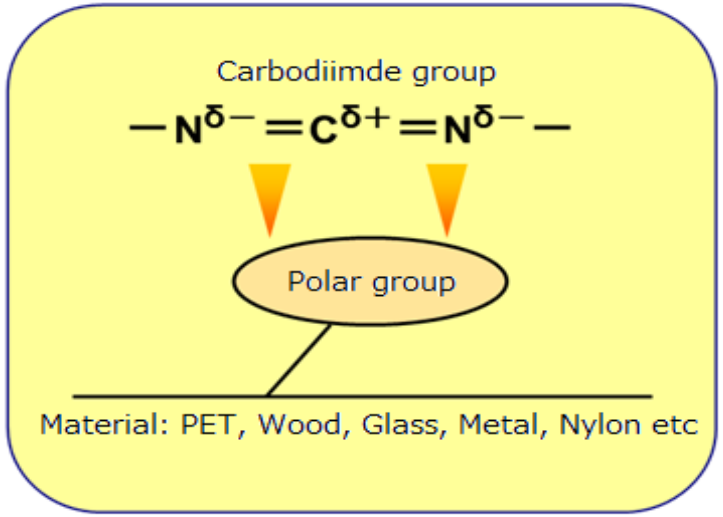

| | |
|---|---|
| Resin | Commercial PUD (N.V.=35%) |
| Crosslinker ( wet % ) | CARBODILITE E-02 , E-05 |
| Substrate | ABS |
| Test method | 95%EtOH D-rubs Test Max score=50 |
| Curing condition | 60degC(140℉)×10min. + RT 24hours |

E-05 having smaller carbodiimide equivalent shows higher performance than E-02 with the same addition amount.

**E-02 NCN equivalent 445**
**E-05 NCN equivalent 310**

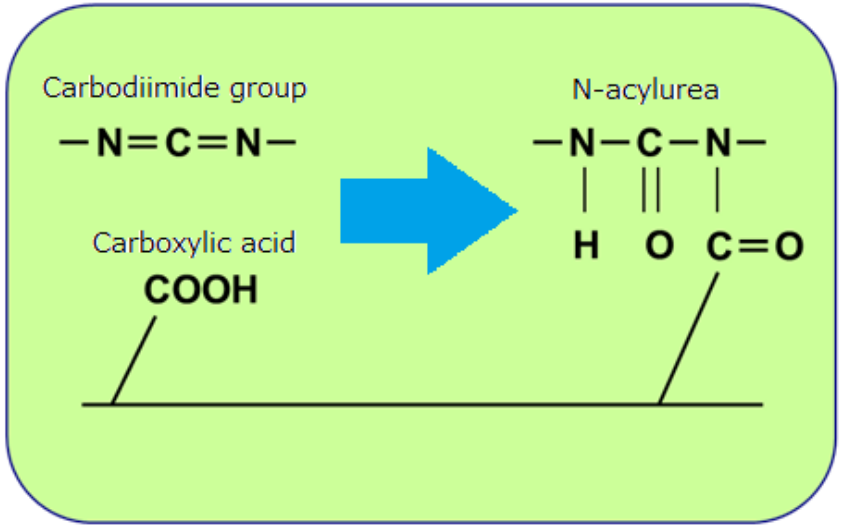
※Theoretically, E-05 shows the same performance with 30% lower addition amount of E-02.

# Adhesion Promotion Mechanism




* Polar group : −OH etc.

Interaction between polar groups on surface of material and carbodiimde groups improve adhesion.




Reaction of carboxylic acid and carbodiimde group on material surface improves adhesion.

# Food Packaging

- **FDA**

  Due to optimized manufacturing process, use of the CARBODILITE crosslinker (V-02, V-02-L2, SV-02) in Food package adhesive (indirect food contact) application according to FDA (21CFR175.105) is possible.

  NOTE:  Base resin should be PUD based on FDA (21CFR 175.105) Regulation .

- **Swiss ordinance**

  Use of the CARBODILITE crosslinker (V-02, V-02-L2, SV-02) according to  Swiss ordinance for packaging ink is possible.

# Applications

- Wood
- Metal
- Textile
- Leather
- Plastic
- Rubber
- Ink
- Adhesive

# General Data

CARBODILITE™

- POT LIFE
- AMBIENT CURE
- CHEMICAL RESISTANCE
- ADHESIVENESS
- UV RESISTANCE

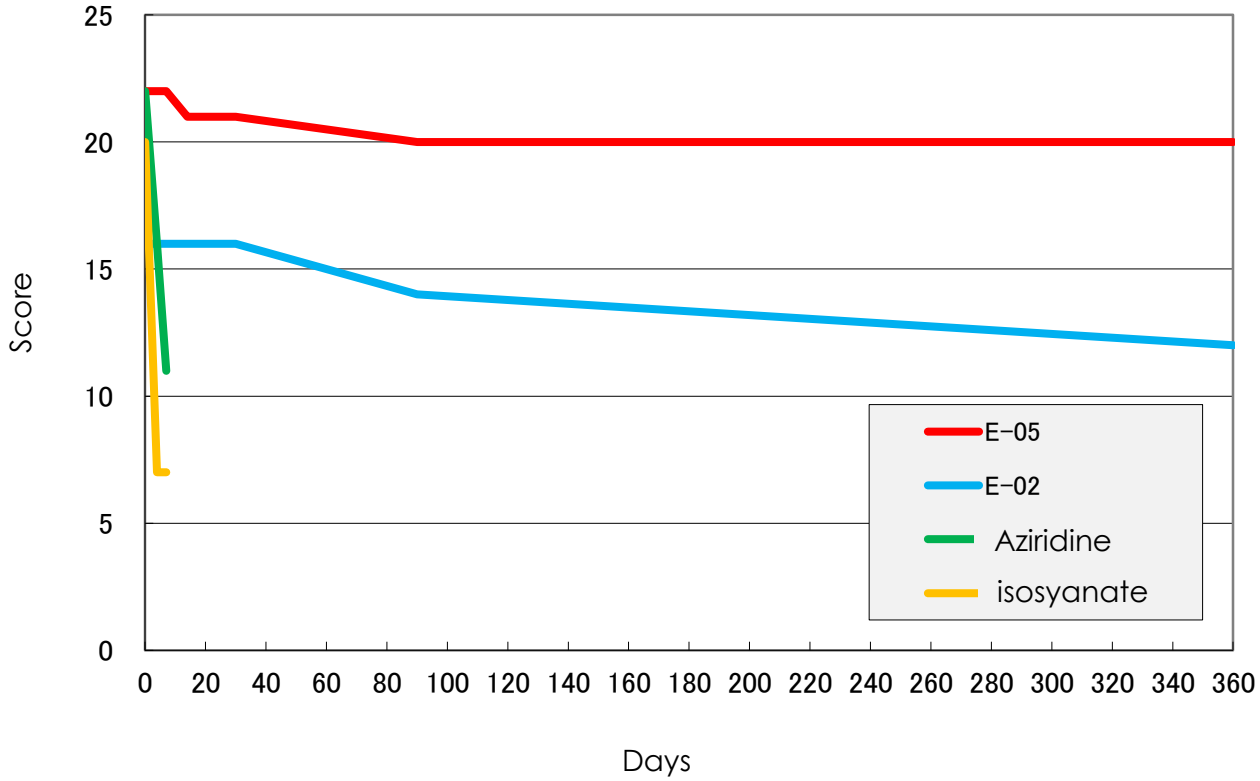
# Pot Life study

- Double Rubbing Test
- Resin : PUD (Sancure815 Lubrizol)
- Loading

  Cardodilite =5wt%,

  Isocyanate=8wt%, Aziridine=2%
- Curing : 120℃(232F) X 10min and RT 1day
- Test method :
- Mix resin and Cross linker and keep it in sealed container. Conduct Double Rubbing test (EtOH) at different time points. Conducted 4different rubbing number for each time point (10times, 25, 50, 75,100)
- Visually score 1-5 (Maximum 25)

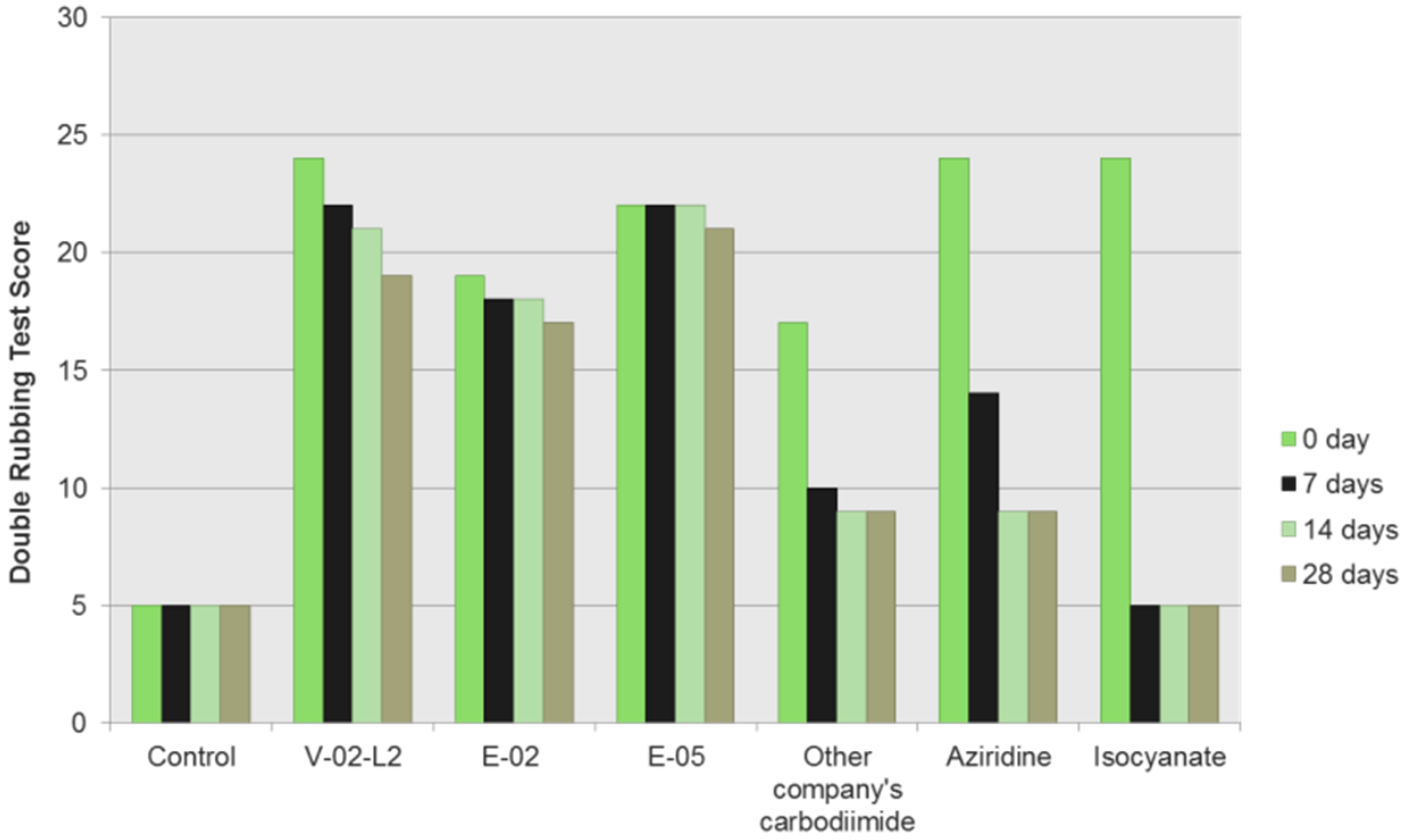
D-Rubs test
Pud storage at 25C(77F)



# Pot Life study

- Double Rubbing Test
- Resin : PUD（Sancure777　Lubrizol)
- Loading : 2% Solid (8% for Isocyanate)
- Curing : 80℃(176F) X 10min
- Test method :
- Mix resin and Cross linker and keep it in sealed container.  Conduct Double Rubbing test (EtOH) At 4 different timepoint.
- Conduct the test 5times. Score 1-5 at each time and Sum the score (Maximum score 25)

*Pot-life (at room temp.)



# Ambient Cure

< Spot Test >

- Resin : PUD (Sancure825 Lubrizol)
- Curing : Room temp
- Substrate : Wood

< Friction ware resistance >

- Resin : PUD (Bayhydrol UH2342 Covestro)
- Curing : Room temp 1and 7days
- Substrate : Wood

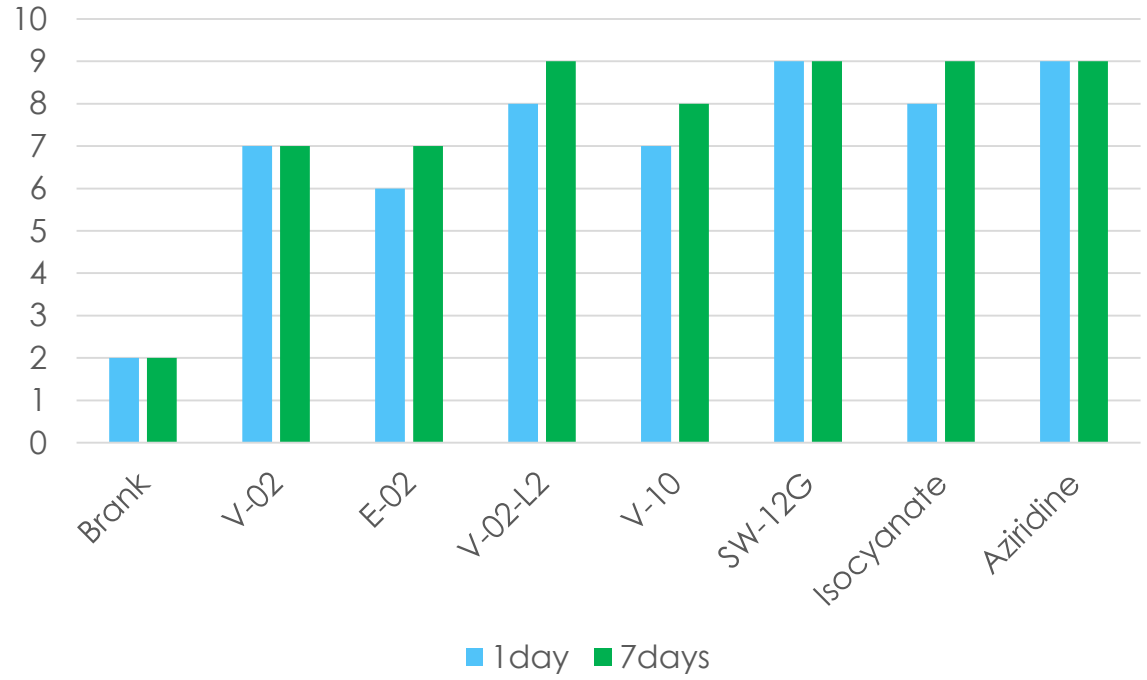
## Spot Test

**Excellent 5 >>>> Poor 1**

| | | Control | CARBODILITE | | | | | Isocyanate | Aziridine |
|---|---|---|---|---|---|---|---|---|---|
| | | | V-02 | E-02 | V-02-L2 | V-10 | SW-12G | | |
| Lord (wet-wet) | | - | 5% | 5% | 5% | 5% | 5% | 8% | 2% |
| Spot Test (7days) | MEK | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 |
| | 70%IPA | 1 | 4 | 5 | 5 | 5 | 5 | 5 | 5 |
| | 50%EtOH | 1 | 4 | 5 | 5 | 5 | 5 | 5 | 5 |
| | 1.4%$NH_3$ | 3 | 3 | 4 | 3 | 4 | 4 | 3 | 4 |
| | 1%NaOH | 1 | 4 | 4 | 3 | 4 | 5 | 4 | 5 |

## Friction ware resistance

Excellent 5 >>>> Poor 1



# Chemical resistance

- Resin : PUD (Suncure815)
- Curing :160℃ (320F) x 10min
- Substrate :Zinc carted steel sheet （6μm）
- Loading :

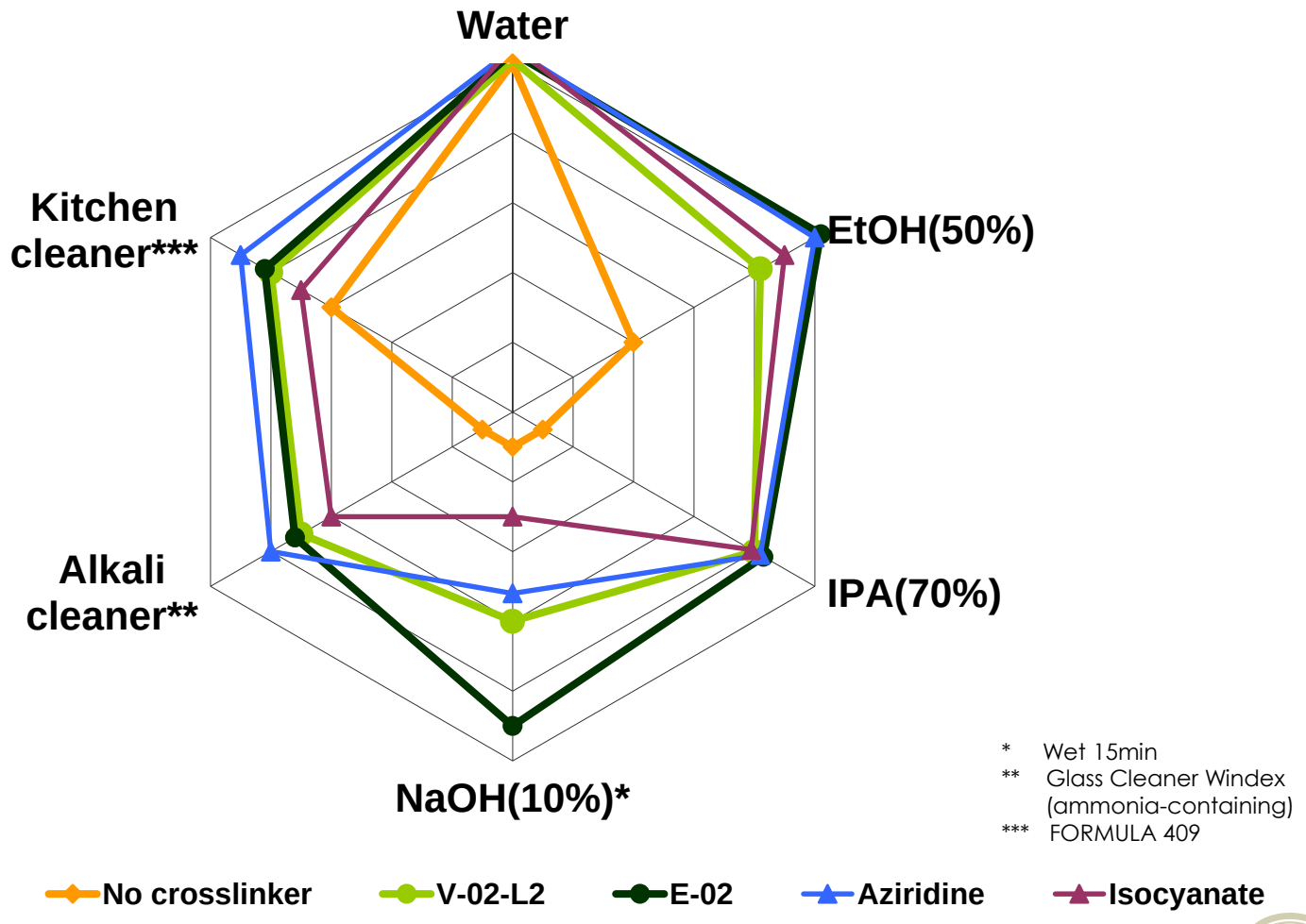
  12% isocyanate

  6% other crosslinker （solid）
- Test method Curing :

①Apply on metal by brush and cure at room temperature （Film thickness 20μm）

②Place cotton balls soaked with solvents for 1 hour or 1 day

③Visual evaluation after removing the cotton balls




* Wet 15min
** Glass Cleaner Windex (ammonia-containing)
*** FORMULA 409

# Cross cut test



## Adhesion

- Resin : Acrylic emulsion
- Substrate : OPP film
- Curing 60℃(140F) X 5sec
  + 25℃(77F) X 3days
- Loading : Isocyanate 16%
  Others 8% (Solid)

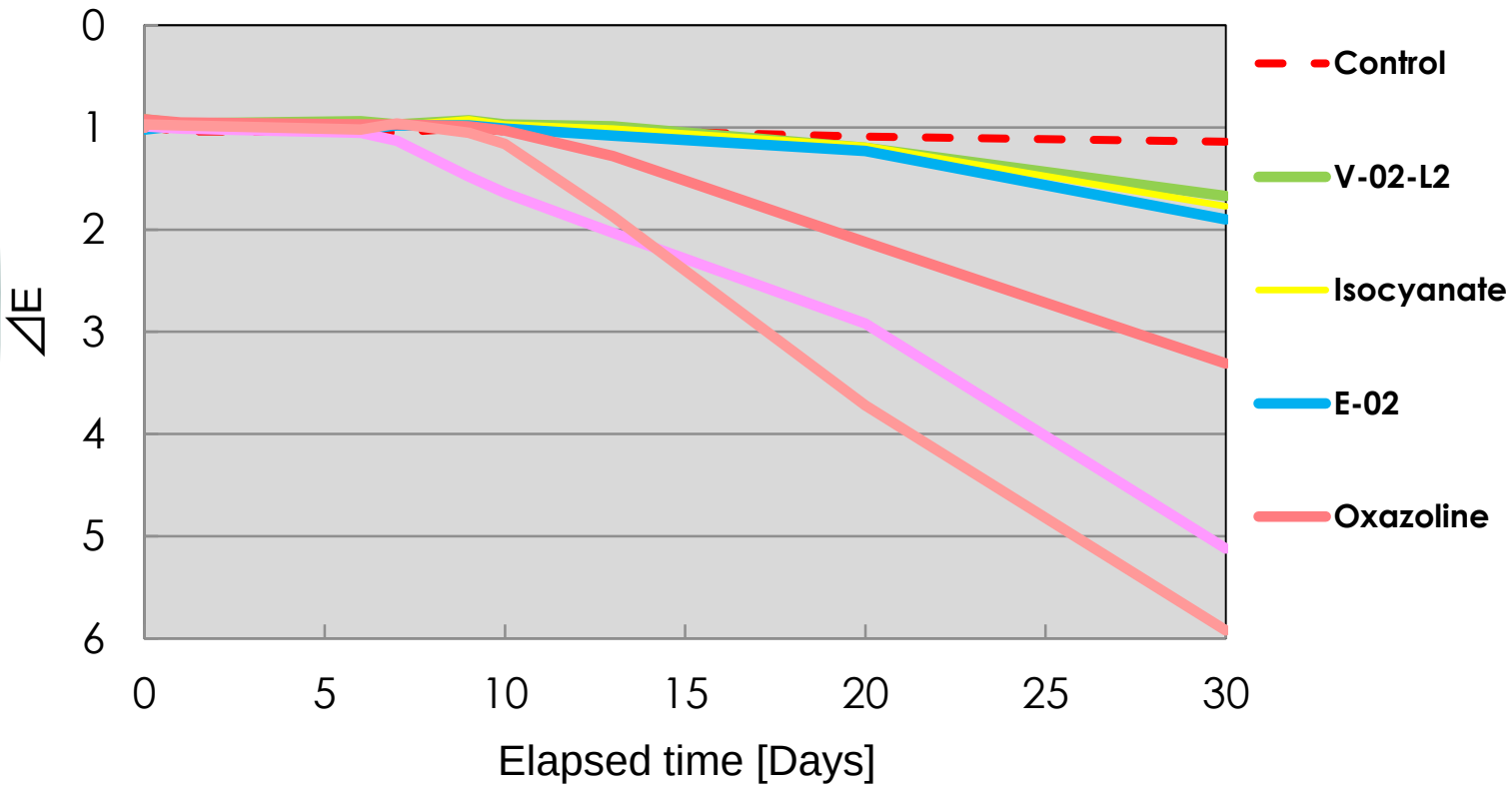
#Cut: 10 x 10 parallel cut

#Tape: Permacel #99


★★★★★no damage >>> ★severe damage

# UV Resistance (color change E/E0)

- Base resin: Suncure815
- Curing Condition: 80℃(176℉) X 15 min
- Loading: 2% solid/solid
- Aged in 110℃(230℉) oven



# THANK YOU

- The numerical values shown in this report are obtained through our reliable method, but these are not guaranteed values.
- We might change these data through our product improvement.
- Forbid modifying these data or disclosing this technical information to third parties without our permission.

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