

# **Gaskamine 240**

**An Innovative Modified Amine**

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## **1. Advantages of Gaskamine 240**

Gaskamine 240 is a reaction product made from meta-xylenediamine (MXDA) and styrene, produced by MGC's patented technology.

Gaskamine 240 is an innovative modified amine, and has a variety of advantages as an epoxy hardener.

### **1. Low Viscosity**

→Potential uses

- **Non-solvent or High-solid paints**
- **Floor coatings with good workability**
- **Adhesives with good workability**

### **2. Long Pot Life and Fast Drying Performance**

- **To apply in warm atmosphere**

### **3. Excellent Appearance and Intercoat adhesion (as a coating film)**

- **To apply warm and tropical condition**
- **Paints with recoatability**

### **4. Good Chemical Resistance (as a coating film and a cast sheet)**

→Potential uses

- **Coatings and linings requiring good chemical resistance**

### **5. High Bond Strength**

→Potential uses

- **Adhesives of steel-to-steel or mortar-to-mortar**

## 2. Properties

Advantage: **Lower viscosity than IPDA adduct.**

Table 1. Typical properties of Gaskamine 240

	G-240	IPDA adduct	Jeffamine D-230
Properties			
Color (Gardner)	< 1	1	<1
Viscosity (mPa·s/ 25°C)	<b>66</b>	2870	9
Amine value	403	514	464
AHEW	103	58	60

IPDA adduct: IPDA / DGEBA = 8 / 1 moles adduct

DGEBA: Bis-A epoxy resin (EEW=186)

Jeffamine D-230: polyoxypropylenediamine

### 3. Curing performance

#### 3-1. Curing properties

Advantage: **Longer pot life than IPDA adduct.**  
**Shorter drying time than Jeffamine D-230.**

Table 2. Curing properties of Gaskamine 240

Hardener	G-240	IPDA adduct	Jeffamine D-230
Formulation			
DGEBA (g)	100	100	100
Hardener (g)	55	31	32
Curing condition	23°C (50% RH)		
Pot life <sup>*1</sup>			
Time (min)	<b>340</b>	72	521
Exotherm temp. (°C)	151	197	80
RCI drying time (hr: min)			
Set-to-touch	4:15	2:45	9:30
Dust free	<b>7:30</b>	4:15	15:30
Dry through	16:45	>24:00	21:30

DGEBA: Bis-A epoxy resin (EEW=186) (Epikote 828; Japan Epoxy Resins Co., Ltd.)

\*1: 300g in cup

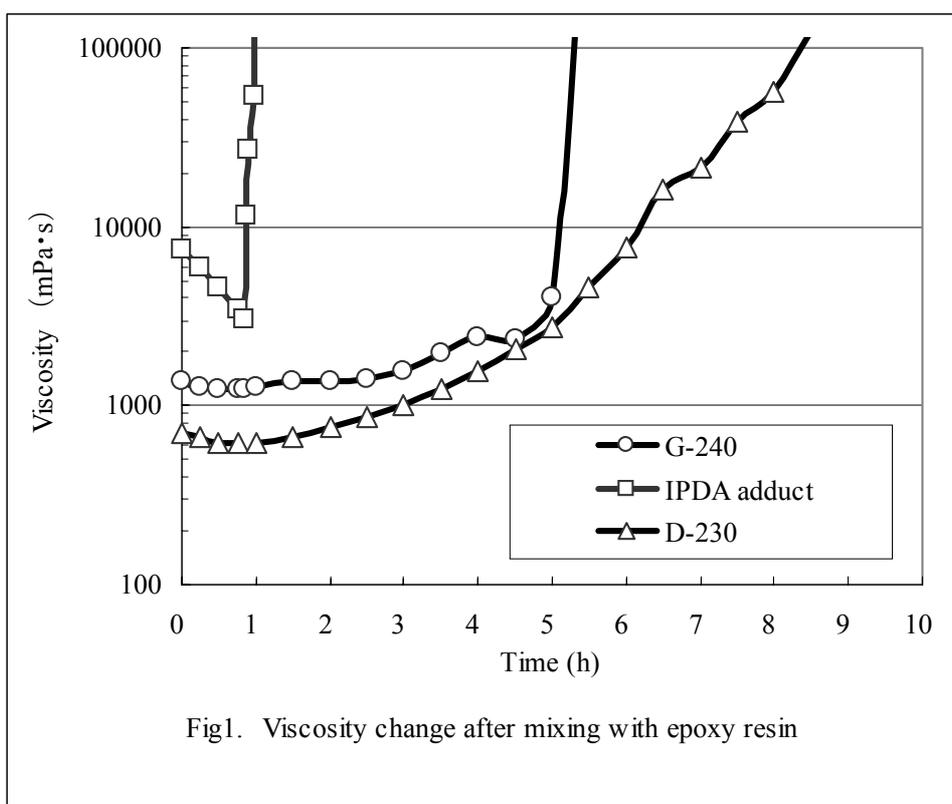
### 3-2. Viscosity change after mixing with epoxy resin

Table 3. Initial viscosity of mixture

Hardener	G-240	IPDA adduct	Jeffamine D-230
Formulation (g)			
DGEBA	100	100	100
Hardener	55	31	32
Curing condition	23°C		
Initial viscosity of mixture (mPa·s)	1370	7460	712

DGEBA: Bis-A epoxy resin (EEW=186) (Epikote 828; Japan Epoxy Resins Co., Ltd.)

\*1: 300g in cup



## 4. Properties of coating film

### 4-1. Properties of coating film under room temperature condition

Advantage: **Excellent appearance (gloss, clarity)**

**Fast drying performance**

**Excellent water spotting resistance**

Table 4. Properties of coating film cured with Gaskamine 240

Hardener	G-240	IPDA adduct	Jeffamine D-230
Formulation			
DGEBA (g)	100	100	100
Hardener (g)	55	31	32
Curing condition	23°C (50% RH)		
Appearance (7 days)			
Gloss/ Clarity	Ex/ Ex	Ex/ Ex	Ex/ Ex
Dryness			
1 day/ 4 days/ 7 days	Ex/ Ex/ Ex	Ex/ Ex/ Ex	Ex/ Ex/ Ex
Water spotting resistance			
2 hr/ 4 hr/ 6 hr/ 8 hr	P/ P/ P/ <b>G</b>	P/ P/ P/ P	P/ P/ P/ P
16 hr/ 1 day/ 4 days/ 7 days	<b>Ex</b> / Ex/ Ex/ Ex	G/ Ex/ Ex/ Ex	P/ F/ Ex/ Ex

Appearance: evaluated visually

Ex: Excellent

G: Good

F: Fair

P: Poor

Dryness: evaluated with finger

Ex: Dry

G: Slightly sticky

F: Sticky

P: Severe sticky

Water spotting resistance:

After curing the coating film at 23°C for 2, 4, 6, 8, 16 hours, 1 day, 4 days and 7 days, water with 10 mm in diameter was placed on the coating film and covered by glass cup. After 24 hours, water on the coating film was wiped up and the condition of the coating film was evaluated visually.

Ex: No visual changes

G: Slightly lower gloss or clarity

F: Slight surface whitening

P: Whitening

#### 4-2. Properties of coating film under tropical condition

Advantage: **Excellent appearance (gloss, clarity, leveling) under tropical condition.**  
**Fast drying performance under tropical condition.**

Table 5. Properties of coating film under tropical condition

Hardener	G-240	IPDA adduct	Jeffamine D-230
Formulation (g)			
DGEBA	100	100	100
Hardener	55	31	32
Curing condition	35°C (90% RH)		
Appearance			
Gloss/ Clarity/ Leveling	<i>Ex/ Ex/ Ex</i>	P/ F/ F	P / P/ P
Dryness			
(1day/ 4days/ 7days)	<i>Ex/ Ex/ Ex</i>	Ex/ Ex/ Ex	P / P/ P

### 4-3. Property of intercoat adhesion of coating film

Advantage: **Excellent intercoat adhesion.**

Table 6. Property of intercoat adhesion of coating film

Hardener	G-240
Formulation (g)	
DGEBA	80
SR-16H	20
Hardener	57
Curing condition	23°C (50% RH)
Intercoat adhesion	
Substrate/Undercoat (/ 25)	<b>25*</b>
Undercoat/Topcoat (/ 25)	<b>25*</b>

SR-16H: 1,6-hexanediol diglycidyl ether (EEW=158) (Sakamoto Yakuhin Kogyo Co., Ltd.)

\*: the number of the pieces left

Curing: 7 days / 23°C (50%RH) for undercoat and more 7 days / 23°C (50%RH) for topcoat.

Method: Coating film was divided into 25 pieces(2mm×2mm square) on the plate by razor blade.

Adhesive tape was applied on the film and then peeled off twice.

Count the number of the pieces left on the plate.

## 5. Chemical resistance

### 5-1 Chemical resistance of coating film

Advantage: **Better chemical resistance than IPDA adduct and Jeffamine D-230.**

Table 7. Chemical resistance of coating film cured with Gaskamine 240

Hardener	G-240	IPDA adduct	Jeffamine D-230
Formulation			
DGEBA (g)	100	100	100
Hardener (g)	55	31	32
Curing condition	7 days/ 23°C (50% RH)		
Chemical resistance (1w/ 4w)			
10wt% NaOH (aq.)	<b>Ex / G</b>	G / F3	Ex / G
10wt% H <sub>2</sub> SO <sub>4</sub> (aq.)	<b>G / G</b>	G / P3	P3 / P3
Water	<b>Ex / Ex</b>	Ex / G	Ex / 8M*
Gasoline*	<b>Ex / G</b>	G / G	Ex / G
Gas oil	<b>Ex / G</b>	Ex / G	Ex / G
Ethylene glycol	<b>Ex / G</b>	P3 / P3	Ex / G
Salt spray 5wt% NaCl	<b>Ex / G</b>	F2 / F2	Ex / Ex

\* ... ASTM Reference Fuel A (ASTM Test Method D 471 ; Isooctane 100%)

Chemical resistance: evaluated visually

Ex: Excellent (No visual changes) G: Good (Slightly lower gloss or clarity)

F: Fair (Slight change) P: Poor (Obvious change)

Change: 1;Whitening, 2;Black spots, 3;Peeling off, 4;Swelling, 5;Dissolution

\*Blister: ASTM D 714

Size: 2, 4, 6, 8 (Big → Small)

Density: F, M, MD, D (Few → Dense)

## 5-2 Chemical resistance of cast sheet

Advantage: **Better chemical resistance than IPDA adduct and Jeffamine D-230.**

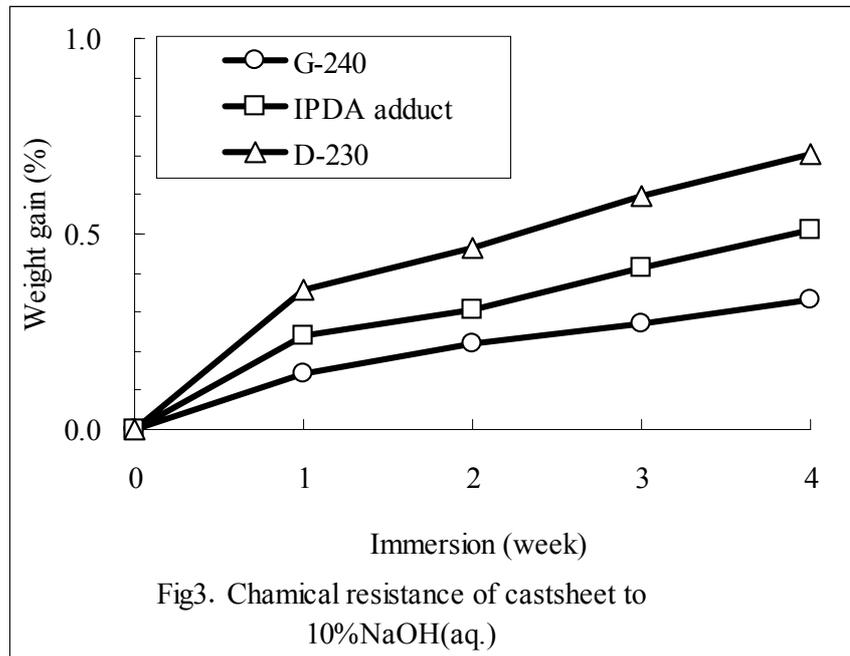
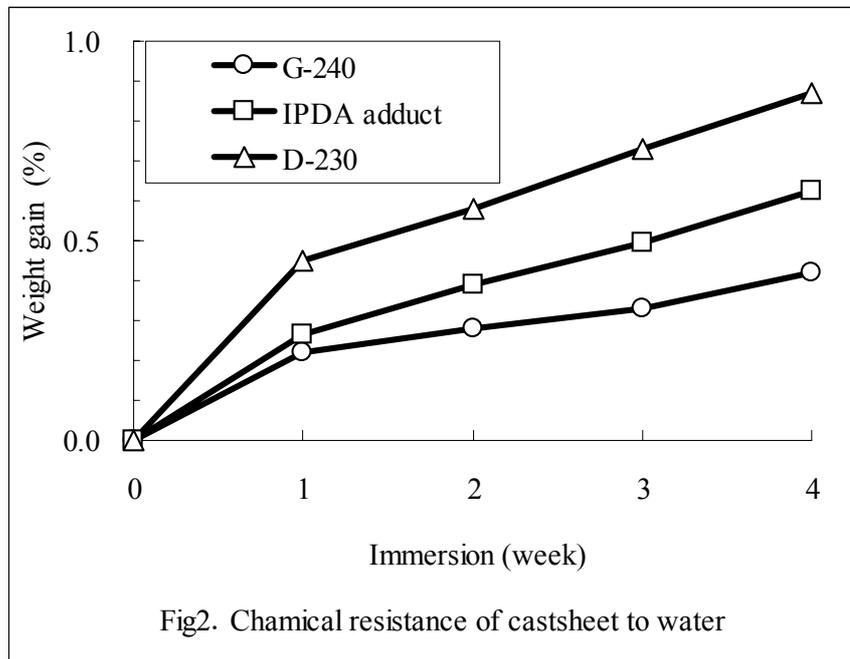
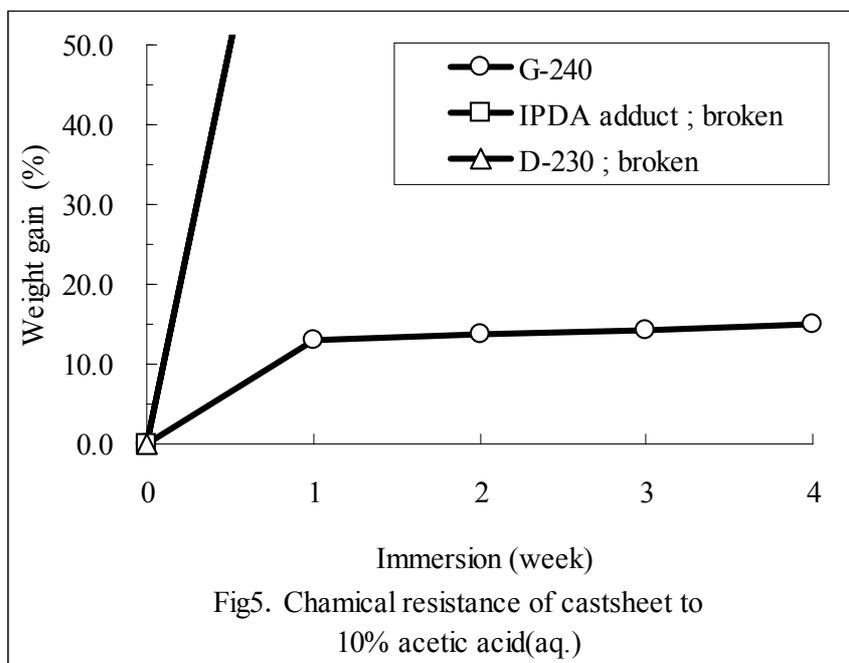
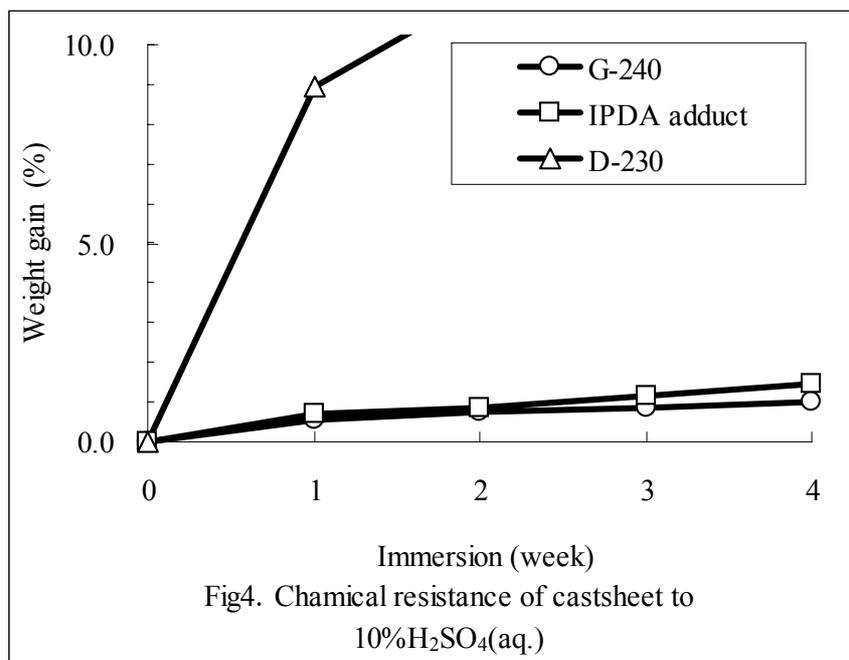
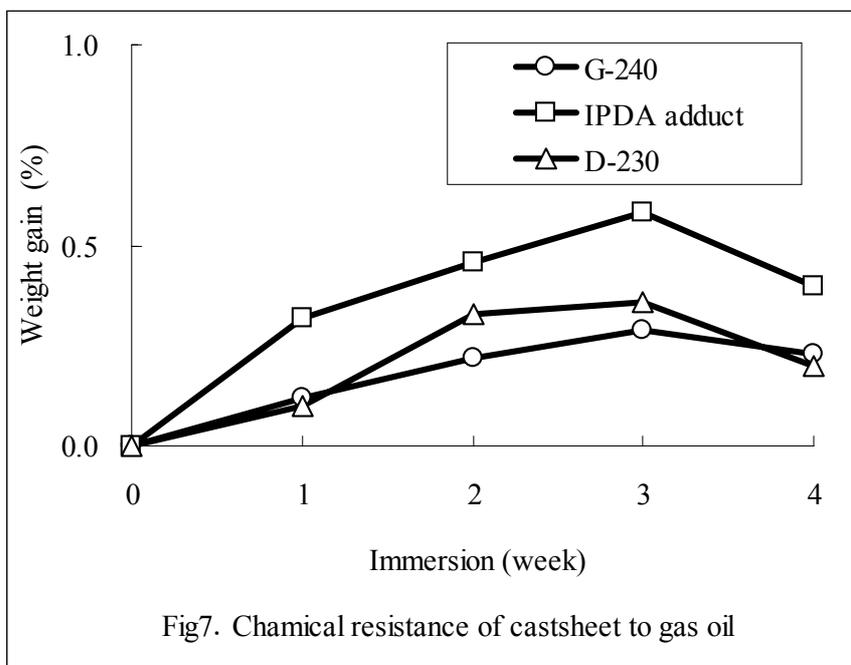
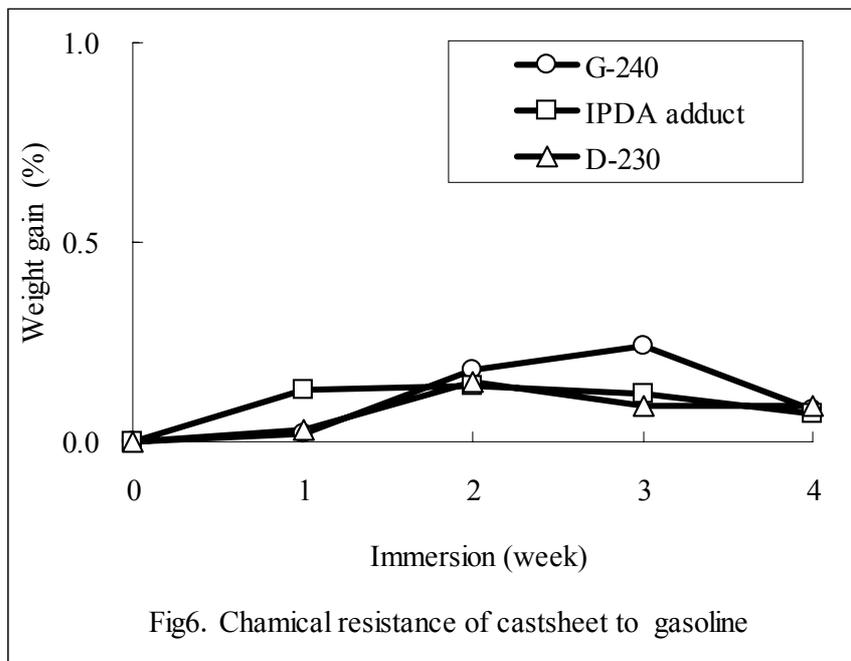
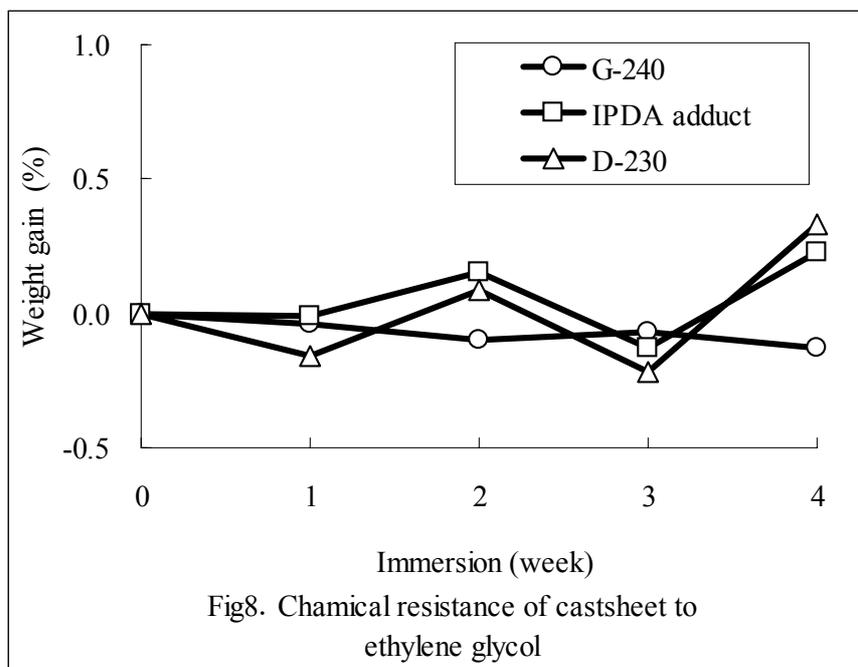


Table 8. Formulation and curing condition of cast sheet

Hardener	G-240	IPDA adduct	Jeffamine D-230
Formulation			
DGEBA (g)	100	100	100
Hardener (g)	55	31	32
Curing condition	7 days/ 23°C (50% RH)		







## 6. Adhesive properties of steel-to-steel or mortar-to-mortar

Advantage: **Higher tensile shear strength of steel-to-steel adhesive than IPDA adduct.**  
**Higher bond strength of mortar-to-mortar adhesive than Jeffamine D-230, especially in wet condition.**

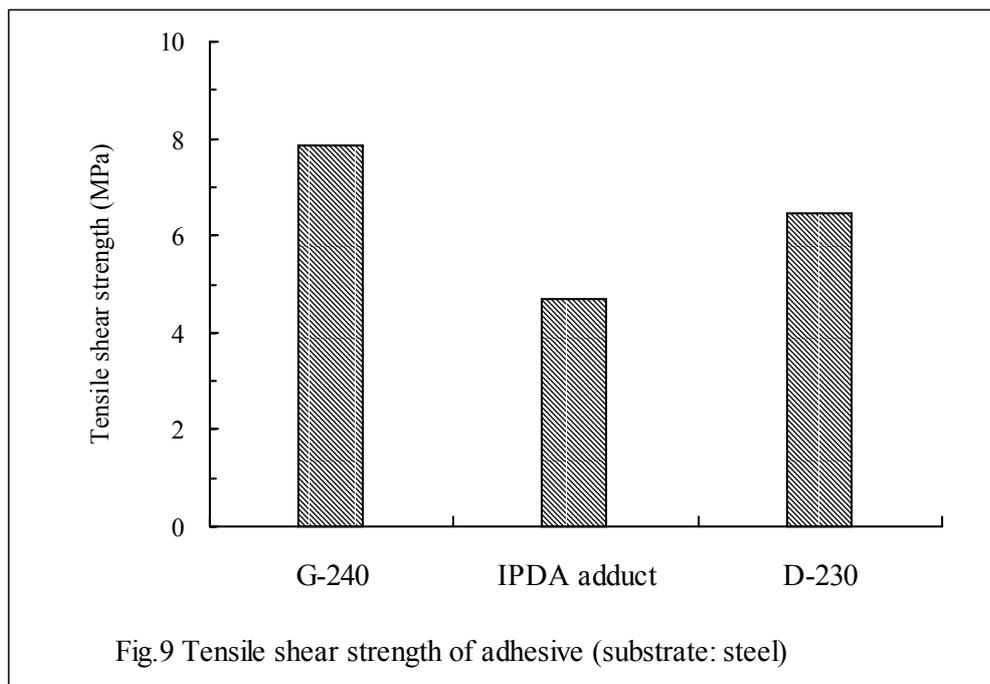


Table 9. Tensile shear strength of adhesive using Gaskamine 240 (substrate: steel)

Hardener	G-240	IPDA adduct	Jeffamine D-230
Formulation			
DGEBA (g)	80	80	80
SR-16H (g)	20	20	20
Hardener (g)	57	32	33
Curing condition	7 days/ 23°C (50% RH)		
Bond strength (MPa)			
Steel-to-steel/ tensile shear strength	<b>7.9</b>	4.7	6.5

SR-16H: 1,6-hexanediol diglycidyl ether (EEW=158) (Sakamoto Yakuhin Kogyo Co., Ltd.)

Table 10. Bond strength of adhesive using Gaskamine 240 (substrate: mortar)

Hardener	G-240	IPDA adduct	Jeffamine D-230
Formulation			
DGEBA (g)	80	80	80
SR-16H (g)	20	20	20
Hardener (g)	57	32	33
Mortar-to-mortar/ bond strength			
Curing condition (in standard) 7 days/ 23°C (50% RH)			
Type of failure	<b>Adherend failure</b>	Adherend failure	Adherend failure
Bond strength (MPa)	(11.5)	(9.3)	(9.6)
Curing condition (in wet) 7 days/ 23°C (85% RH)			
Type of failure	Adhesive failure	Adhesive failure	Adhesive failure
Bond strength (MPa)	<b>10.1</b>	9.2	3.1

SR-16H: 1,6-hexanediol diglycidyl ether (EEW=158) (Sakamoto Yakuhin Kogyo Co., Ltd.)

## 7. Testing method

### 7-1 Coating condition and curing condition

Epoxy resin: DGEBA (Bis-A epoxy resin)(EEW=186) (Epikote 828; Japan Epoxy Resins Co., Ltd.)

Formulation: Stoichiometric amount based on active hydrogen equivalent weight.

Coating: 200 $\mu$ m doctor blade, on cold rolled steel (70 x 150 x 0.8 mm) sanded by #240 emery paper.

Curing: 7 days / 23°C (50%RH)

### 7-2 Testing method and evaluation

#### (1) Pot life

Time to the peak exothermic temperature (300g, 23°C)

#### (2) RCI drying time

Coating 76 $\mu$ m initial thickness on glass plate (25×300×2 mm) with an applicator. The time to ST, DF and DT is measured.

ST: Set-to-touch

DF: Dust free

DT: Dry through

0:00 : Indicate hours and minutes

#### (3) Changes in viscosity with time for epoxy resin/amine systems

Epoxy resin: DGEBA (Bis-A epoxy resin)(EEW=186) (Epikote 828; Japan Epoxy Resins Co., Ltd.)

Formulation: Stoichiometric amount based on active hydrogen equivalent weight.

#### (4) Appearance

Gloss and clarity are evaluated visually.

Ex: Excellent

G: Good

F: Fair

P: Poor

Dryness is evaluated with the finger.

Ex: Dryness

G: Slight stickiness

F: Stickiness

P: Severe stickiness

#### (5) Water spotting resistance:

After curing the coating film at 23°C for 2, 4, 6, 8, 16 hours, 1 day, 4 days and 7 days, water with 10 mm in diameter was placed on the coating film and covered by glass cup. After 24 hours, water on the coating film was wiped up and the condition of the coating film was evaluated visually.

Ex: Excellent No visual change

G: Good Slightly lower gloss or clarity

F: Fair      Slight surface whitening  
P: Poor      Whitening

(6) Properties of intercoat adhesion of coating film

Epoxy resin: DGEBA (EEW=186) (Japan Epoxy Resins Co., Ltd.)

SR-16H (EEW=158) (Sakamoto Yakuhin Kogyo Co., Ltd.)

DGEBA : SR-16H = 80:20 Blend

Formulation: Stoichiometric amount based on active hydrogen equivalent weight.

Curing: 7 days / 23°C (50%RH) for undercoat and more 7 days / 23°C (50%RH) for topcoat.

Coating: 150µm doctor blade for undercoat and 150µm doctor blade for topcoat, on cold rolled steel (70 x 150 x 0.8 mm) sanded by #240 emery paper.

Method: Coating film was divided into 25 pieces(2mm×2mm square) on the plate by razor blade.

Adhesive tape was applied on the film and then peeled off twice.

Count the number of the pieces left on the plate.

(7) Chemical resistance of coating film:

Immersion: 4 weeks / 23°C

Salt spray: 4 weeks / 35°C

Test: evaluated visually

Ex: Excellent (No visual changes) G: Good (Slightly lower gloss or clarity)

F: Fair (Slight change)      P: Poor (Obvious change)

Change: 1; Whitening, 2; Black spots, 3; Peeling off, 4; Swelling, 5; Dissolution

Blister: ASTM D 714

Size: 2, 4, 6, 8 (Big → Small)

Density: F, M, MD, D (Few → Dense)

(8) Chemical resistance of cast sheet

Formulation: Stoichiometric amount based on active hydrogen equivalent weight.

Formulated epoxy resin was degassed enough, and poured into the cast (50×50×3 mm) and cured.

Curing: 7 days / 23°C (50% RH)

Immersion: 4 weeks / 23°C

7-3 Bond strength

Epoxy resin: DGEBA (EEW=186) (Japan Epoxy Resins Co., Ltd.)

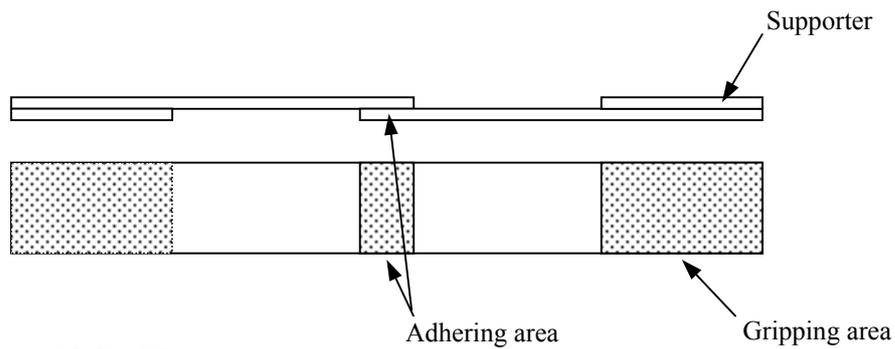
SR-16H (EEW=158) (Sakamoto Yakuhin Kogyo Co., Ltd.)

DGEBA : SR-16H = 80:20 Blend

Formulation: Stoichiometric amount based on active hydrogen equivalent weight.

(1) Steel-to-steel bond strength, by tensile shear strength

Substrate: Cold rolled steel ( $100 \times 25 \times 1.6$  mm) sanded by #240 emery paper



Adhering area:  $12.5 \times 25$  mm

Curing: 7days /  $23^\circ\text{C}$  (50% RH)

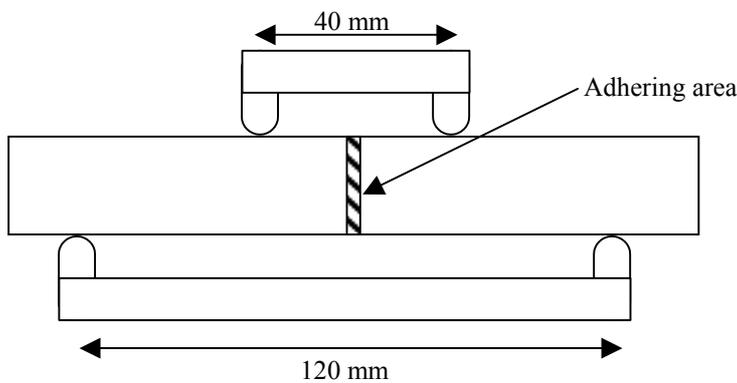
Test: Instron type tester Cross head speed: 2 mm / min

(2) Mortar-to-mortar bond strength

Substrate: Mortar block ( $40 \times 40 \times 80$  mm) was made from 1 part portland cement and 3 parts sand and 0.50 part water, and cured at  $20^\circ\text{C}$  (90 % RH) for 24 hours and in water at  $20^\circ\text{C}$  for 27 days.

Adhering area:  $40 \times 40$  mm

Thickness of glue line: 1 mm



Curing: standard condition:

7 days /  $23^\circ\text{C}$  (50% RH)

: wet condition:

Before adhering, mortar blocks are immersed in water for 1 day. Cured at  $20^\circ\text{C}$  (85% RH) for 7 days.

Test: Instron type tester Cross head speed: 1 mm / min

## Updated

Date	Version	Remarks
2002/06	Ver.1.0	TSR02061H
2002/11	Ver.1.1	Water spotting resistance of 2,4,6,8hr.
2003/02	Ver.2.0	Changes in viscosity with time for epoxy resin/amine systems. Properties of coating film under tropical condition. Properties of intercoat adhesion of coating film. Chemical resistance of coating film and cast sheet(gasoline, gas oil, ethylene glycol).

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