Basic Adhesive Knowledge

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

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- ✓ Silicone

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PART A

Chemistry of Adhesive

Introduction

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❖ The basic definition of an adhesive as used by the Adhesive Sealant Council in America is A material used for bonding that exhibits flow at the time of application.

❖ For a material to perform as an adhesive it must have four main requirements:

- It must "wet" the surfaces - that is it must flow out over the surfaces that are being bonded, displacing all air and other contaminates that are present.
- It must adhere to the surfaces - That is after flowing over the whole surface area it must start to adhere and stay in position and become "tacky".
- It must develop strength - The material must now change its structure to become strong or non-tacky but still adherent.
- It must remain stable - The material must remain unaffected by age, environmental conditions and other factors as long as the bond is required.

Introduction

❖ The raw materials for adhesives are mainly polymeric materials, both naturally occurring and synthetic.

❖Epoxy is one of the synthetic adhesives.

❖Epoxy resin has excellent properties on mechanical strength, chemical resistance, electrical insulation. This is due to epoxy resin is able to have various different properties as it is combined and cured together with various curing agents.

❖Generally, epoxy resins can be cured by several methods

❖Curing take place either under increased or ambient temperature as conventional thermal curing method, or as it is an alternative – radiation curing – such as UV curing methods.

PART A1

HEAT CURABLE EPOXY ADHESIVE

EPOXY RESINS

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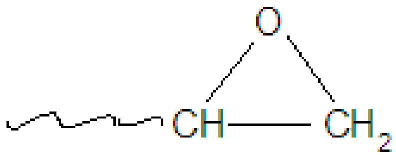
What are Epoxy resins?

- A family of thermoset resins which have the following chemical group (oxirane):



Oxirane group

- When it reacted with a hardener (or curing agent), they set to a hard mass which does not melt or dissolve in solvents.

One part epoxy adhesive

- One part epoxy adhesive require a latent curing agents or cationic thermal initiator, which it does not react with epoxy resin at or below room temperature, but will react with epoxy resin at elevated temperature.

- Example of latent curing agents are dicyanodiamide (DICY) and epoxy - amine / imidazole adduct.

- An epoxy-amine/imidazole adduct is formed by partial react of the amine/imidazole with the epoxy resins.

One part epoxy adhesive

- Formulated epoxy / DICY composition have excellent storage stability (> 2 weeks) but it must be cure at high temperature, ≥150^{0}C , for long time. An accelerator will be added to reduce the curing temperature and curing time.

- Meanwhile, epoxy formulated epoxy-amine / imidazole adduct curing agent have good storage stability and cure at lower temperature (80 to 120 ^{0}C).

- One part epoxy formulated with cationic thermal initiator can be cure rapidly at elevated temp. (100 to 150 ^{0}C, snap cure).

PART A2

HEAT CURABLE SILICONE ADHESIVE

SILICONES

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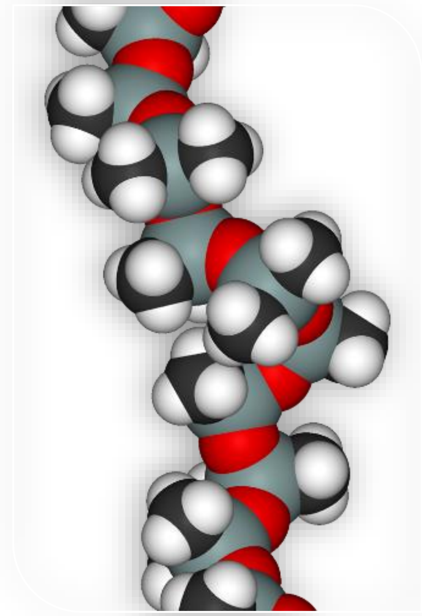
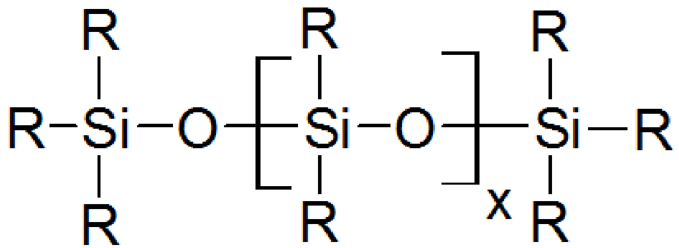


What is silicone?

- Also know as **polysiloxanes**.
- An **inorganic polymer** with silicon-oxygen backbone (··· -Si-O-Si-O-Si-O- ···) with organic side groups (R) attached to the silicon atoms, which are four-coordinate.



R = methyl ($-CH_3$), phenyl ($-C_6H_5$), vinyl ($-CH=CH_2$), hydride (-H), hydroxyl (-OH), etc.

X = 0, 1, 2, …. or more

Crosslinking reaction of silicones

During crosslinking reaction, the individual silicone polymer chains are linked together to form one giant molecule.

Silicones can be crosslinked via:

1) **Platinum cure (Addition cure)**
2) **Moisture cure (Condensation cure)**
3) **Peroxide cure (Free radical polymerization)**

Addition Cure Systems	Condensation Cure Systems
No by-products released	Liberate alcohol / volatile by-product during cure
Low odour	Odour smell
Low cure shrinkage (dimensional stable)	Higher cure shrinkage
Can cure in completely sealed assemblies	Depth of cure limitation (moisture unable to penetrate through thick section, must avoid closed curing system)
Sensitive to cure inhibition	Virtually no cure inhibition (suitable to contact with most of materials)
Work time and cure rate can be adjustable (fast cure to slow cure)	Cure upon expose to atmospheric moisture. Usually short work time.
Cure may be either room temperature cure (RTV) or heat accelerated (HTV).	Cure only at ambient temperature (preferred 25 to 40˚C)
High tear strength and tough, range from ultra soft to hard rubber, can be formulated upon requirement.	Moderate strength, durable and elasticity.
More expensive	Generally cheaper

Example of substances will inhibit addition cure silicone system

Addition cure system is sensitive to:

- **Sulfur compounds** (mercaptans, sulfates, sulfides, sulfites, thiols and rubbers vulcanized with sulfur will inhibit contacting surfaces)
- **Nitrogen compounds** (amides, amines, imides, nitriles)
- **Tin compounds** (condensation-cure silicones, stabilized PVC)
- **Moisture**
- **Phosphate compounds**

Product Proposal – Thermal Putty

- Dispensable TIM solutions.

Thermal Putty	TH235-2	TH930	TH855-1	TH949-1
Color	Light Blue	White	Light Grey	Light Grey
Thermal Conductivity, W/mk	4.0	5.0	7.5	11
Extrusion rate, g	8.5 2.5mm, 50psi	0.11 GA15, 50psi	0.35 GA15, 50psi	1.43 2.5mm, 50psi
Volatile Content, 150C	0.45	0.39	0.06	0.04
Operation Temperature, C	-40-120	-40-200	-40-200	-40-200
Flammability, UL94	V0	V0	V0	V0
Bleed Test, 100C/100hrs, blot width, mm	45	6	9	3

Product Proposal – Gap Filling

- Low modulus/shrinkage/temp-cure epoxy suitable for filling mechanical gaps within the module。

Property	DA659	PT605-9	UF253-1	EN418-12	PT328-1	OP993-13	EN893-2
Chemical	Epoxy	Epoxy	Epoxy	Epoxy	Epoxy	Silicone	Silicone
Application	Die Attach	Die Attach	Underfil	Gap filling and bonding	2 parts Filling and Potting	Gap Filling	Gap Filling and Wire protection
Viscosity, cps	1266	970	1200	9850	450	1433	4300
Thermal conductivity,, W/mk	0.2	1.1	0.6	0.4	0.2	0.2	0.2
Glass Transition, °C	27	-28	128	122	97	-98	-98
CTE, a1, ppm/K	80	78	31	38	65	>200	>200
Hardness	A74	A66	D88	D86	D83	gel	00 55
Modulus, 30C, Mpa	32	200	>4000	3680	1361	0.5	2
Curing Profile, °C	100C/2hr 125C/1.5hr	100C/1hr 130C/10 mins	100C/1hr 130C/10mins	85C/2hrs 100C/1hrs	25°C/24hrs 100C/2hrs	100C/2hrs	100C/2hrs

Product Proposal – Glob Top

- Glob-top epoxy that ideally can insulate heat on Silicon wafer and ICs.

Property	TH514	EN525	TH737-1
Application	TEC 200um-420um gap filling and heat insulation	Glob Top with height 2mm	IC bonding
Chemistry	Silicone	Epoxy	Epoxy
Filler Size, um	90	150	150
Filler Content, %	>30	>20	>30
Thermal Conductivity, W/mk	0.1	0.5	2.6
Density, g/cm3	0.62	1.97	2.64
Glass Transition, °C	<-90	123	133
Operation Temperature, °C	-40-300	-40-150	-40-300
Hardness	gel	D90	D94
Adhesion Strength, kf/cm3	NA	185	133
Cure Profile	150C/30mins	120C/1hr 150C/30mins	90C/30mins

THANK YOU!

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

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Penchem Technologies Sdn Bhd
1015, Jalan Perindustrian Bukit Minyak 7,
Kawasan Perindustrian Bukit Minyak,
Mk.13, 14100 Penang, Malaysia.
T: +604-501 5973, 74, 75, 76, 77, 78
E: enquiry@penchem.com
W: www.penchem.com