Assembly Technology Expo 2004

AD-03: Adhesives in Assembly: Delivering Superior Form + Function

Selecting the Right Elastic Bonding and Sealing Chemistry for Your Application

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Selecting the Right Chemistry

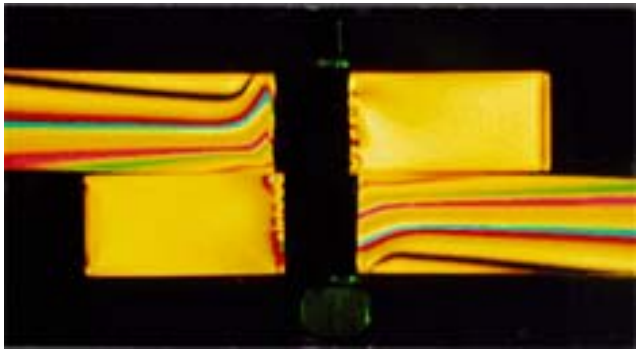
- Elastic Bonding and Sealing Explained
- One-Component Moisture Cure Systems
  - Understanding the Chemistries
  - Comparing Chemistries, Strengths/Weaknesses
- Selecting the Appropriate System

Elastic Bonding and Sealing

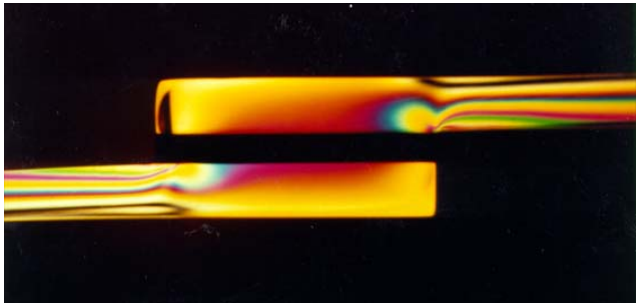
The primary function of elastic bonding is to join and seal components with a flexible, polymeric material to achieve long term flexibility, adhesion, and durability.

- **Uniform stress distribution**
- **Good tolerance compensation and gap-filling**
- **Good resistance against impact stress**
- **Joining of dissimilar materials, styling freedom**
- **No deformation or damage to the substrates**

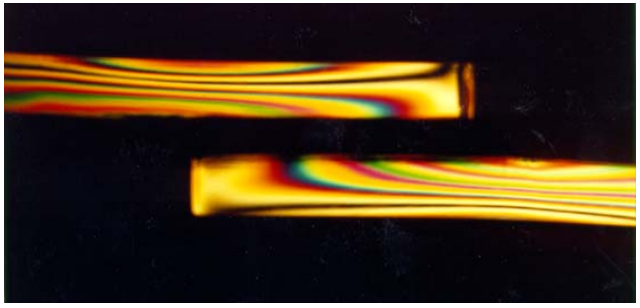
Elastic Bonding and Sealing



Mechanical Fastener



Rigid Bond line



Elastic Bond line

One-Component Moisture Cure Systems

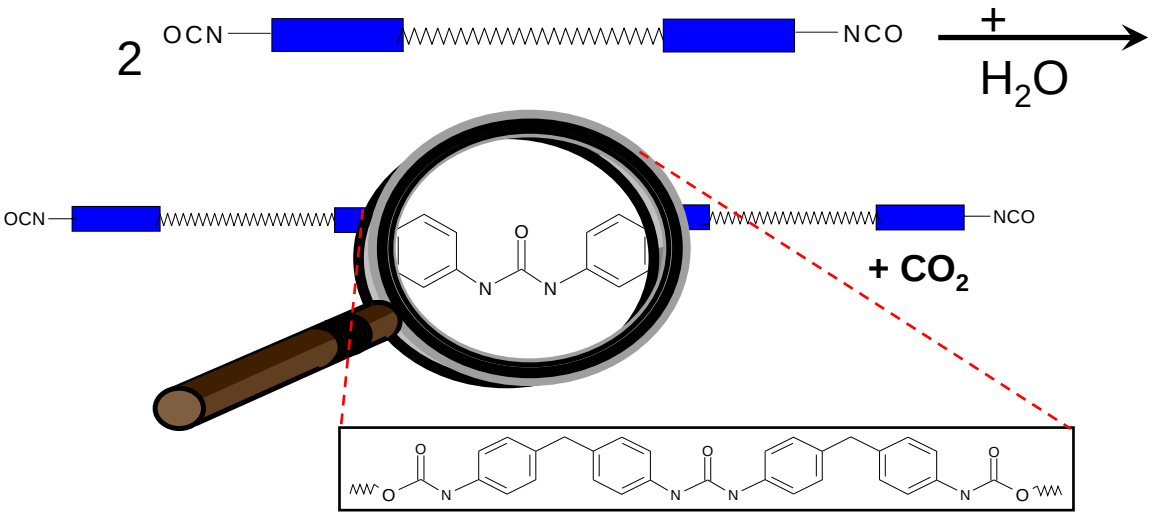
- Elastomeric sealants/adhesives
  - One-Component Technology
    - Moisture Cure
      - Polyurethanes
      - Silane Terminated Polymers (STPs)
      - Silicones

One-Component Moisture Cure Systems

- Consistency: stiff, paste-like
- Application by using a cartridge gun or pump-operated application equipment
- Applied in bead form, a few millimeters
- Application and curing temperatures 5-35ºC (ideally 15-25ºC)
- Tack-free time between 10 minutes and 1 hour plus (depending on product and conditions)
- Rate of cure a few mm/day, depends on conditions (temperature and relative humidity)

Polyurethanes

Prepolymer-based flexible adhesives and sealants that cure on exposure to atmospheric moisture to form a durable elastomer



Polyurethanes

Strengths

- Excellent mechanical properties
- Paintable
- Fastest cure rates when compared to STPs and Silicones

Weaknesses

- Adhesion without primer/cleaners limited in comparison to STPs and Silicones
- Limited UV weathering characteristics

Silane Terminated Polymers (STPs)

MS and Polyurethane Hybrid adhesives and sealants containing silane functional groups that cure on exposure to atmospheric moisture to form a durable elastomer

PUR-Hybrid + water → Polymer **+CH_3 OH (Methanol)**

Cross linking PUR-Hybrid Polymer

Silane Terminated Polymers (STPs)

Strengths

- Better resistance to UV degradation and weathering than one-component PUR
- Excellent adhesion to a wide range of substrates with minimum surface preparation
- Mechanical properties comparable to one component PUR
- Isocynate Free
- Low in VOC‘s and free from and solvents (depending on formulation)
- Paintable

Weaknesses

- Susceptible to creep under constant static loading
- More susceptible to water absorption vs PUR

Silicones

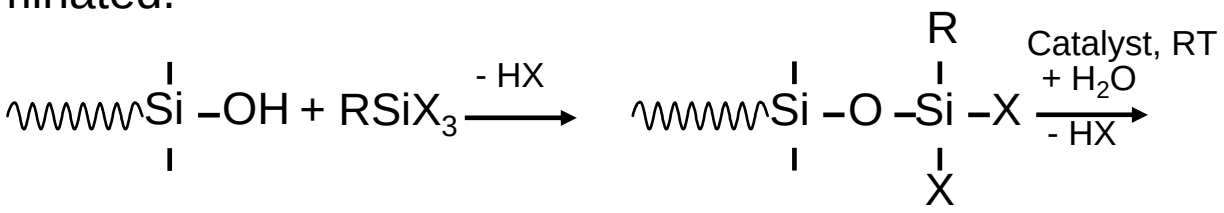
Adhesive/sealant systems based on an organo-silane elastomeric polymer that cure by reaction with atmospheric moisture. These systems are commonly referred to as RTV Silicones. RTV stands for Room Temperature Vulcanizing.

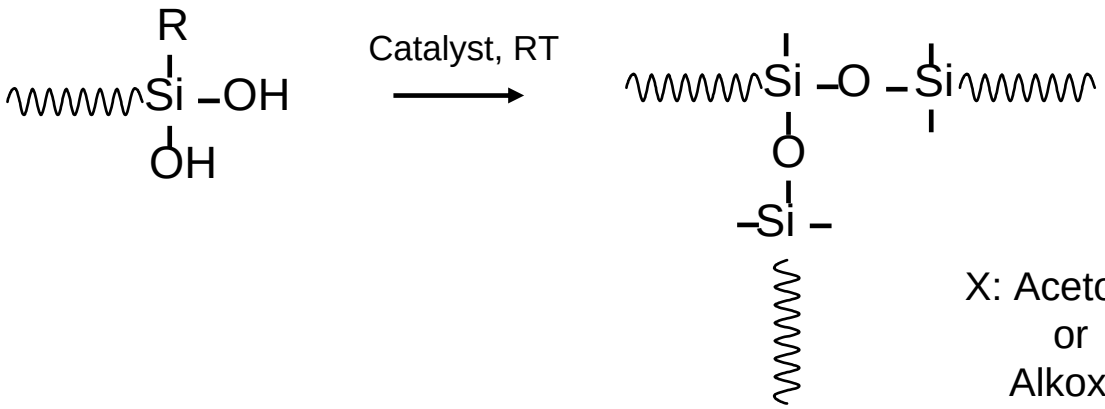
Silicones

Two Silicone Chemistries to focus on today:

Acetoxy means that an acid group, most commonly Acetic Acid, is eliminated during cure.

Alkoxy means that an alcohol, most commonly Methanol, is eliminated.





Silicones

Strengths

- Best resistance to UV degradation and weathering
- Higher continuous service temperature compared to PURs and STPs
- More resistant to mold growth
- Available in clear or translucent

Weaknesses

- Lower mechanical properties than PURs and STPs
- More susceptible to water absorption vs PURs and STPs
- Non-paintable
- Less resistance to high humidity vs PURs and STPs
- Slower curing vs PURs and STPs

Chemical Summary

Polyurethane

- polyether backbone
- direct end-cap: Isocyanate
- carbon dioxide by-product

STP- PUR Hybrid

- polyether backbone
- two step end-cap: Isocyanate ⇨ Silane
- methanol by-product

STP- MS Polymer

- polyether backbone
- direct end-cap: Silane
- methanol by-product

Silicone (Acetoxy cure)

- polydimethylsiloxane backbone
- direct end-cap: silane
- acetic acid by-product

Silicone (Alkoxy cure)

- polydimethylsiloxane backbone
- direct end-cap: silane
- methanol by-product

All require moisture to cure

Comparing Chemistries, Strengths/Weaknesses

Property	1C Silicone	1C STP	1C PUR
Shelf Life in Cartridge	12 months (loss of cure after)	9 months	9 – 12 months
Sag	All Non-Sag		
Skin Time	Similar Ranges, depends on formulation		
Cure Through Time	Slow	Medium	Fast
Cure Byproducts	Methanol or Acetic Acid or Other.	Methanol	CO_2
Overpaint	No	Yes	Yes
Mechanical Properties	Good, low strength, low creep	Better, medium creep. Hybrid better than MS	Best balance of properties
Service Temperature Range	-40 to 150C Acetoxy -40 to 120C Alkoxy	-40 to 90 C	-40 to 90 C
UV Resistance	Superior, sealant and bonds	Good	Poor - fair
Primer less Adhesion	Fair - Good	Good	Fair - Good
Adhesion Durability	Acceptable, but sensitive to humidity at high Temp. Even with primer	Acceptable, but problems with porous materials in wet/humid environments	Acceptable in most conditions with proper surface preparation
Mold Resistance	Good	Poor - Fair	Poor - Fair

Selecting the Appropriate System

- Gather all information regarding the opportunity:
  - What are the substrates?
  - What type of application (hand applied, automated)?
  - What are the time constraints?
  - What are the strength requirements?
  - What are the environmental conditions for downstream processing and end use?
  - How much handling/green strength is required?
  - Can the parts be fixtured, if so, for how long?
  - Do substrates require pre-treatment?
- Contact your adhesive/sealant supplier for assistance!

Selecting the Appropriate System

What you should expect from your adhesive/sealant supplier:

- Design partnership
- Identification of performance specifications
- Adhesive durability data
  - creep
  - fatigue
  - environmental resistance
- Adhesion evaluation (on your substrates)
- Process / Training / Audit

Selecting the Appropriate System

Be Flexible!