

# PPG is...



- **A global maker of paints, coatings, chemicals, optical products, specialty materials, glass and fiber glass**
- **Founded in 1883**
- **Headquartered in Pittsburgh, Pa.**
- **Owned by 154,000 shareholders, including 20,000 employees and retirees**

# PPG's Global Operations



- More than 37,600 employees
- More than 150 manufacturing sites and equity affiliates
- In more than 60 countries

 PPG Presence





# Glass



- **Fiber Glass:**  
Yarn, chopped strand, roving and mat products for use in electronics, insect screening, medical casting, recreation, filtration fabrics, and thermoset and thermoplastic composites
- **Performance Glazings:**  
Glass for commercial construction and residential markets, as well as appliance, mirror and transportation industries

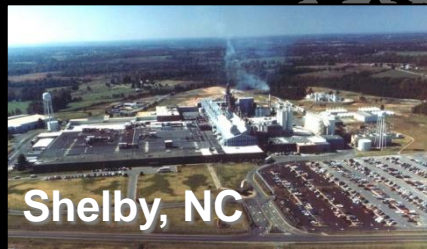
# Innovation



- **Global R&D and marketing functions team to bring innovation to market faster.**
- **PPG invests hundreds of millions of dollars each year in R&D.**
  - ▶ **More than 30% of sales are from products 5 years old or newer.**
  - ▶ **Pioneered cationic electrodeposition automotive primers that have virtually eliminated rust.**
  - ▶ **Introduced plastic photochromic eyewear lenses that automatically darken in sunlight.**
  - ▶ **Introduced revolutionary insulated glass technology for residential doors and windows.**



# PPG Worldwide Fiber Glass Plants



Shelby, NC



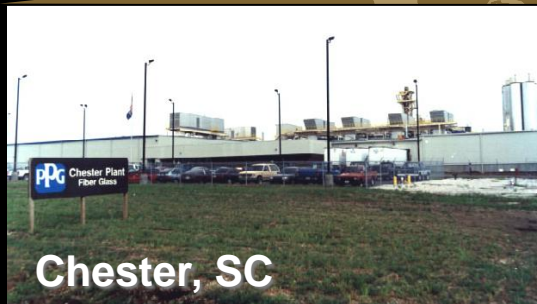
Wigan, UK



Hoogezand, Neth.



Zibo, China

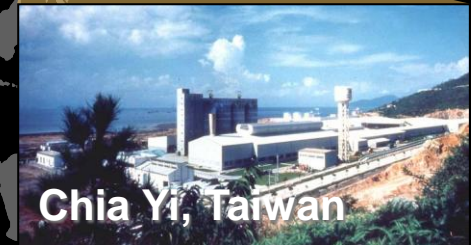


Chester, SC



Lexington, NC

Kunsan City,  
China (2003)



Chia Yi, Taiwan

# PPG Fiber Glass Product Portfolio



**Electronics**



**Specialty**



**Thermoplastics**



**Thermosets**



**Roofing**



# Fiber Glass Products



## Thermosets

*Direct Draw*

*Assembled Rovings*

*Mat – Chopped*

*Mat – Continuous*

*Chopped Strand*

*Wet Chop*

*String Binder*

## Electronics

*Course Yarn*

*Fine Yarn*

## Roofing

*Wet Chop*

## Specialty

*Twisted Yarn*

*Texturized Yarn*

*Beamed Yarn*

*DE Chop*

## Thermoplastics

*Chopped Strand*

*Roving*

*Wet Chop*

*Mats*

# Fiber Glass Market Segments



## Thermosets

*Direct Draw*

*Assembled  
Rovings*

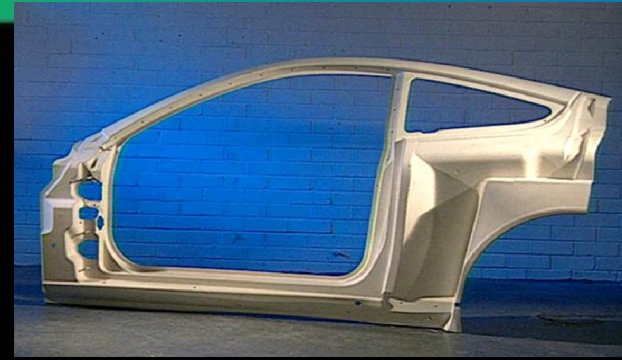
*Mat – Chopped*

*Mat – Continuous*

*Chopped Strand*

*Wet Chop*

*String Binder*



## **Automotive**

- Epoxy, Vinyl Ester, UPolyester, Styrenics, etc.
- Pultrusion, Filament Winding, Spray – Up, RTM, Infusion, Compression Molding, etc.



## **Mass Transit**



## **Energy**



## **Recreation**

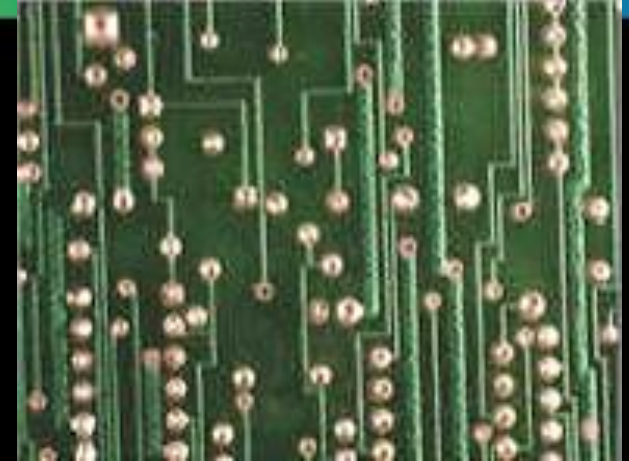
# Fiber Glass Market Segments



## Electronics

*Course Yarn*

*Fine Yarn*



**PCB for Computing / Telecommunication / Entertainment**

- **FR4 Epoxy, High Tg Resins**
- **Woven Fabrics from Yarn**
- **Prepreg, Lamination, Curing**



# Fiber Glass Market Segments



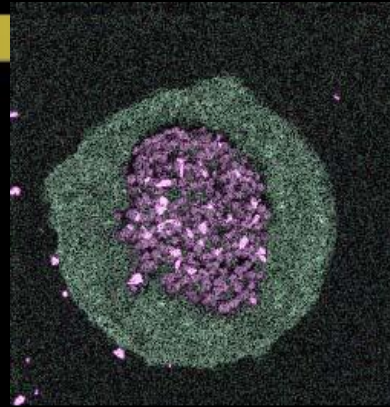
## Specialty

*Twisted Yarn*

*Texturized Yarn*

*Beamed Yarn*

*DE Chop*



EM Mag 200X

100µm



**Outdoor Screening**

- **PVC, Epoxy, None**
- **Coated Strands, Woven Fabric, Wet-Laid**
- **Thermal curing, Lamination,**



**Aerospace**



**Air Particulate Filtration**



**Specialty Paper**

# Fiber Glass Market Segments



## Roofing

### *Wet Chop*

- Asphalt
- Nonwoven mats via wet laid process
- Thermal curing, Flood Coating



**Residential and Commercial Roofing**



**Wet Laid Nonwoven Mats**

# Fiber Glass Market Segments



## Thermoplastics

*Chopped Strand*

*Roving*

*Wet Chop*

*Mats*



**Automotive Engines**

- Polyolefins, Polyamides, Polyesters
- Extrusion Compounding
- Injection and Compression Molding



**Industrial Equipment**



**Consumer Equipment**



**Consumer Appliances**

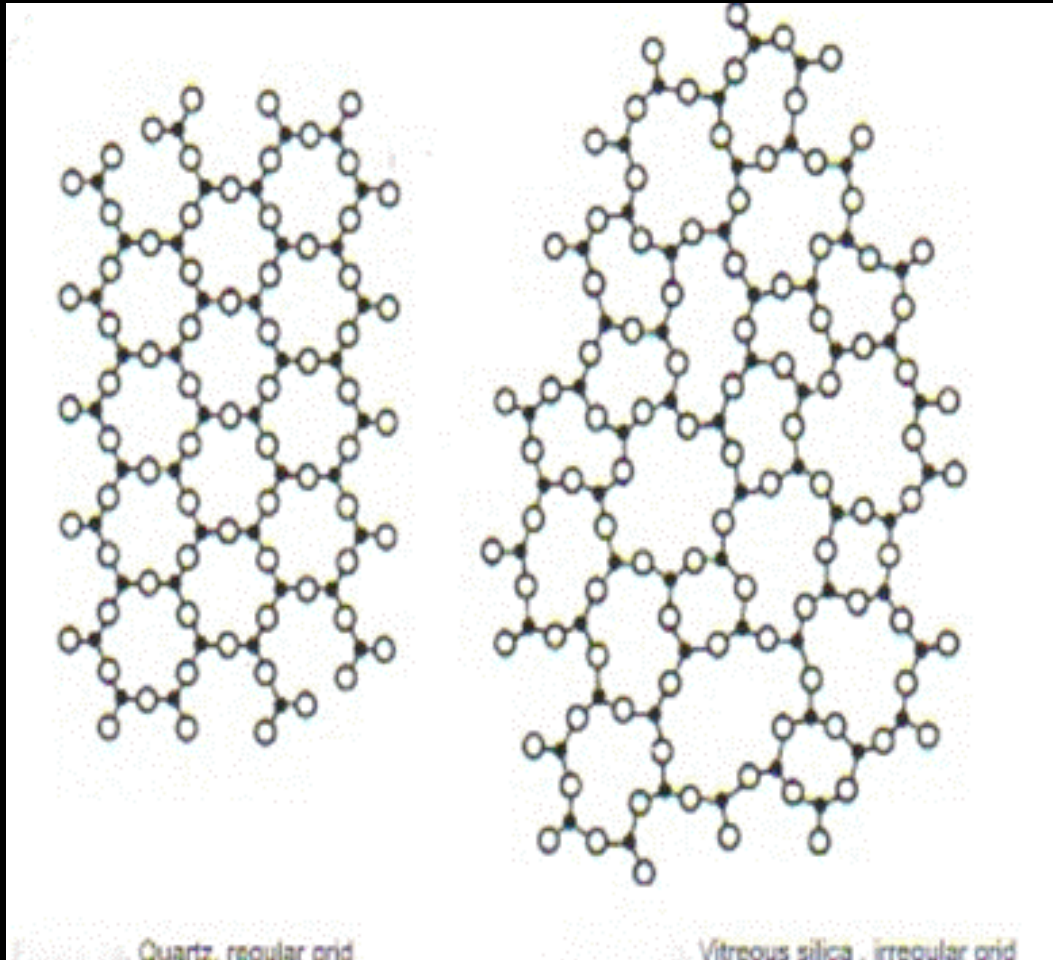


# The Fiber Glass Production Process

# Glass

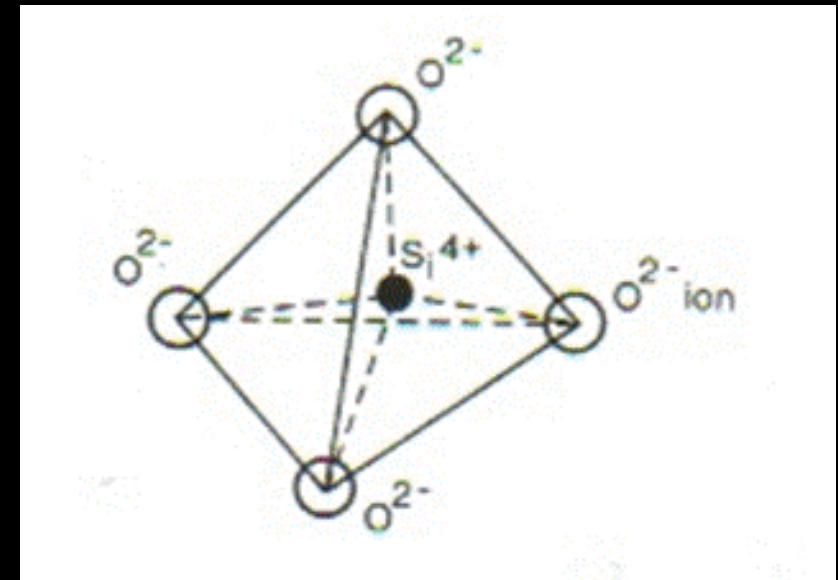


“Glass – an inorganic product of fusion that has cooled to a rigid condition without crystallization”

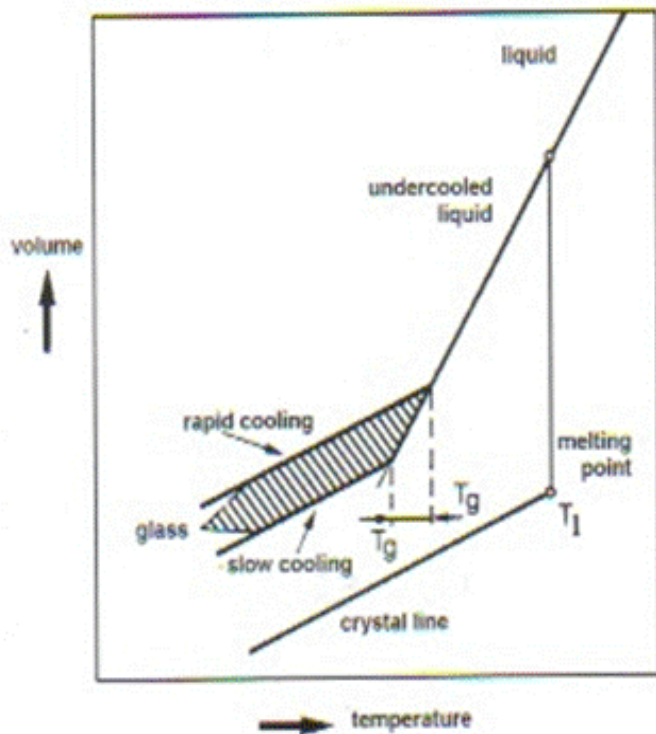


ASTM-C162

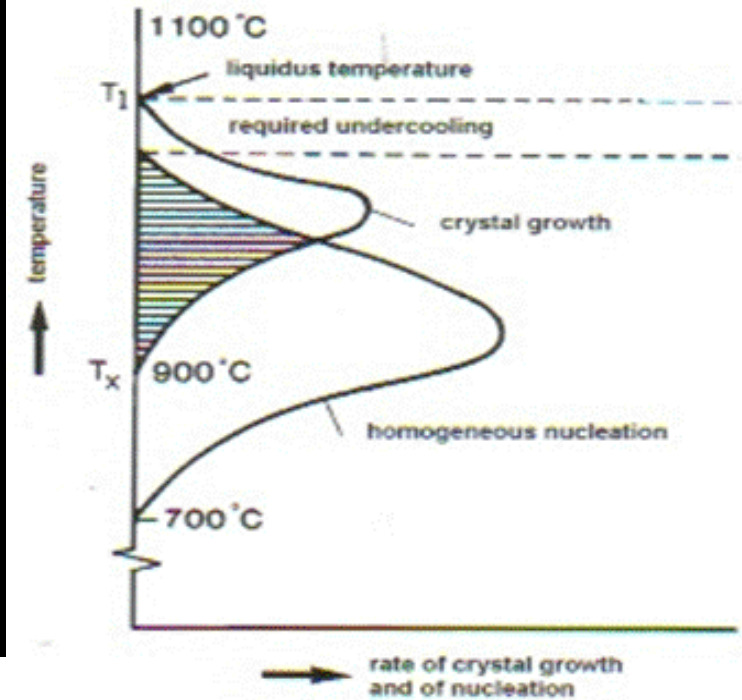
DIN – Standard 1259



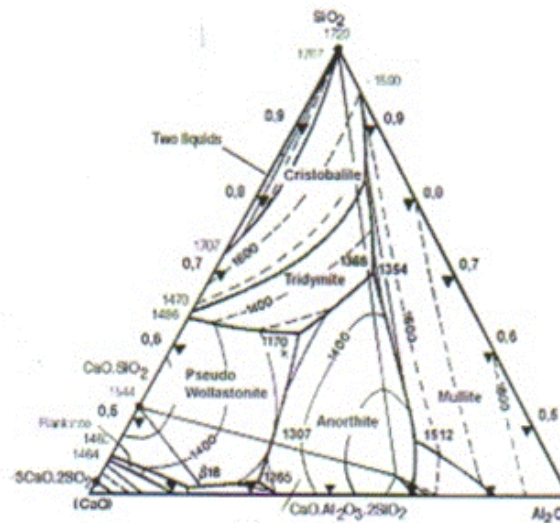
# Glass - “a frozen undercooled liquid”



“Glass is amorphous and isotropic”



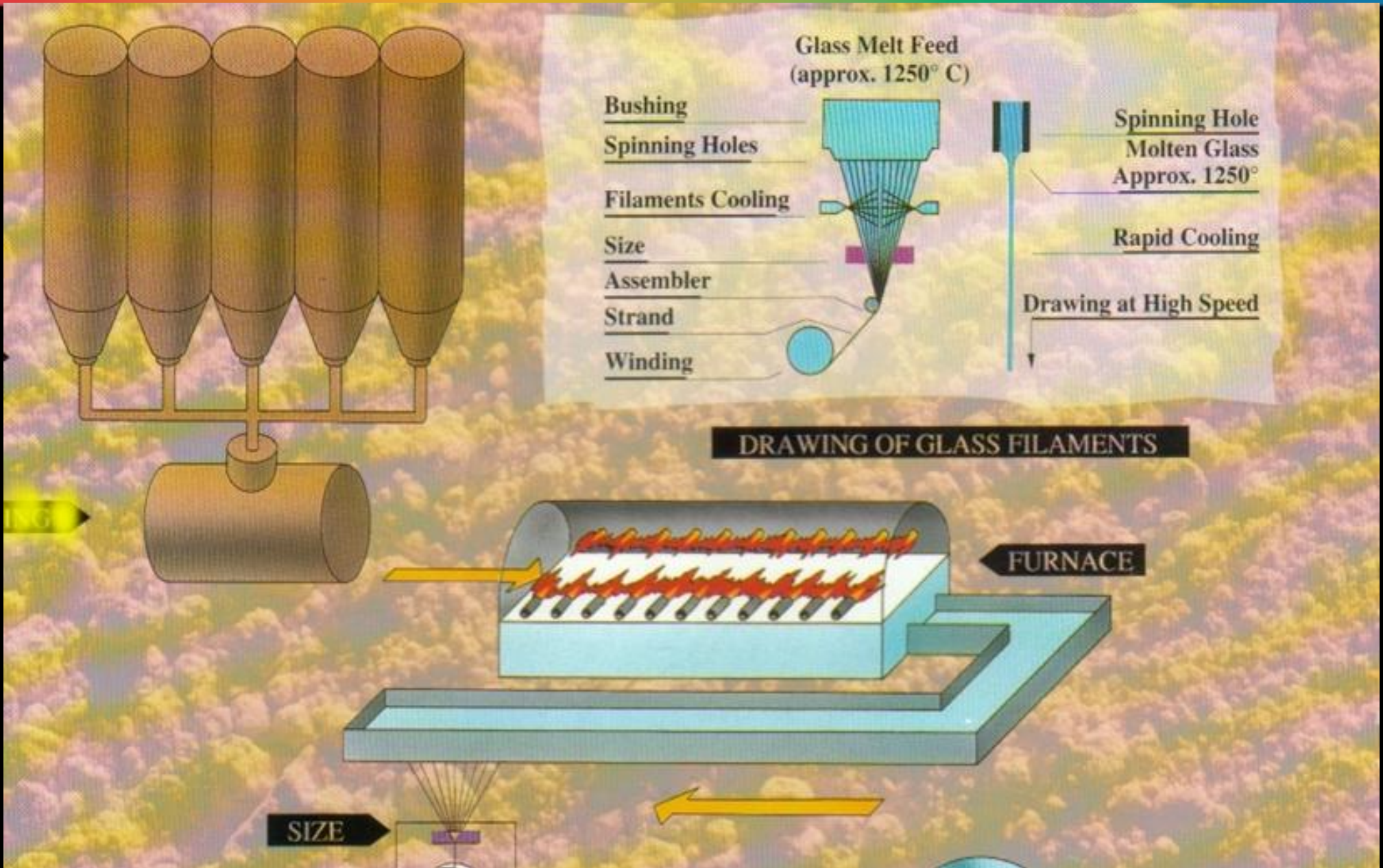
“Specific compositions required for fiber forming”



Part of the phase diagram  $\text{CaO}-\text{Al}_2\text{O}_3-\text{SiO}_2$  (concentrations in wt%).

“Sufficient gap between  $T_{ff}$  and  $T_1$ ”

# Fiber Glass Manufacturing



# The Sizing Development Process: *It's Polymer Driven*



- **Thermosets**

- ▶ Epoxy
- ▶ Polyester
- ▶ Vinyl Ester
- ▶ Phenolic

- **Thermoplastics**

- ▶ Polypropylene
- ▶ Nylon
- ▶ Polyester
- ▶ Specialties

# Overview of Fiber Glass Sizing Components

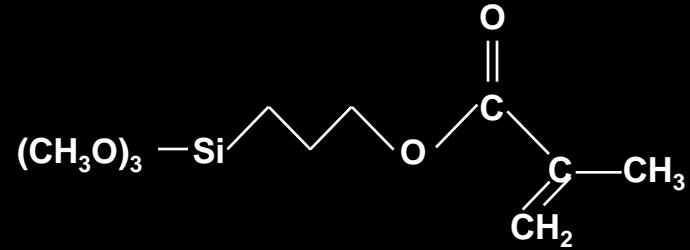


- **Film former(s)**
  - ▶ **Polymeric compatible glue (often emulsions)**
- **Lubricant(s)**
  - ▶ **Fiber-to-fiber**
  - ▶ **Strand-to-contact**
  - ▶ **Plasticizer**
- **Various aids**
  - ▶ **Antifoam**
  - ▶ **Stabilizers (anti-oxidants, etc.)**

# Sizing Chemistry



## I 1% to 20% Organofunctional silane



## I 1% to 5% Process Aids

- » lubricants
- » antistats
- » antioxidants

# What is a Glass-Filled Molding Compound?

