

**University of Virginia**

**Department of Physics**

Physics 606: How Things Work II

Lecture #36 Slides:

**Windows and Glass II**

**and**

**Plastics**

## Tempered Glass

- Tempering glass
  - Heat glass to softening point
  - Cool outside of glass quickly
  - Outside stiffens while inside is still hot
  - Shrinking inside compresses outside
  - Compressed outside stretches inside
- Resists fractures because surface is compressed
- Crumbles when cracked because inside is

## Question:

Which window of a car can tolerate the larger stress before breaking?

1. The front windshield
2. The side window
3. They're equally strong

## Plastics

## Question:

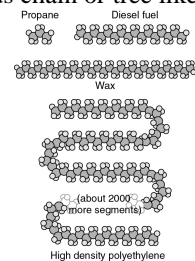
Which is more effective at cleaning your hair: a thick, viscous shampoo or a thin, freely flowing shampoo, or are they probably about equal?

## Observations About Plastics

- Some plastics are clear, others translucent
- Some plastics are stiff, others are flexible
- Some plastics stretch, others don't
- Some plastics melt, others don't
- Some plastics smell, particularly when hot
- Some glues dry, others harden without drying

## Plastic

- Polymers: enormous chain or tree like molecules



## Chemical bonds

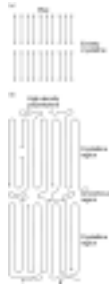
- Metallic bond
  - electrons shared between many atoms
- Ionic bond
  - atoms become oppositely charged ions
- Covalent bond
  - atoms share a pair of electrons

## Polymerization

- Plastics employ covalent bonds
- Individual monomer molecules are joined
- This polymerization forms giant molecules
  - Some molecules are linear chains
  - Some are branched tree-like structures
  - Some are networked together completely

## Plastic structure

- Amorphous
  - random mess of polymers
- Crystalline
  - neatly oriented polymers



## Regimes

- Glassy: hard, brittle solid
- Glass-rubber transition: leathery
- Rubbery plateau: flexible and elastic
- Rubbery flow: viscous flow but elastic
  - Reptation: chains slide along their length
- Liquid flow: viscous liquid

## Changing regimes

- Temperature
- Plasticizers
  - Chemical dissolved in a polymer to soften it
  - Shift a polymer's behavior to a different regime