

# POLYMER - SCHMOLYMER

WHAT'S IT ALL ABOUT?

The background of the slide is a grayscale, halftone-style image of a winding road through a dense forest. The road curves from the bottom left towards the center. The trees are tall and thin, creating a misty atmosphere. At the bottom of the slide, there is a horizontal strip with a golden, glowing, and blurred effect, resembling a car's dashboard or a speedometer with colorful lights.

**“MY CAR IS BROKE!”**

# WHAT'S WATER?

- Hydrogen plus oxygen equals water
- Covalent bonds
  - Strong
  - Takes lots of energy to break

# Weak Bonds

- pi-pi bonds (graphite)
- hydrogen bond
  - sulfur oxygen ties with hydrogen
- van der Waals

Covalent bonds are 10 to 100  
times stronger than weak bonds



# POLAR vs NON-POLAR



# POLAR

- Link together using hydrogen bonding and pi-pi bonding
- Form a network

# NON-POLAR

- Fill in space between polar network





# GOOD ASPHALT

- Balance between polar and non-polar
- Too many polar,
  - network links together too tightly and
  - binder is stiff and brittle
- Too many non-polar,
  - weak network,
  - material is soft and oily at high temperature

# INTERACTIONS BETWEEN MOLECULES ARE WEAK

- Apply heat or pressure
- Bonds break and reform



# VISCO-ELASTIC

- Elastic property
- Viscous property
- Swimming pool



# AGING, WHAT HAPPENS?

- Non-polar molecules containing sulfur react with oxygen and become polar
- Molecules with S=O and C=O form stronger networks (ie stiffen more as they age)

# LOW TEMPERATURE CRACKING

- Controlled by non-polars
- Non-polars align and shrink
  - Cause crack in bonding network
  - High molecular weight non-polars crystallize

# MODIFIERS: WHAT DO THEY DO?

- Change high temperature properties
- Little effect on low temperature properties

# MODIFIERS: WHAT ARE THEY?

- Polar molecules
- Form part of the network

# SBS

- Styrene-butadiene-styrene
- Styrene bonds to polar molecules (stronger than H-bonding)
- Butadiene bond (rubber)



# SB Linked

- Styrene bond to polar molecules
- Sulfur (or other linking agent) reacts with butadiene and links two butadienes together

# PLASTOMERS

- EVA
- Polyethylene
- Other plastics
  
- Link to polar network more strongly than H-bonding

# ACID MODIFIED

- Increases number of H-bonding sites
- Increases high temperature stiffness

# POLYMER SCHMOLYMER

Change the Way the Molecules  
are Hooked Together

Change the Performance of the  
Asphalt

