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MOTIVATION

- Why elastomers?
 - Wide Application, Big Market, Huge Industry
- Where they come from?
 - Rubber tree
 - Petroleum oil
- Why bio-based?
 - Sustainable
 - Friendly to Environment



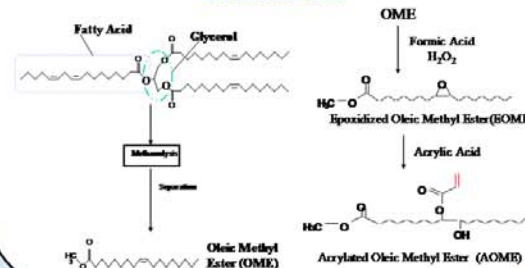
OBJECTIVE

- Develop Bio-based Elastomers:
 - Develop and optimize the plant oil resin system to produce high performance elastomers
 - Obtain a fundamental understanding of the network of crosslinked plant oil resins

BACKGROUND

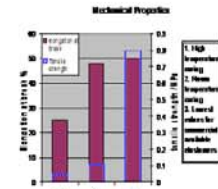
- Unique property
 - Long-range resilience
- Special molecular structure
 - Flexible polymer sequence
 - No strong interactions between neighboring segments
 - High molecular weight
 - Low concentration of chemical or physical cross links
 - (10⁻⁵-10⁻⁴ mole cm⁻³)

SYNTHESIS



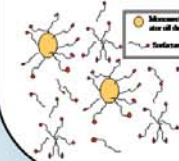
PRELIMINARY RESULTS

- Bulk copolymerization
 - AO ME+EGDMA (ethylene glycol dimethacrylate)
 - High Temperature Curing
 - initiator: methyl ethyl ketone peroxide (MEKP)
 - temperature: 80°C
 - time: 2 hrs
 - Room Temperature Curing
 - catalyst: cobalt naphthenate
 - initiator: MEKP
 - time: over night



- Mechanical properties
 - Tensile strength of RT is 2.5 times of HT
 - Elongation at break of RT is twice of HT

MINI-EMULSION POLYMERIZATION



- Polymerization method for highly hydrophobic monomers
- Mini-batch reaction
- Reaction components:
 - AO ME 10g
 - Sodium dodecyl sulfate 0.2g
 - Azobisisobutyronitrile (AIBN) 0.03g
 - Distilled water 40g
- One hour's reaction at T=80°C Mn= 10⁶

CROSSLINKING OF POLYACRYLATES

- Crosslinking strategies
 - Heating with alkaline substances: sodium silicate/potassium hydroxide
 - Poly(AO ME) dissolved in THF then mixed with potassium hydroxide, cured at T=140°C
 - Copolymerization with monomer with cure site
 - dienes
 - halogen
 - epoxides
 - copolymerization with allyl glycidyl ether
 - molecular weight not decrease
 - crosslink by reaction with dibasic carboxylic acid
 - miscellaneous acrylic material

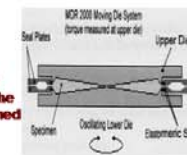
RUBBER COMPOUNDING

- Compounds
 - rubber: Poly (AO ME)
 - curative: 1,3,4-thiadiazole (Vanax 82)
 - accelerator: Rheonogran Diuron-80
 - retarder: stearic acid
 - lubricant: TE 58-A (proprietary mate)
- Mixing
 - banbury mixer
 - room temperature mixing
 - speed: 40 parts/hr
 - time: 5 min

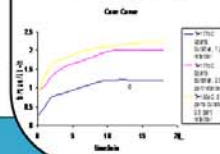


CROSSLINKING

- Moving die rheometer
 - Torque is proportional to low-strain modulus of elasticity
 - Increase of torque during curing is proportional to the number of crosslinks formed per volume of rubber
 - Cure curve is obtained



CURE CURVE ANALYSIS



- Poly(AO ME) can be cured within 10 mins
- Higher temperature is preferred for the crosslinking
- Cure curve is sensitive to contents of compounds

CONCLUSIONS

- Soybean oil resins have the potential to synthesize elastomers.
- Bulk copolymerization gives some elastic network but with poor mechanical properties.
- Mini-emulsion polymerization is a good way to synthesize elastomers.
- Poly(AO ME) can be compounded similarly as the conventional acrylate rubbers.

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