**Lactic Acid: A Possible hard block**

**Goal: Oligomerization of Lactic Acid (OLLAs)**
- 8 monomers in a linear chain
- Determine: time to complete the physical change
- Constraint: continual production of water

**Procedure**
- Start: 90% Lactic Acid, 150°C, open system, 2 hours
- Initial pressure change: 100 Torr, 150°C, 2 hours, used needles in a septum to control pressure
- Final pressure change: 30 Torr, 11 hours

**Results**
- Test: Nuclear Magnetic Resonance (NMR)
  - Chain Length: 12.63
  - Yield: 31%

**Analysis/Conclusion**
- While it appeared that having a system that pulls consistent vacuum increased the chain length, the trade off was a significant reduction in yield of product. Future research should include design modifications to increase yield while having a desired chain length.

**Goal: Polymerization of Lactic Acid (PLLA)**
- PLLA chains linked linearly
- Target: minimum molecular weight of 20,000 g/mol
- Variables: temperature, pressure, time
- Determine: time required for high molecular weight without crosslinking

**Procedure**
- Catalysts: Tin(II) Chloride dihydrate (0.34 wt%), p-Toluenesulfonic acid monohydrate (0.4 wt%)
- Reaction temperature: 180°C
- Pressure: Decrease over 2 hours, 10 Torr for 13 hours
- Dissolve: Tetrahydrofuran (THF)
- Crash: Hexanes
- Filter and dry

**Results**
- Test: Gel Permeation Chromatography (GPC)
  - Molecular weight: 281654 g/mol
  - Yield: 77% when going from OLLA to PLLA.

**Analysis/Conclusion**
- According to the GPC tests the molecular weight was higher than any other recorded trials of PLLA. This is ideal because a high molecular weight for the hard block will provide a high molecular weight for the di-block that it will be a part of. The properties of a high molecular weight di-block are desired when replacing the current petroleum products in use.

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**Bio TPE’s**

**What are they?**
- Bio TPE’s are compounds based on renewable substances that have the goal of replacing current petroleum based polymers solely with “green” monomers.

**The Goal of Our Research**
- To make a wide variety of biorenewable based TPE’s that replaces current petroleum based elastomers and that could be used in a wide variety of applications, predominantly in tires and asphalt.

**Advantages**
- Soybean oil price is a less volatile than current petroleum products
- Cheaper than the current products being used
- Is a total replacement of 650,000 tons annually of imported petroleum products

**Disadvantages**
- Easily crosslinks during polymerization

**Current Studies**
- Use of polylactic acid as a hard block and attach to soy oil, our current soft block

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**NMR of trial 6. The integral under the curve at 4.3 represents the terminal CH group and at 5.6 it represents the CH groups in the polymer chain.**

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**GPC of the PLLA. The integral under the curve will give the molecular weight of the polymer.**

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**TPE’s**

**What are they?**
- TPE’s are a combination of hard blocks (i.e. plastic bottles) and a soft block (i.e. rubber bands) that are covalently bonded together to make a polymer that has the properties of both.

**Materials made of TPE’s**
- Gaskets, Seals, Stoppers, Valves, Bumpers, Casters, Fuel line covers, Shoe soles, Cosmetic cases, Handles, Grips, Knobs, Tires, Asphalt

**Their Structure**
- High molecular weight
- Diblock copolymer (AB)
- Triblock copolymer (ABA)
- Hard block provides rigidity to restrain soft block from viscous flow

**Advantages**
- Easy to control polymerization
- Relatively high cost
- Are fossil fuel dependent
- Highly oxygen sensitive

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