**High Performance Polymers are NOT Sustainable:**

- Toxicity poses added cost to government in increased production costs and decreased competition and prohibition in new uses.
- More than $20,000/yr PMR-15 usage which contains 4.4% methylenediamine (MDA), a liver toxin and carcinogen for aircraft parts requiring high temp durability.
- 100M lbs/yr Carbon fiber usage which generates HCN.
- Vinyl esters generate styrene hazardous air pollutant emissions.
- Epoxy resins can cause sensitization (e.g. blisters, hives) and use toxic epichlorhydrin.
- Bisphenol A (BPA) causes endocrine disruption and is a component of epoxies, vinyl esters, and polycarbonates.

**DoD Composites and Polymer Use**

- Increasing use of polymers and composites in DoD and commercially for lightweighting and corrosion control.
- Challenge: Increased demand requires key property improvements while reducing toxicity, cost, and environmental concerns.
- Key properties:
  - Viscosity – processing
  - Tg, Tc – operating temp. window
  - E, G – weight and durability

**Successes and Limitations of Fatty Acid-Based Composites**

- Prepared highly filled composites using lignin as filler.
- Use of renewable oils to make high performing polymers and composites.
- Dis: We are limited in what we can use and still maintain high performance.

**Paradigm Change in Polymer Manufacture**

- Overall Hypothesis: Use of renewable resources gives access to new molecular structures and monomers that can:
  1. Reduce toxicity
  2. Produce novel polymers
  3. Improve polymer properties

**Summary And Conclusions**

- Developed various structure-property relationships for furan, isosorbide, and lignin-derived polymers.
- Renewable polymers can have outstanding properties, if designed properly.
- Isosorbide methacrylate has best overall properties.
- Highest achieved properties for lignin-based carbon fibers.
- High temperature polymides possible with renewables.
- Bio-based polymers can be designed to have reduced toxicity vs. petroleum analogs.
- Highly promising resin technology for transition into industry.
- DoD positioned well to develop and make use of sustainable resin technology.

An image of a page from a document discussing the environmental and health impacts of polymeric materials, with a focus on the use of renewable resources. The text highlights the limitations and challenges of traditional polymers, and the potential benefits of using biobased materials. It includes graphs and charts illustrating the properties and processing of various polymers. The page also references specific studies and authors, indicating a collaborative effort within the military and academic sectors to develop sustainable polymer alternatives.