

Development of Materials for Fused Deposition Modeling

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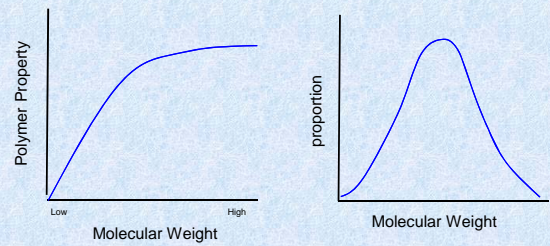
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Polymers for Aerospace Structures

- Expertise in synthesis of structural engineering materials
 - Polyimides
 - Poly(arylene ether)s
- Resins to resist combined exposure to:
 - High Temperature
 - Oxidizing Atmosphere
 - Mechanical Strain
 - Solvents, moisture, aircraft fluids
 - UV Radiation

Effect of Polymer Molecular Weight

- Mechanical properties level out with increasing molecular weight
- Balance molecular weight, processability, and other properties through synthesis



Example Composites from High Speed Research Program

F-Frame Fabricated via RTM using PETI-RTM



Credit: Lockheed Martin

Parts Made From PETI-RFI via RFI



Credit: Boeing Long Beach



Credit: Boeing Long Beach

PETI-5/IM7 Skin Stringer Panel (1.83 m x 3.05 m)

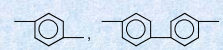


Credit: Boeing St. Louis

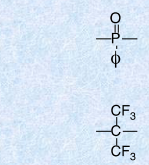
2 Bay Stiffened Panel



Credit: Boeing Long Beach



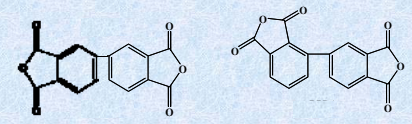
Representative Group Effects on Polymer Properties



Bulky pendant groups (CH₃, phenyl)

- Increases T_g and melt viscosity, contributes to crystallinity, decreases solubility
- Increases T_g, provides atomic oxygen and fire resistance
- Improves solubility, leads to reduced color, lowers dielectric constant
- Increases T_g, improves solubility, lowers melt viscosity

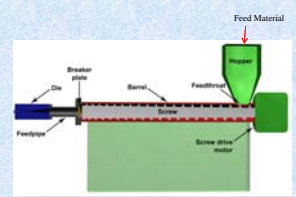
- Liquid crystalline units for reduced melt viscosities
- Asymmetric (i.e. linear vs. kinked) monomer



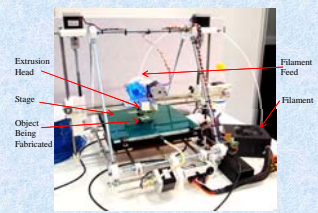
- Incorporation of kinked units in polyimides has been shown to impart low melt viscosities while the polymers retain good mechanical and physical properties

Engineering thermoplastics (i.e. Ultem™, PEEK, PC)

- Injection molding
 - Polymer melted with high shear
 - Mold pressures typically range 70 – 200 MPa
 - As injected part cools, material is held under pressure
- FDM
 - Melted in extrusion head
 - Semi-molten deposition
 - No consolidation pressure -> high void content



Credit: Mikeeg55 for the wikipedia project, Wikimedia Commons.



Credit: Tisa Morito, Wikimedia Commons.

Revector in-house capabilities

- Apply knowledge to development of new FDM materials
- Design materials specifically to leverage advantages of net shape fabrication
- Focus on properties required for structural aerospace applications