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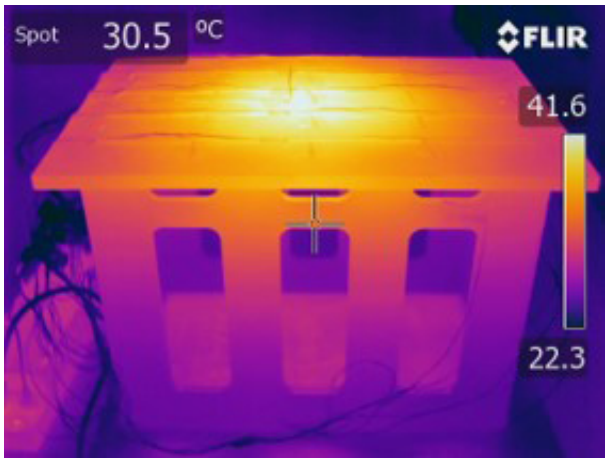
A232

Thermal behaviour

Foundational knowledge article



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Themes	• Thermal management
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Overview[edit | edit source]

The thermal history of an uncured composite material plays a critical role in how the material properties evolve, how the material can be handled during the various stages of manufacturing, including the thermal cure step, and how the final microstructure and properties of the composite are created. The following pages provide KPC users with an understanding of the foundational topics in processing science.

The foundational knowledge volume contains pages for the following thermal behaviour topics:

- Basics of heat transfer
- Thermal phase transformation of polymers
- Curing of thermosetting polymers
- Melt and crystallization of thermoplastic polymers
- Chemical degradation of polymers
- Physical aging of polymers

By visiting the links provided, you can explore the topics and learn more.

Basics of Heat Transfer[edit | edit source]

Link to main Heat Transfer page

Heat transfer is the physics process responsible for the redistribution of thermal heat energy between systems. For composites, this includes the redistribution of heat both within the laminate itself, and between the laminate body and its surrounding environment. The heat transfer process has important roles in both the composite manufacturing process and the operational service of the composite material.

Thermal Phase Transformation of Polymers[edit | edit source]

Link to main Thermal Phase Transformation of Polymers page

Polymers go through several distinct phase transition points at particular temperatures. These transitions induce changes to their specific volume, mechanical properties, and physical behaviour.

Curing of Thermosetting Polymers[edit | edit source]

Link to main Curing of Thermosetting Polymers page

For thermosetting polymers, the manufacturing process step of curing is necessary to transform the viscous polymer resin into a rigid solid. During this process, chemical reactions take place that result in the formation of molecular bonds that set the polymer into shape.

Melt and Crystallization of Thermoplastic Polymers[edit | edit source]

Link to main Crystallization and Melting of Thermoplastic Polymers page

During processing into a composite matrix, thermoplastics are heated to melt flow and impregnate the reinforcement fibres. The polymer is then cooled to solidify. During this solidification process, molecular re-arrangement of the polymer chains, referred to as crystallization, is occurring that give the polymer its solid-state material characteristics.

Chemical Degradation of Polymers[edit | edit source]

(Coming soon)

With exposure to elevated temperatures beyond their temperature stability limit, polymers can begin to chemically degrade. Material damage can involve both oxidation, and the breaking of covalent bonds within the polymer. The temperature limit at which degradation begins represents the ultimate temperature at which the polymer may be processed and used, although practically – the service temperature of the polymer may be lower for mechanical property reasons such as softening and loss of suitable stiffness.

Physical Aging of Polymers[edit | edit source]

(Coming soon)

Physical aging is the volumetric relaxation of a polymer that results in the stiffening of the polymer. It is separate from chemical aging, which is the result of chemical degradation. Physical aging occurs when a polymer is in a meta-stable non-equilibrium state and attempts to progress towards

its natural equilibrium state. It is a phenomena commonly experienced by thermoplastics when they are rapidly cooled from an elevated temperature during their shape manufacturing process.

Explore this area further

- Thermal behaviour - A232
  - Heat transfer - A132
    - Conduction - A118
    - Convection - A106
  - Thermal phase transitions of polymers - A102
  - Cure of thermosetting polymers - A162

Related pages

Page type	Links
Introduction to Composites Articles	
Foundational Knowledge Articles	• Conduction - A118 • Convection - A106 • Heat transfer - A132 • Materials science - A235 • Processing science - A151 • Thermal behaviour - A232
Foundational Knowledge Method Documents	
Foundational Knowledge Worked Examples	
Systems Knowledge Articles	
Systems Knowledge Method Documents	
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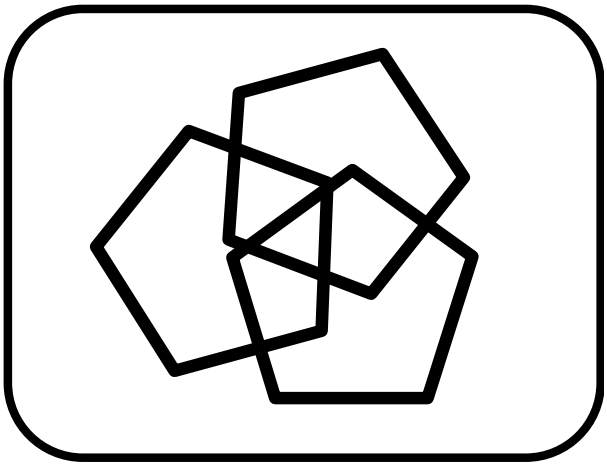
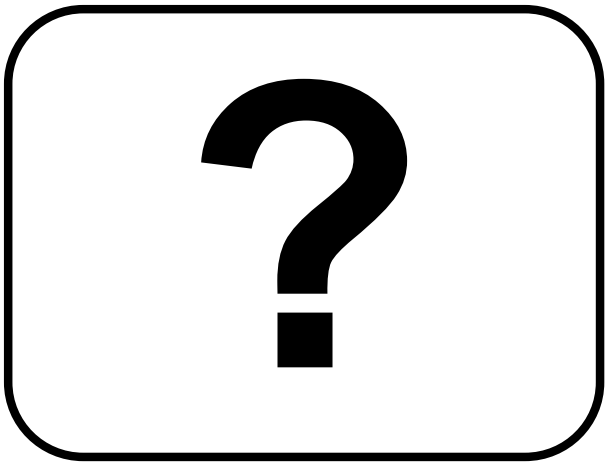
Systems Catalogue Articles	
Systems Catalogue Objects – Material	
Systems Catalogue Objects – Shape	
Systems Catalogue Objects – Tooling and consumables	
Systems Catalogue Objects – Equipment	
Practice Documents	
Case Studies	
Perspectives Articles	• Composites Process Simulation: A Review of the State of the Art for Product Development - A283 • Dr. Anoush Poursartip's cdmHUB global composites expert webinar - A136



About



Help

Engineered materials (designed to have specific properties) made from two or more constituent materials with different physical or chemical properties. The constituents remain separate and distinct on a macroscopic level within the finished structure.

For polymer matrix composites (PMCs), resin refers to the matrix; the continuous material phase that binds the reinforcement together, maintains shape, and transfers load. Resins are divided into two main groups: thermosets and thermoplastics.

The continuous material phase that binds the reinforcement together, maintains shape, transfers load, protects the reinforcement from environment and damage, and provides the composite support in compression.

Desirable characteristics:

- Moisture/chemical resistance
- Low density
- Processability