1 **CHAPTER 6**

The Fiber-Manufacturing Process

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- Fiber spinning:
  - Prepare viscous dope or melt;
  - Extrude dope or melt through spinneret to form fiber;
  - Solidify fiber by coagulation, evaporation, or cooling.
- Raw material: Substance to form solution.

3 **Manufacturing Fibers**

- Spinning solution (dope, melt): Material from which fiber is formed.
- Extrusion: Forcing dope or melt through tiny holes in the spinneret.
- Spinneret: Small nozzle through which dope/melt is forced.

4 **Methods of Manufacturing Fibers**

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  - Wet spinning: Raw material dissolved by chemicals, fiber spun into chemical bath and coagulated.
  - Dry spinning: Resin solids dissolved by solvent, fiber spun into warm air, solvent evaporates.
  - Melt spinning: Resin solids melted, fiber spun into air, cooled.
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5 **Fiber Modifications**

- Parent fiber: Fiber in its simplest form.
- Modifications: Changes of parent fiber relative to properties or chemical composition; engineered for end use.

6 **Spinneret Modifications**

- Fiber size: Control size of spinneret opening, amount of drawing, or extrusion rate; size based on end use.
  - Apparel: less than 7 denier
  - Furnishings: 5-25 denier
  - Industrial: any size
  - Microdenier: less than 1.0 denier per filament (dpf)
  - Ultrafine fibers: Smaller than microdenier fibers
  - Mixed denier fiber bundling: Combines regular size fiber with microfibers in a yarn.

7 **Spinneret Modifications (cont.)**

- Fiber shape: Alter properties.
  - Solid fibers: Even diameter.
  - Thick-thin fibers: Uneven diameter.
  - Hollow/multicellular fibers: Use gas-forming compounds, inject air, or modify spinneret hole.
  - Trilobal shape: Three-sided fiber cross sectional shape designed to imitate silk.
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8 **Spinneret Modifications (cont.)**

- Molecular structure & crystallinity modifications
  - High tenacity fiber types:
    - Draw or stretch to increase orientation.
    - Chemical modifications increase DoP.
  - Low-pilling: Decrease molecular weight slightly to reduce flex life and decrease pilling.
  - Binder staple: Polyester with very low melting point.
  - Low-elongation modifications: Reinforcing fibers to blend with cellulosic fibers.

9 **Additives to Polymer or Spinning Solution**

- Delustering: Titanium dioxide reduces luster; produces dull, not bright fibers.

- Solution dyeing or mass pigmentation: Colored pigments/dye to spinning solution; gel dyeing; Color added after spinning but before fiber hardens.
- Whiteners or brighteners: Resist yellowing.
- Cross dyeable or dye affinity: Dye-accepting chemicals incorporated into molecular structure as a direct part of polymer; not colored when extruded.

10 **Additives to Polymer or Spinning Solution (cont.)**

- Antistatic: Incorporate conductor of electrons.
- Sunlight Resistance: Incorporate sunlight stabilizers.
- Flame Resistant: Incorporate flame retardant compound.
- Antibacterial: Incorporate a compound that protects from bacterial growth.

11 **Modifications in Fiber Spinning**

- Self-crimping fibers
- Fiberfill

12 **Complex Modifications**

- Bicomponent fibers: One fiber incorporates two polymers which are chemically different, physically different, or both. If components represent two different generic classes, they are bicomponent bigeneric.
- Types:
  - Side-by-side or bilateral
  - Core-sheath or sheath-core
  - Matrix-fibril

13 **Performance Fibers**

- Used to enhance human performance.
- Three layers:
  - Moisture management layer
  - Warmth or insulation layer
  - Protection layer
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14 **Bicomponent Fiber Structure**

15 **Environmental Impact**

- Perception of manufactured fibers
  - Amount of petrochemicals used for fiber production
  - Effect of fiber production on environment
- Concerns
  - Chemical spills
  - Recycling
  - Health and safety

16 **Environmental Impact (cont.)**

- Regulations, safety concerns, costs, & image
- Changes
  - Use less hazardous chemicals
  - Recycle & manage waste
- Dispose of consumer wastes