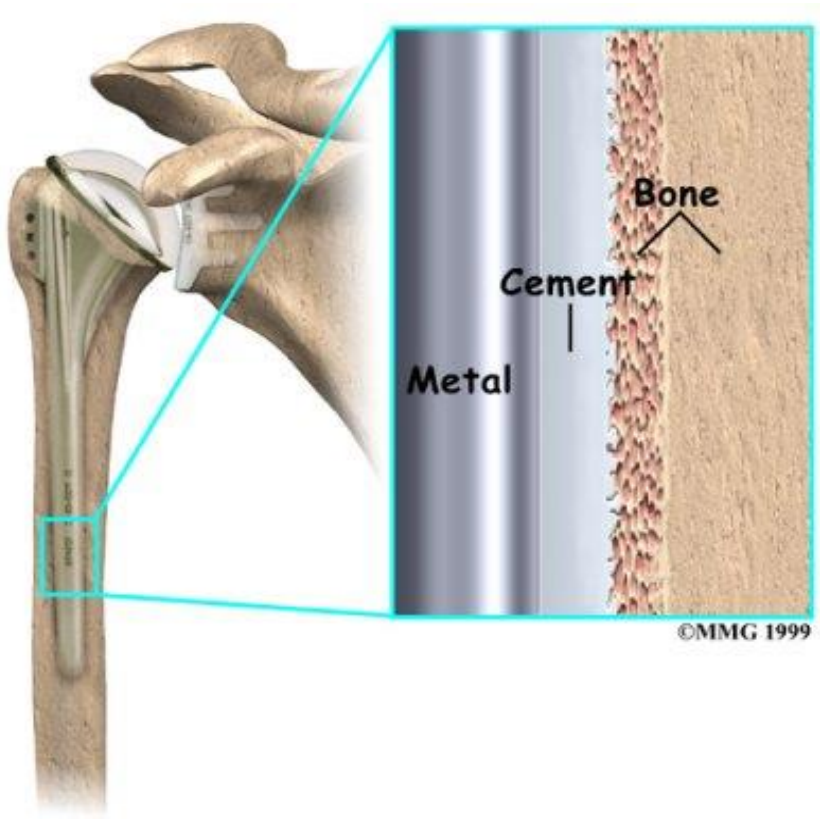
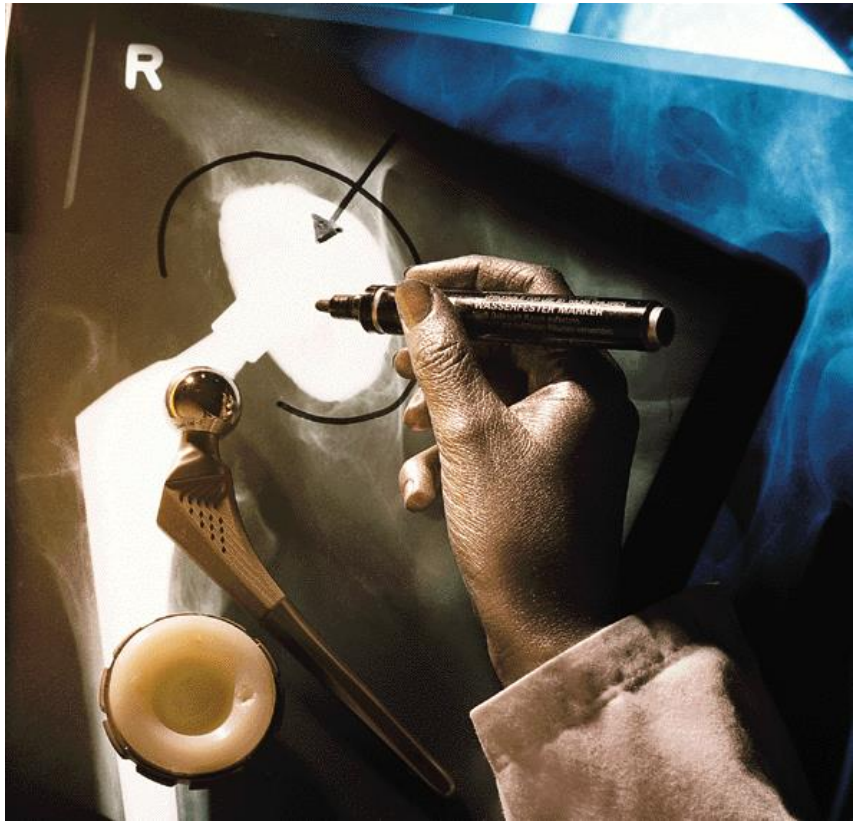
Tissue Engineering & Materials Processing

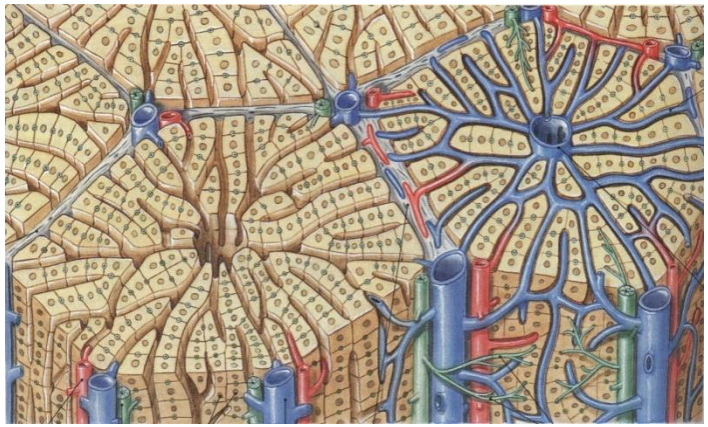
Replacements Parts

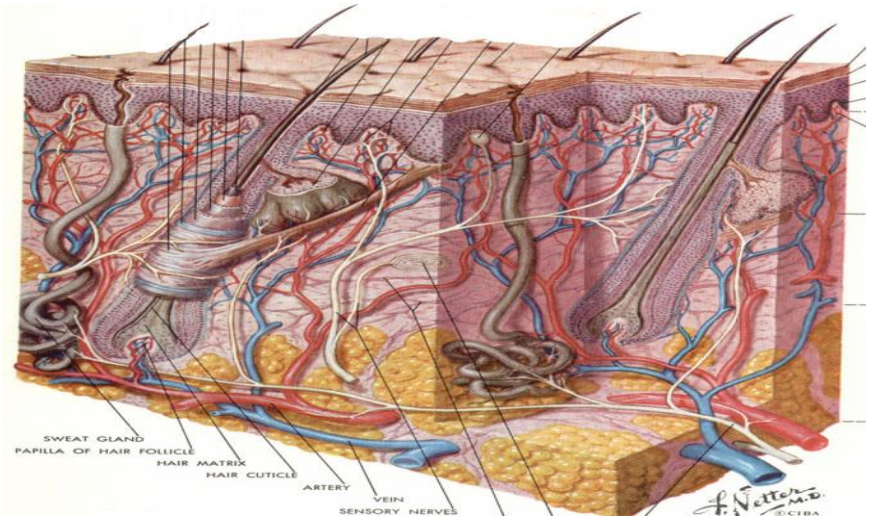


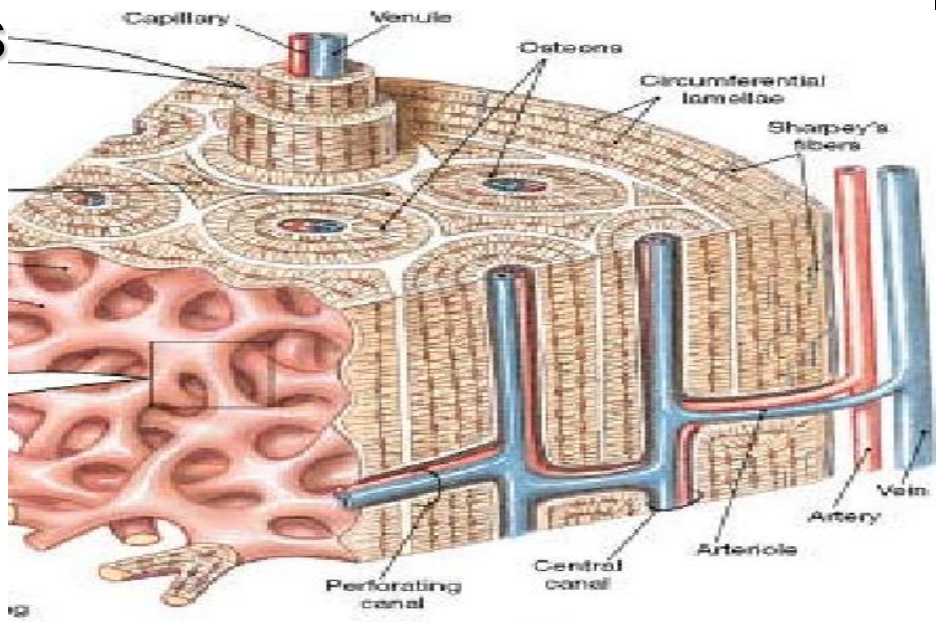


Features of Soft Tissues

- Multi-cellular
- Three-dimensional structures
- Multi-functional
- Takes cues from the environment
- Blend in with surroundings

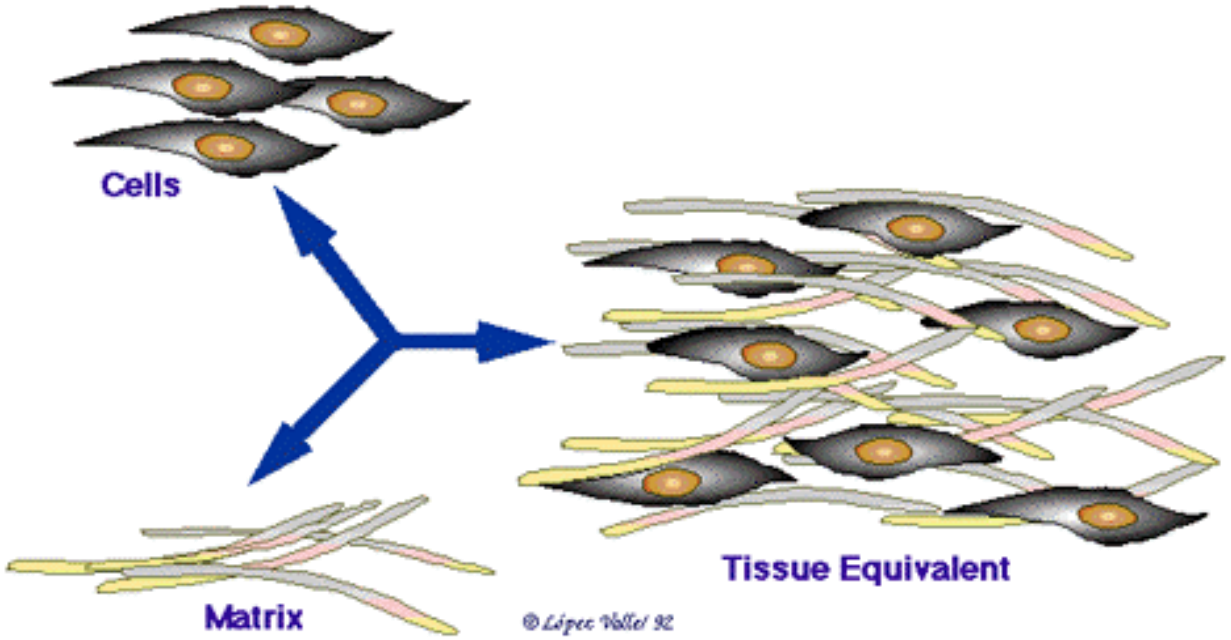




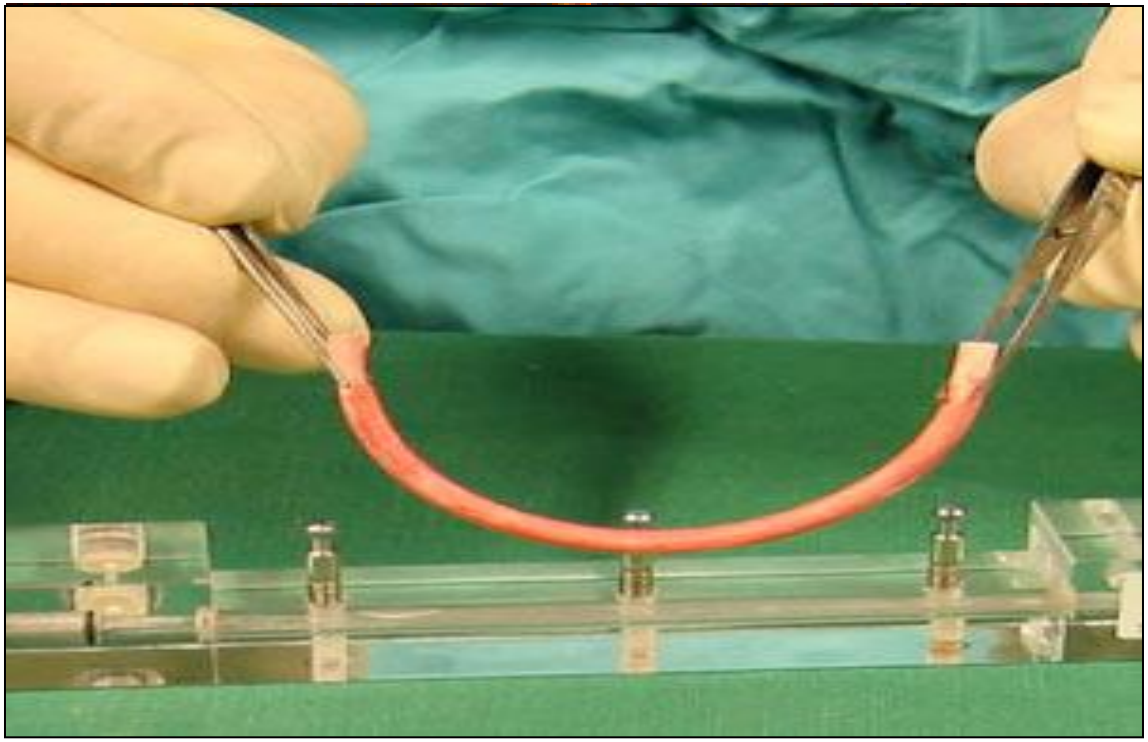


Tissue Engineering

Applies the principles of engineering and the life sciences toward the development of biological substitutes that restore, maintain, or improve tissue function.

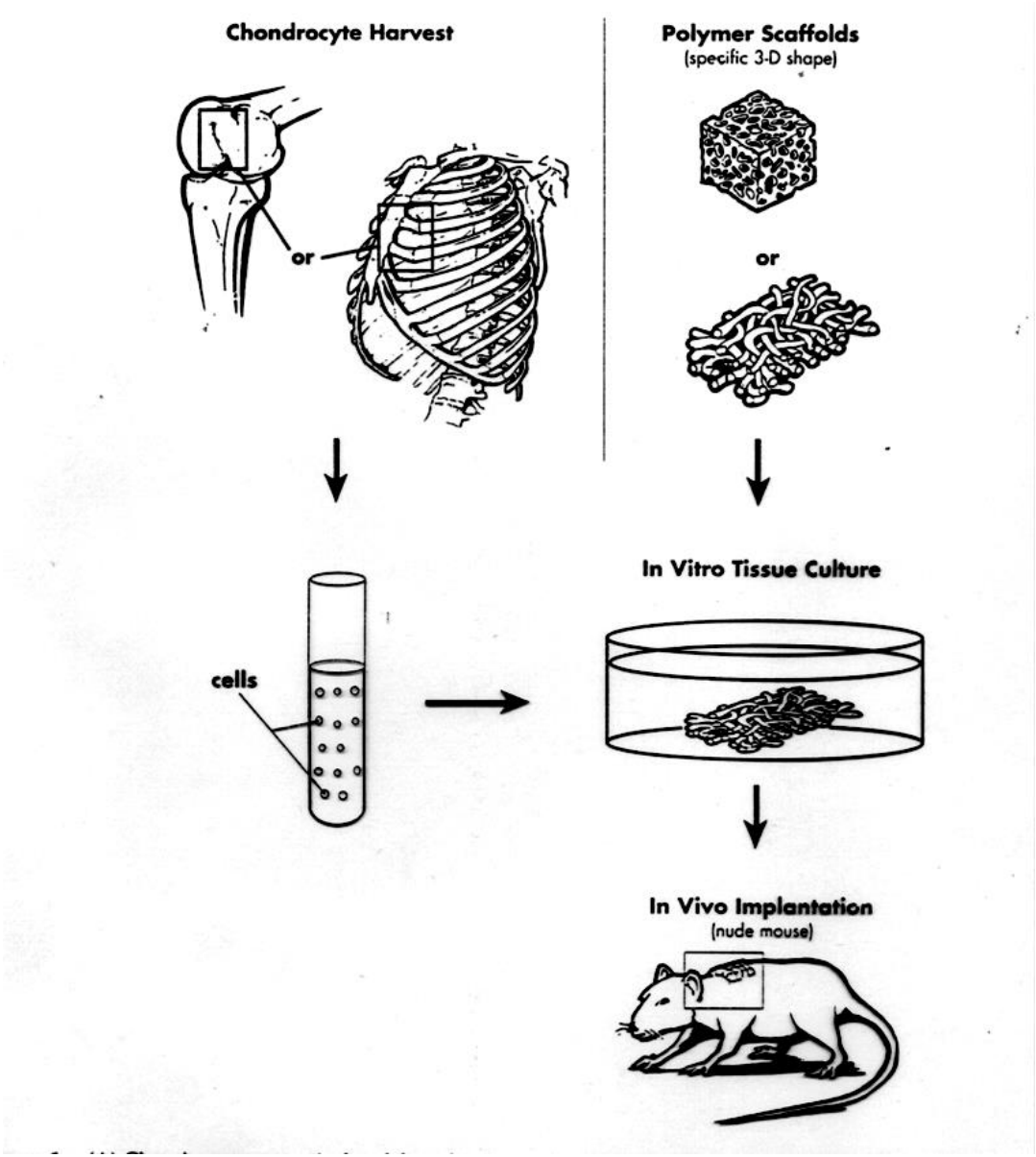


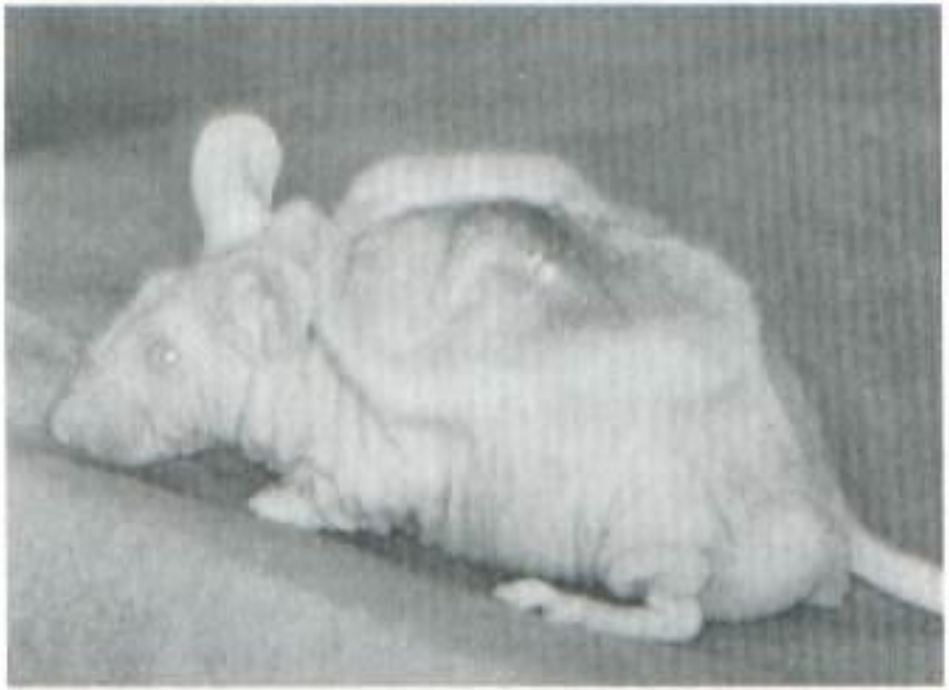
Engineered Heart Patches and Blood Vessels



Engineered Skin

Tissue Scaffold Approach:





Scaffold Fabrication Methods

Solvent Casting (I)

- Procedure:

  Polymer is dissolved in a suitable solvent;
  Poured into a mold and frozen;
- Solvent is then removed, leaving the polymer set in the desired shape.

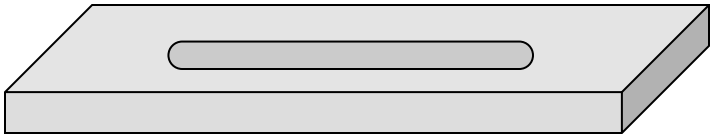
  Polymer concentration: 10-30%
- Advantages

  Ease of fabrication, without the need of specialized equipment; Simple; Inexpensive; Room Temperature, no effect on degradation behavior.
- Limitations

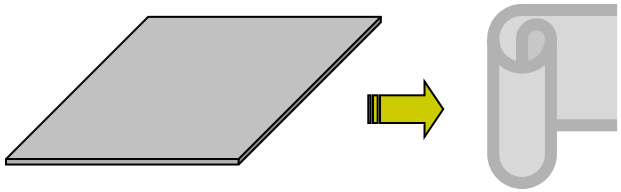
  Limited to simple shapes -can be stacked;
  Possible retention of toxic solvent within scaffold/ Can be overcome by allowing scaffold fully dry and using vacuum to further remove.
  Use solvent can denature proteins and other incorporated molecules.

Solvent Casting (II)

- Flat Structures



- Tubular Conduits

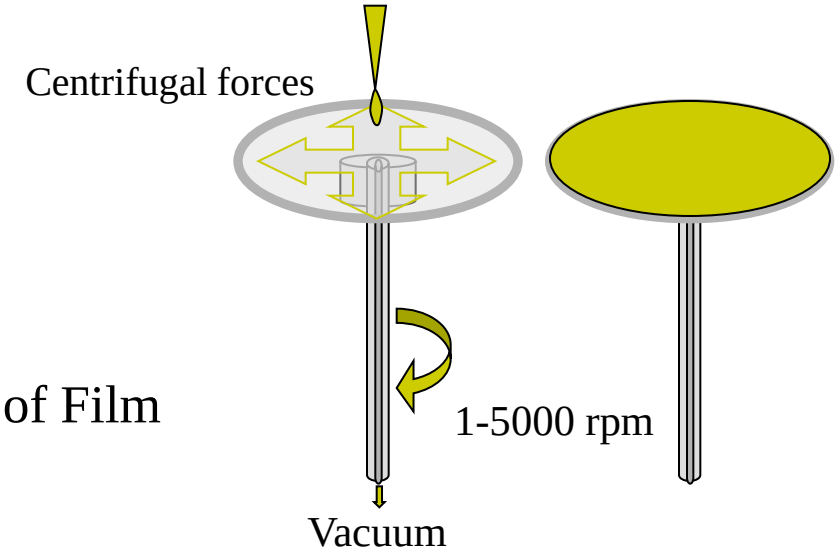


Spin casting/coating(A sub-type of solvent casting)

- Form Ultrathin films (<5μm). Polymer concentration 5-20%.
- Non-stick, smooth surfaces (Glass coverslips; silicon wafers)

- Rotation speed
  Acceleration
  Spinning time
  Solution viscosity
  Solution density

Thickness of Film



Leaching (I)—Particle Leaching

Polymer solution

Sieved Particles (Porogen)

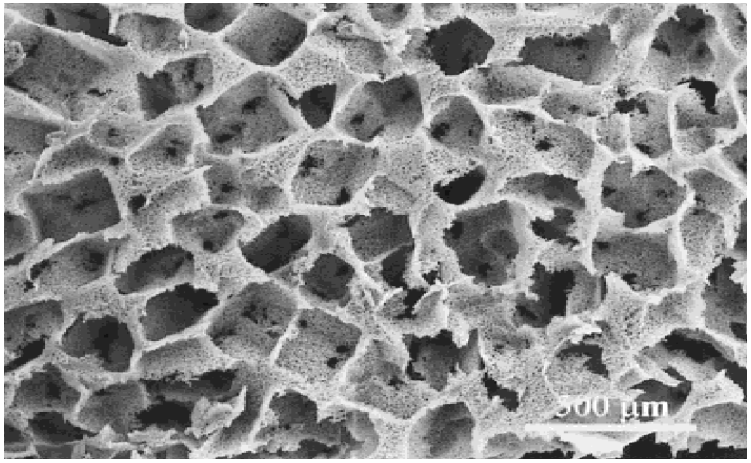
Well mixed solution

Pour into Mold

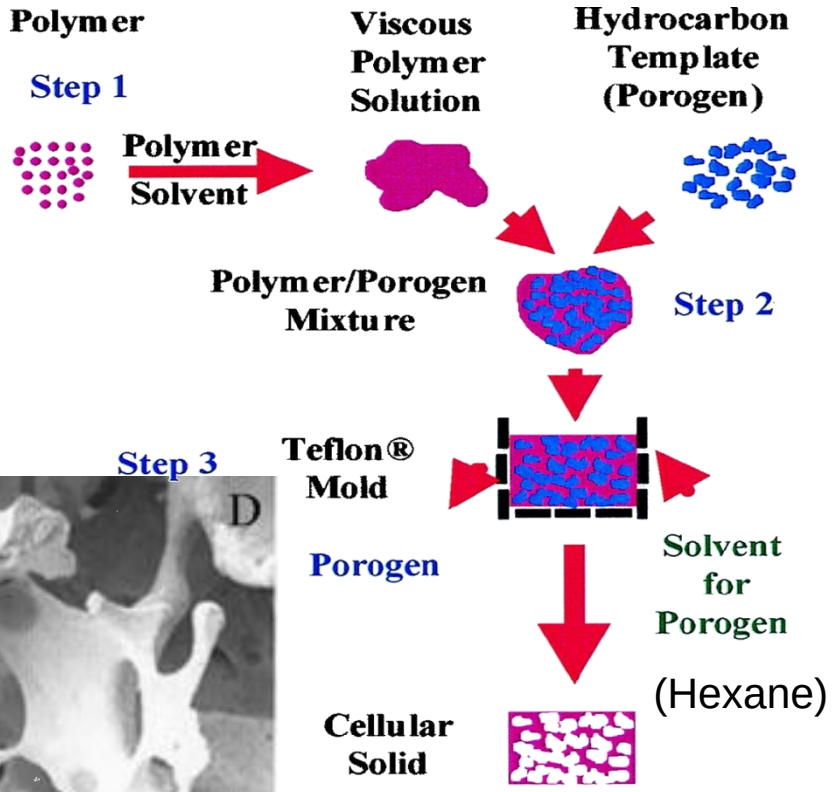
Solvent Evaporation

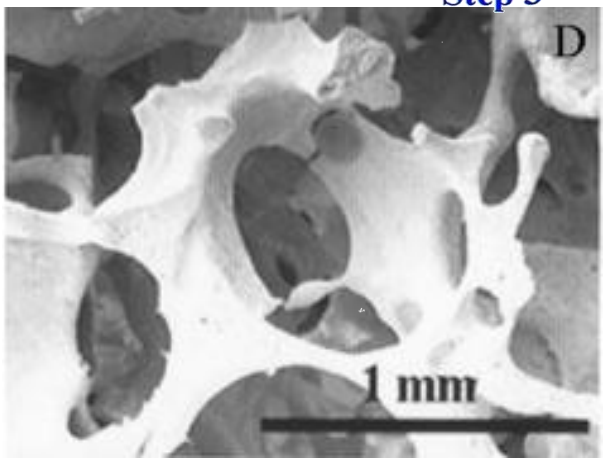
Immerse into solvent for particles

Porogen(>70%): Salt, Sugar, Wax…..

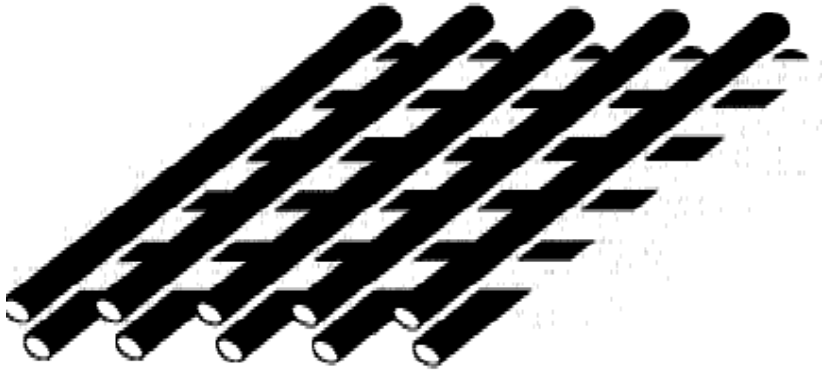


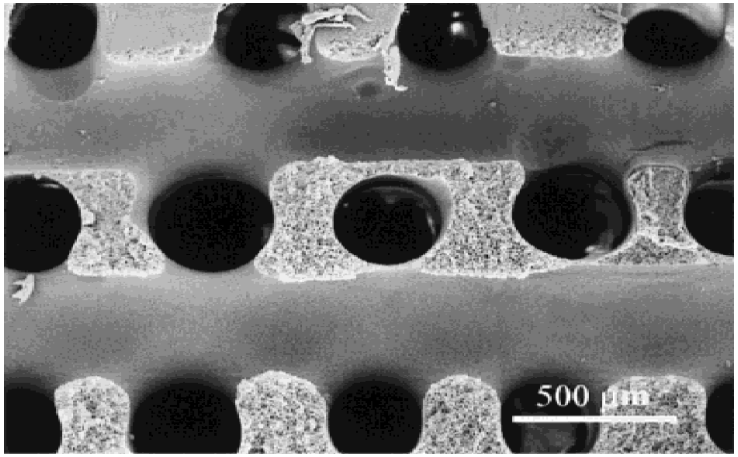
Leaching (II)—Ball Leaching

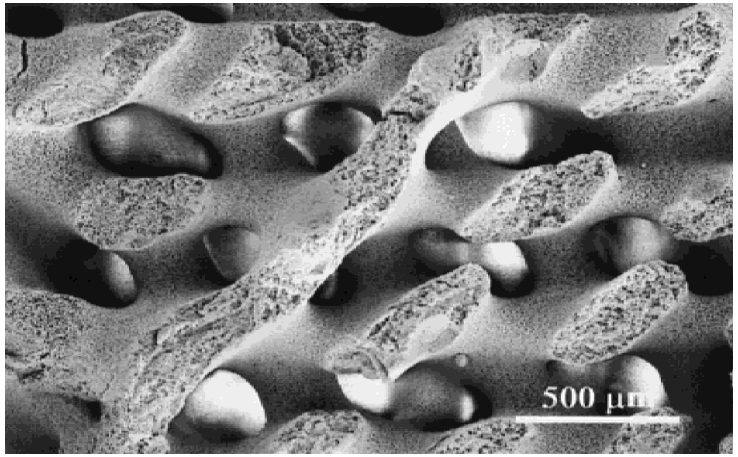




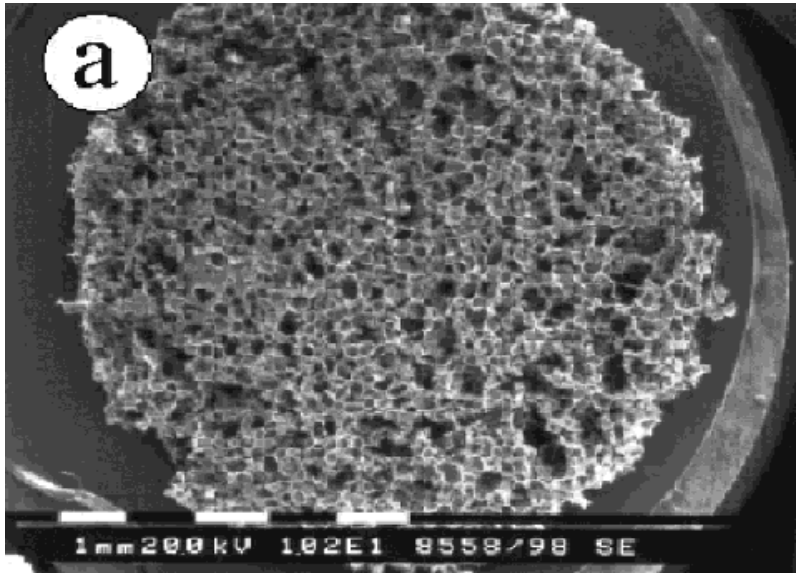
Leaching (III)—Fiber Leaching

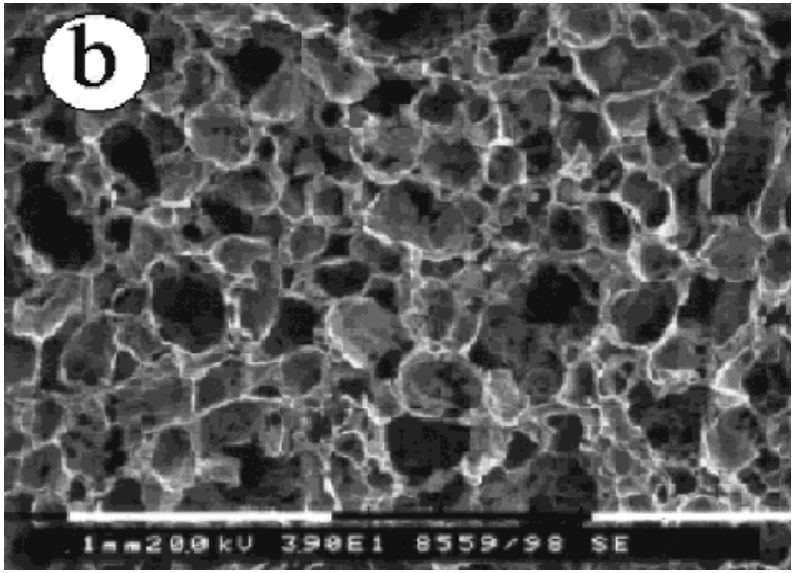




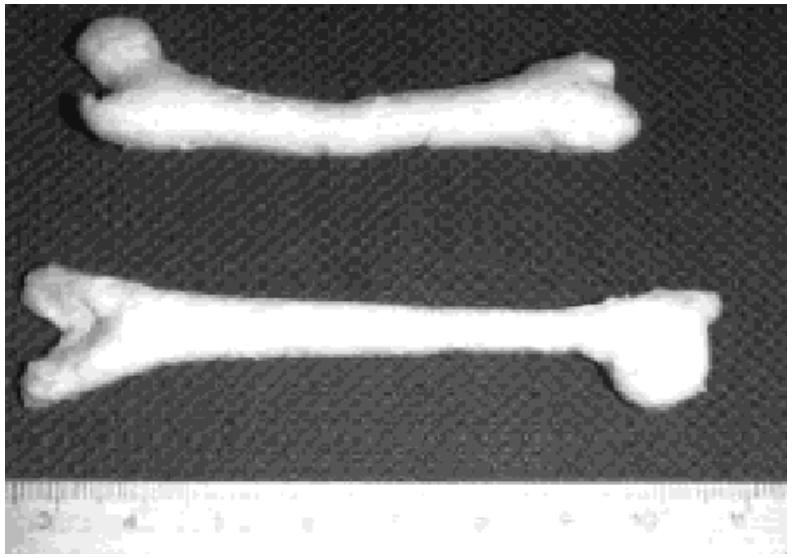


Gas Foaming



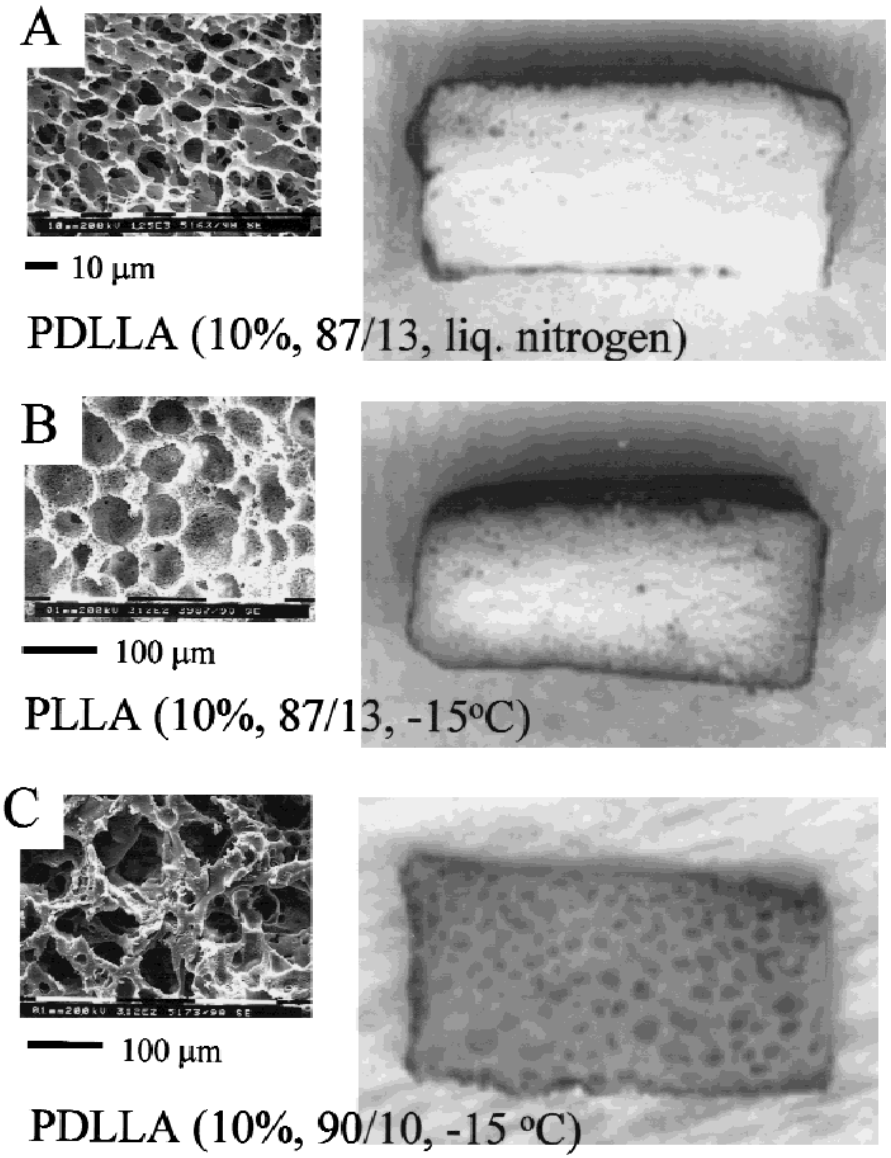


- Route 1:
  - Foam forming agent: Ammonium Bicarbonate;
  - Vacuum dry or immerse in water.
- Route 2:
  - High pressure CO_2 for long time
  - Rapid decrease to atmospheric pressure



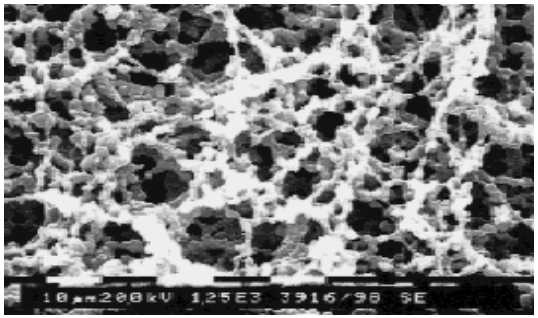
Emulsification/Freeze-drying (I)

- Polymer is dissolved in solvent, nonsolvent is added to form an emulsion, mixed well
- Mixture is cast into mold
- Quench using liquid nitrogen/low temperature
- Freeze-dried (Removal both solvent and non-solvent)

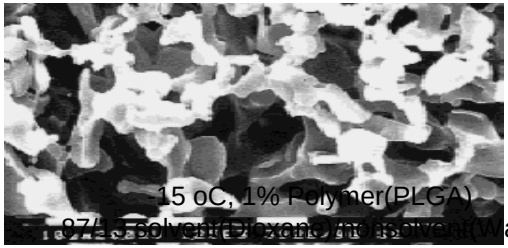


Emulsification/Freeze-drying (II)

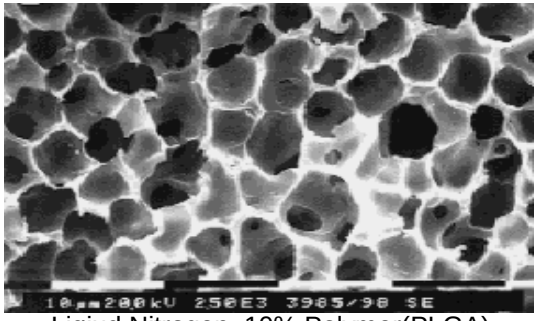
- Quenching condition (temperature)
- Polymer concentration;
- Solvent/Non-solvent ratio



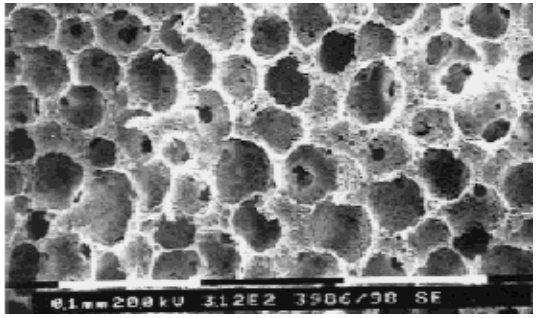
Liqiud Nitrogen, 1% Polymer(PLGA)
87/13 solvent(Dioxane)/nonsolvent(Water)



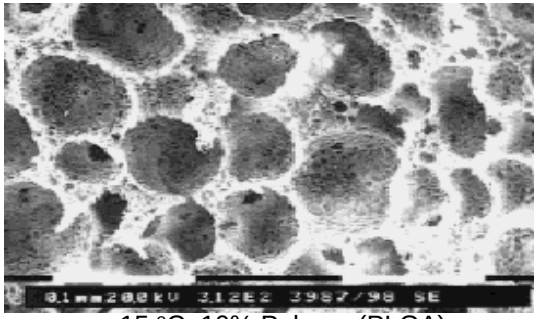
15 oC, 1% Polymer(PLGA)
87/13 solvent(Dioxane)/nonsolvent(Water)



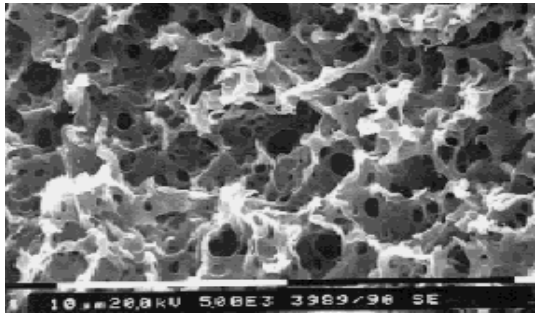
Liqiud Nitrogen, 10% Polymer(PLGA)
87/13 solvent(Dioxane)/nonsolvent(Water)



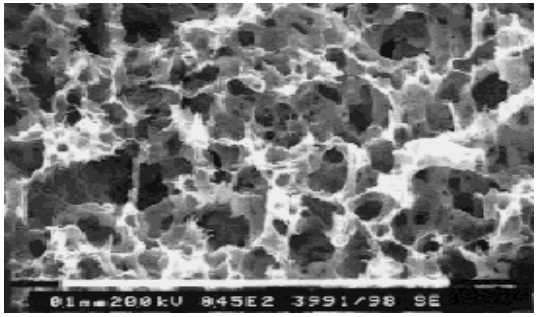
-40 °C, 10% Polymer(PLGA)
87/13 solvent(Dioxane)/nonsolvent(Water)



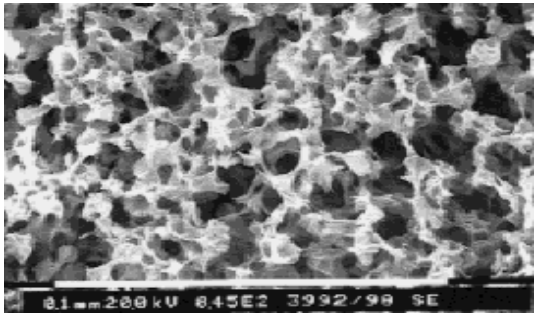
-15 °C, 10% Polymer(PLGA)
87/13 solvent(Dioxane)/nonsolvent(Water)



Liqiud Nitrogen, 10% Polymer(PLGA)
90/10 solvent(Dioxane)/nonsolvent(Water)

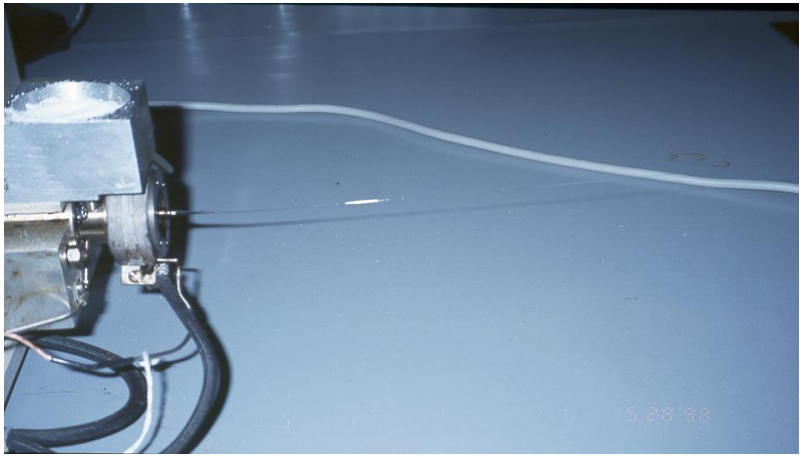


-40 °C, 10% Polymer(PLGA)
90/10 solvent(Dioxane)/nonsolvent(Water)

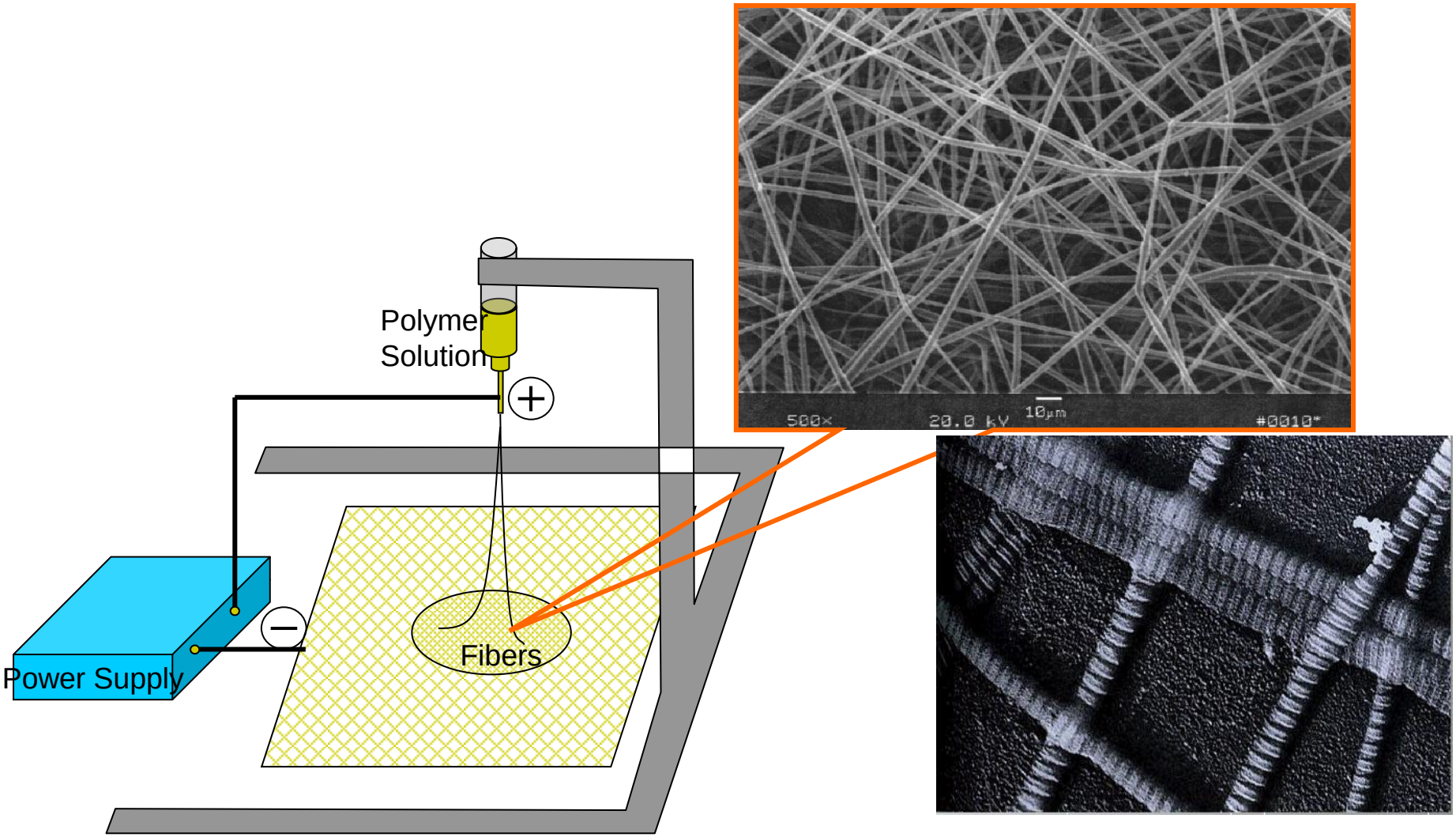


-15 °C, 10% Polymer(PLGA)
90/10 solvent(Dioxane)/nonsolvent(Water)

Melt Spinning

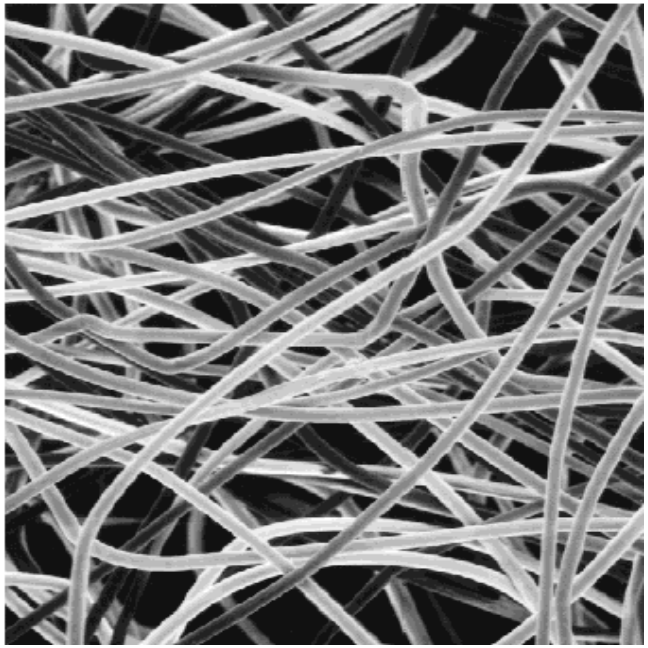


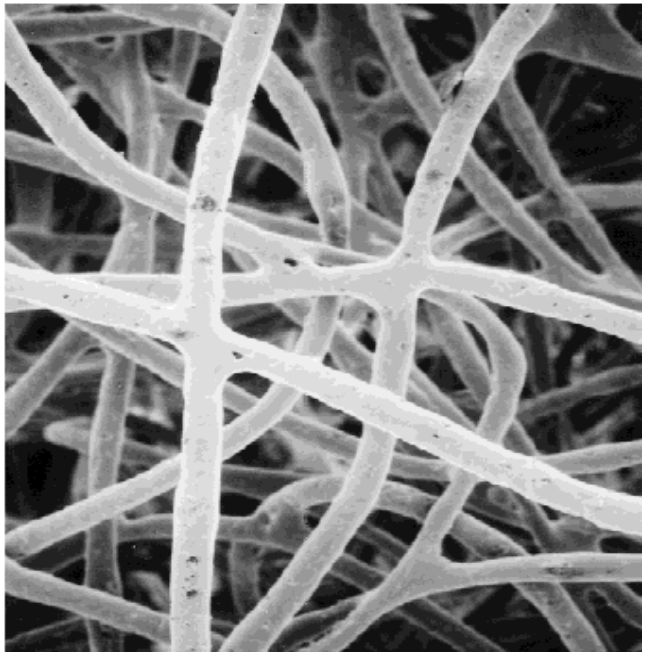
Electrospinning



Fiber Bonding (I)

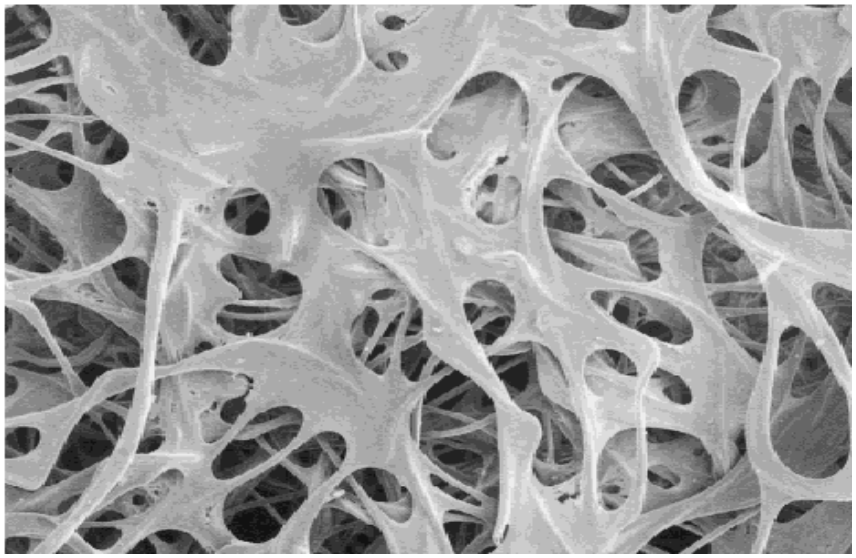
- Welding by Melt (High temperature)
- Spray using polymer solution: Thin spray and thick spray. (Toxic solvent removal)

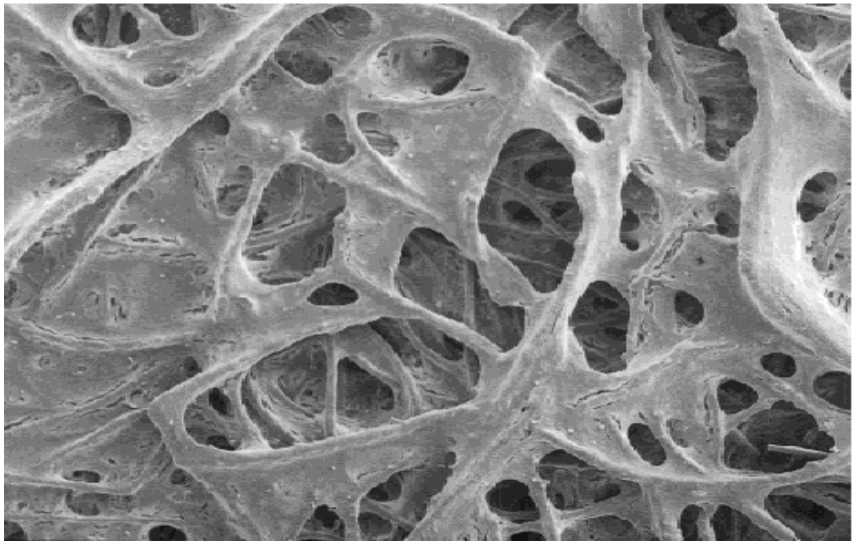




Before fiber bonding and after fiber bonding

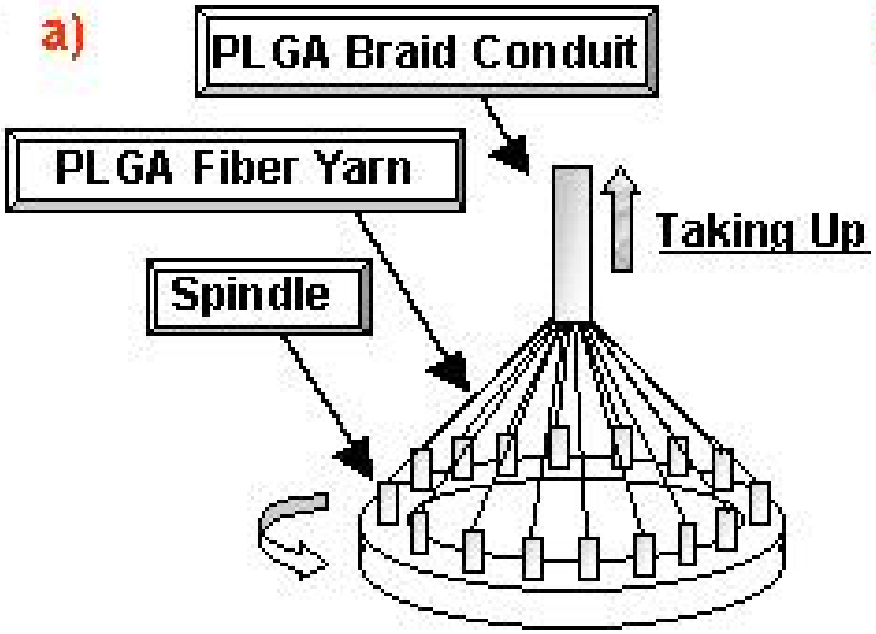
Fiber Bonding (II)

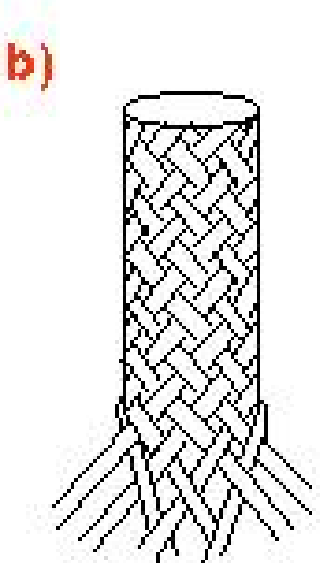


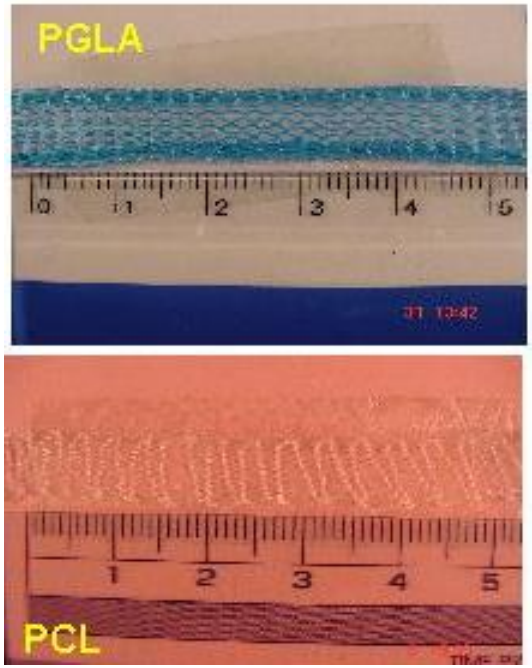


Tubular scaffold fabrication by thick spraying fiber bonding

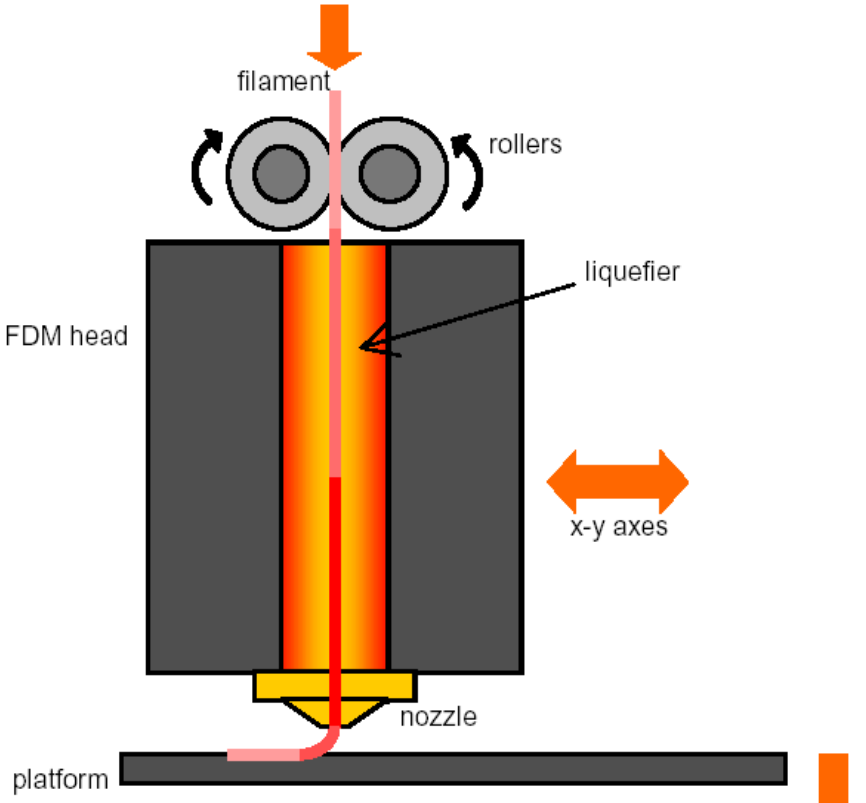
Braid Techniques

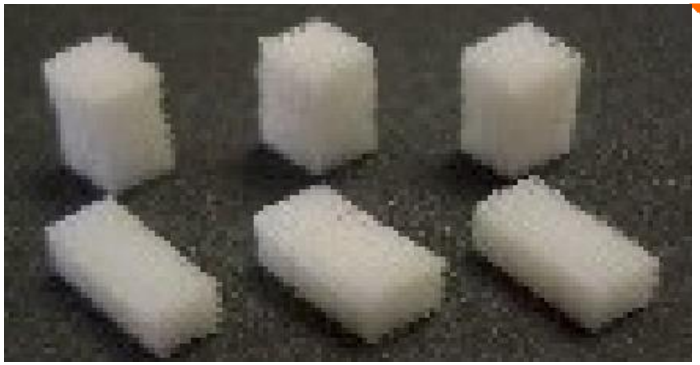


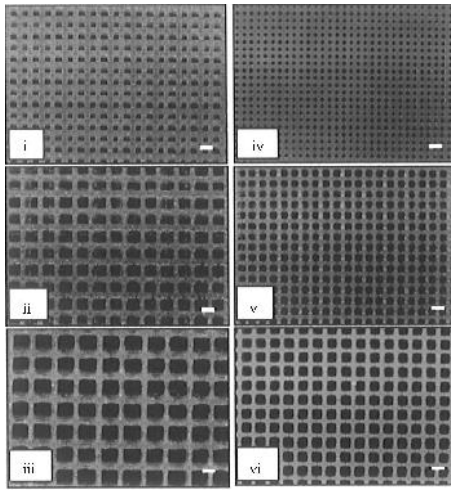


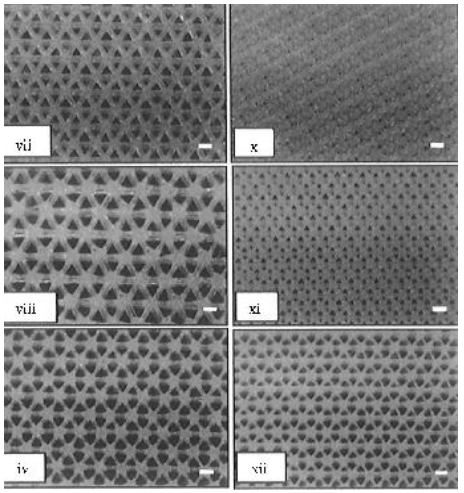


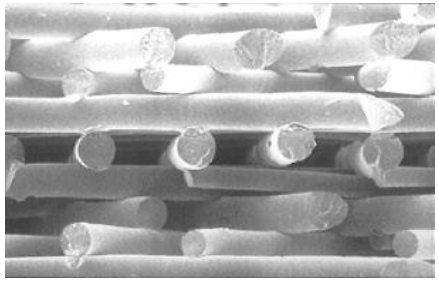
3-D printing: Wafer Stacking System

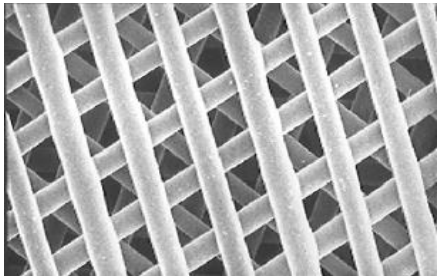


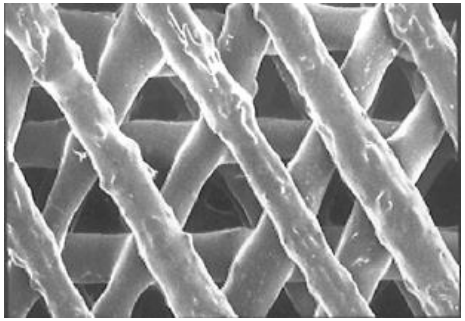


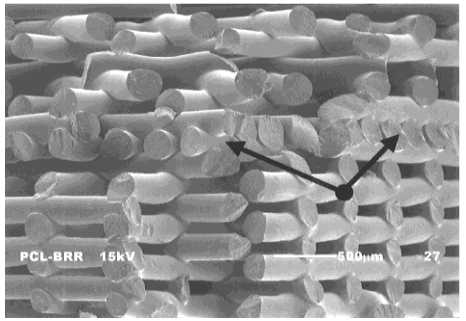












Scaffold Assembly System (I)