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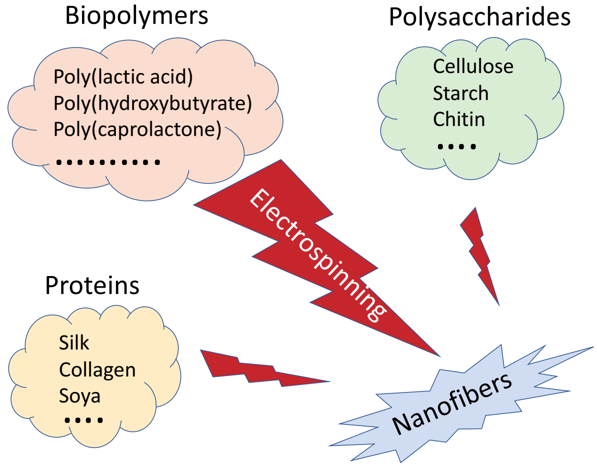
電界紡糸法によるバイオナノファイバー形成

Background

The lab focuses on the study of fabricating biobased materials into nano-/micro- fibers by using electrospinning. Now we are dealing with different kinds of biodegradable polymers, including biopolyesters, polysaccharides, and proteins. The nanofiber fabrication is related with the scientific problems of physics, chemistry, and biochemistry, which will be applied to process high-performance nanofibers. In addition, the relationships among polymer properties, processing parameters, and fiber qualities are systematically studied. Finally, the nanofiber products as scaffold will be applied in tissue engineering for cell culture.



Bionanofiber Fabrication

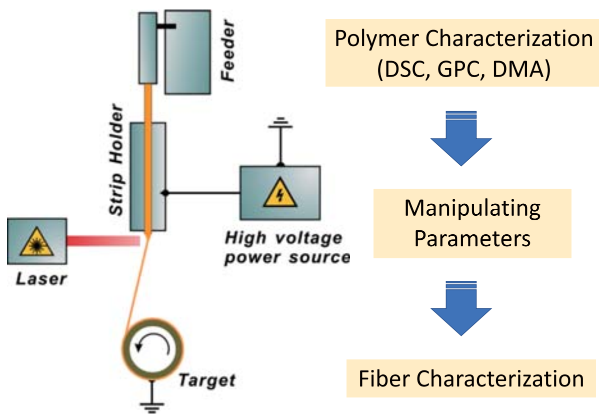
Electrospinning is a versatile method to process various polymers in to nanofibers. Most polymers can be transformed into nanofibers by using solution electrospinning. However, good solvents are always poisonous for body health and environment. One way is to find the substitute solvents that are more environmentally friendly, and the other way is to use the melt electrospinning. In our lab, laser was chosen as the heating source to melt polymers. In order to achieve high-quality fibers, the following items will be studied.

1) Polymer characterization (molecular weight, thermal properties, rheological properties, etc.);

2) Manipulation of processing parameters (temperature, voltage, distance, etc.);

3) Characterization of fiber sheets (mechanical properties, crystal information, hydrolysis, etc.).

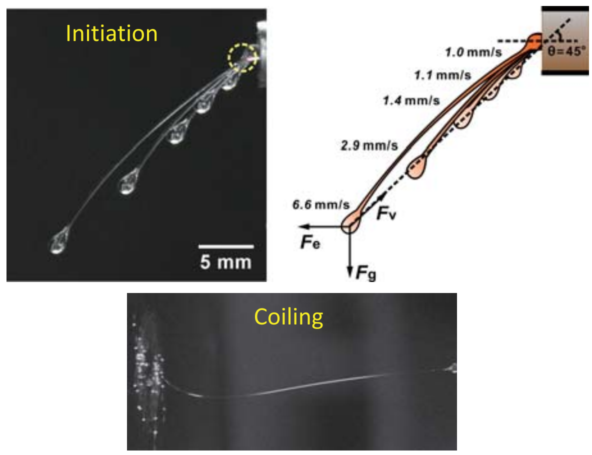
Laser-heating electrospinning



Mechanism of Jet Formation

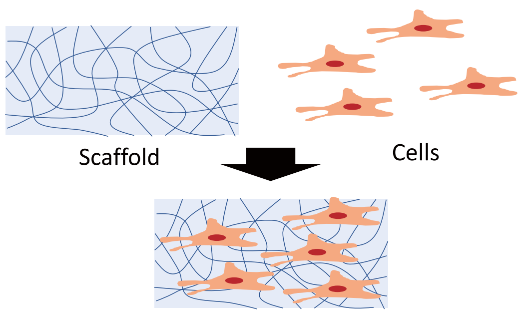
The electrospun jet connects the raw material to the fibers, so the hydrodynamics of the jet are the key to understand the relationships between processing parameters and the fiber quality. Polymer melt or solution will be drawn out from a needle tip when a high electrostatic field is loaded between nozzle and collector, forming into micro jet. The jet drawing behaviors such as the stability of Taylor-cone, jet thinning, thermal transfer, or solvent evaporation directly influence the morphology and mechanical properties of the fiber. Generally, observation and modeling are conducted in parallel.

Kinematics of Jet



Application

The biodegradable nanofiber web can be applied in scaffold-based tissue engineering. Cytotoxicity, cell adhesion, and hydrolysis are the key indexes to evaluate the scaffold. According to the repair time of tissue, from several weeks to years, the degradation rate can be manipulated by molecular weight, crystallinity, fiber diameter, etc. Also, the porosity and the mechanical property of the scaffold should be compatible with the cell size and the applying location, respectively.



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