論 文 の 要 旨

題 目　Fabrication of Short Polymer Fibers by Electrospinning and Control of Fiber Length
（静電紡糸法によるポリマー短繊維の合成および繊維長の制御）

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Polymer nanofibers are commonly fabricated by electrospinning methods for application such as affinity membranes, filter media, and electrical application, etc. Short polymer fibers have certain length, in which reliable as filler in composite materials, drugs carrier, and material template. In this dissertation, two types of one-step fabrication processes for short polymer fibers by electrospinning were developed, which is used electric spark as cutting tool and is controlled electrospinning conditions. The methodology to control the length of short polymer fibers was developed by altering a needle inner diameter, applied voltage, flow rate of polymer solution, and added the nanoparticles.

Chapter 1 provides an introduction and current progress of various methods to fabricate polymer fibers, which are drawing method, template synthesis, phase separation, self-assembly, and electrospinning.

Chapter 2 describes a development of one-step electrospinning process by electric spark as a cutting tool to fabricate short electrospun polymer fibers. A solution of cellulose acetate and organic solvent was ejected from a syringe needle and was stretched by the electric field then it cut after passed through the gap between the tips of two electrodes that generated an electric spark with frequency of 5 kHz. The obtained short fibers have average length of 231 μm, and the theoretical calculation of fiber length has been developed based on solution flow rate and electric spark frequency, which fit with the experimental data.

Chapter 3 describes a simple one-step fabrication of short elcectrospun polymer nanofibers with controllable length by manipulating polymer concentration, flow rate, and applied voltage. The concentration of the cellulose acetate polymer in the solution was important factor which varied from 13 to 15 wt. %. The length of fibers was increased by increasing the flow rate of the solution, and it was decreased with an increase in applied voltage, resulting in controllable length of short nanofibers at 37 to 670 μm. The polymer solution jet ejected straight from the needle tip then it split and segmented into short fiber because of the rapid increase of the repulsive force from surface charges combined longitudinal forces from the applied voltage.

Chapter 4 describes the effect of inner diameter of a needle on the length of electrospun polymer fibers. Cellulose acetate solution was ejected from various needles with different inner diameter then it split and breaks into short polymer fibers by electrostatic repulsion. The length could be controlled from 10 to 240 μm by increasing the inner diameter of needle from 0.11 to 0.26 mm.

Chapter 5 describes the fabrication of short composite nanofibers of TiO2/cellulose acetate.

The length of the short composite nanofibers was significantly decreased from 112 to 70 μm by the addition of 5 wt. % concentration of nanoparticles, and it gradually continued to decrease as the nanoparticle concentration was increased to 50 wt. %. The length of the short composite nanofibers with a low concentration of nanoparticles was affected by the surface charge of the nanoparticles, and negatively charged nanoparticles readily dispersed to the negatively charged polymers in solution, which resulted in an elongation of the fabricated short composite nanofibers.

Chapter 6 describes a summary and some comments for further investigations.