# 論文 / 著書情報
# Article / Book Information

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| Title(English) | Melt blowing process for production of non-woven nano-fiber web |
| 著者(和文) | RUAMSUKRENUKARN |
| Author(English) | Renukarn Ruamsuk |
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# 論 文 要 旨

THESIS SUMMARY

| 専攻：<br>Department of | 有機・高分子物質専攻　専攻 | 申請学位（専攻分野）：<br>Academic Degree Requested | 博士<br>Doctor of　（　学術　） |
|---|---|---|---|
| 学生氏名：<br>Student's Name | Renukarn Ruamsuk | 指導教員（主）：<br>Academic Advisor(main) | 鞠谷 雄士 |
| | | 指導教員（副）：<br>Academic Advisor(sub) | |

要旨（英文 800 語程度）
Thesis Summary (approx.800 English Words )


This thesis entitled "Melt blowing process for production of non-woven nano-fiber web" is consisting of seven chapters.

In Chapter 1, melt blowing process, a process for producing non-woven fabrics, is introduced. In order to improve this process, the reduction of fiber diameter to nano-scale is required to obtain some favorable properties for applications. Therefore, the objective of this research was set to develop technology for producing non-woven web of nano-fibers as well as to investigate the fiber formation behavior in the melt blowing process.

In Chapter 2, the fundamental of melt blowing process is investigated with Polymethylpentene (PMP) and polypropylene (PP) by study the effect of spinning conditions on the fiber diameter and the structure of fibers. It was found that fiber diameter of both polymers decreased with the decrease of polymer throughput and increase of air flow rate. In case of DCD, PMP fiber diameter was not affected by DCD, whereas PP fiber diameter increased with increasing of DCD. Through the structure analysis, crystallized structure was observed for PMP fibers, whereas mesomorphic structure was observed for PP. These results suggested that the PMP fiber was solidified in the spinning process. On the other hand, PP fiber was still in a molten state when the fibers reached the collector. Therefore, PP fiber diameter was affected by DCD changing.

In Chapter 3, formation behavior of fine fibers in the spin-line was investigated using high speed camera. Reduction of polymer throughput rate and increase of air flow rate were necessary to achieve the fine diameter fibers, however these conditions generally cause the instability. Observation of the spin-line revealed the periodic accumulation of polymer near the spinning nozzle followed by the quick pulling down of the accumulated polymer by the air flow. This behavior caused the periodic fiber diameter fluctuation as well as the breakage of the spin-line under extreme conditions. Diameter distribution of the fibers was analyzed to compare with the spinning behavior. Fiber diameter distributions were narrow and symmetric under stable spinning conditions, whereas skewed diameter profiles with a maximum at a low diameter value and a long tail to the larger diameter region were observed under unstable conditions. Intermittent spin-line breakage caused flaws of "shot" and/or "fly", and the wider of skewed fiber diameter distribution.

In Chapter 4, effect of the utilization of extremely small diameter spinning nozzle was investigated. When nozzle diameter was reduced, average fiber diameter below 1 μm was achieved. In terms of fiber structure, the results for PMP exhibited that the structure of fibers under various spinning conditions showed insignificant difference except for the influence of nozzle size. When small nozzle size was used, WAXD result exhibited crystalline structure with orientation of c-axis along the fiber length, whereas using large diameter nozzle the fibers presented no preferred orientation crystalline structure. In case of PP, almost all spinning conditions exhibited a mesomorphic structure except the fiber prepared with small DCD conditions that exhibited the α-form crystals. This result is due to the higher temperature of the web on the collector. The observation of fiber formation behavior using high speed camera confirmed the stabilization of the overall spinning process when using smaller diameter nozzles for both polymers.

In Chapter 5, effects of the application of electric field and the addition of wax to the polymer for the production of fine diameter filaments were investigated. In case of electric field, the reduction of average fiber diameter exhibited only in unstable condition. This because the electric charge on the fiber surface stabilized the spinning line through the reduction of surface tension which causes the fiber breakage. As the minimum fiber diameter was reduced from 120 nm to 60 nm indicating that the electric charge is effective exclusively for the fibers of smaller diameter.
Effect of the blending of PP wax to PP on the spinning behavior and the fiber diameter were investigated. It was found that the blending of the PP wax of up to 50 wt% caused the significant reductions of both mean and minimum diameters. At the throughput rate of 15 mg/min/hole, the mean

fiber diameter of less than 500 nm were achieved. Observation of the spin-line revealed that there was a formation of polymer pool on the surface of the spinneret. Nevertheless, very fine diameter filament can be created consecutively after the falling down of accumulated polymer melt.

In Chapter 6, bi-component fibers of PP and polylactic acid (PLA) with side-by-side cross-sectional configuration was compared with those ordinary single-component. The result of fiber diameter exhibited the similar or even lower diameters of PP/PLA fibers in comparison with those single-components. Web of bi-component fibers also exhibited an improvement of thermal characteristics with lower percentage of shrinkage in comparison with the web of single-component PLA which exhibits high percentage of shrinkage. This indicates the better coefficient of the web when using bi-component side by side melt blown.

In last chapter, results obtained through this research are summarized.