

**DEVELOPMENT OF WET-SPUN ALGINATE FIBERS FOR WOUND  
DRESSING APPLICATIONS**



Anyarat Watthanaphanit

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**By:** Anyarat Watthanaphanit  
**Program:** Polymer Science  
**Thesis Advisors:** Assoc. Prof. Ratana Rujiravanit  
Assoc. Prof. Pitt Supaphol  
Prof. Seiichi Tokura

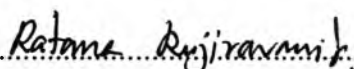
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Accepted by the Petroleum and Petrochemical College, Chulalongkorn University, in partial fulfilment of the requirements for the Degree of Doctor of Philosophy.


  
..... Dean  
(Asst. Prof. Pomthong Malakul)


**Thesis Committee:**


  
.....  
(Asst. Prof. Pomthong Malakul)

  
.....  
(Assoc. Prof. Ratana Rujiravanit)

  
.....  
(Assoc. Prof. Pitt Supaphol)

  
.....  
(Prof. Seiichi Tokura)

  
.....  
(Dr. Thanyalak Chaisuwan)

  
.....  
(Dr. Manisara Phiriyawirut)

## ABSTRACT

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Smart alginate-based wound dressings were successfully developed using the wet spinning process. In order to improve the mechanical properties and include the ability to promote tissue reconstruction of neat alginate fiber, chitin whisker, a nanofibrilla chitin, was incorporated in the alginate wet-spun fibers. Incorporation of low amount of chitin whiskers in the nanocomposite fibers improved the mechanical properties as well as accelerated the biodegradation process of the fibers in the presence of lysozyme. Antimicrobial property was introduced to alginate fibers by coating/incorporating the fibers with silver particles/chitosan whiskers, respectively. Good distribution of silver particles was observed at a low amount of the silver-coated alginate fiber, resulting in the enhancement of the mechanical properties of the fibers. The embedded chitosan whiskers lead the fibers to increase in the tensile strength but lowering the elongation at break. Both of the fibers show antibacterial efficacy against both gram-positive *Staphylococcus aureus* and gram-negative *Escherichia coli*. Lastly, a novel method of using chitosan in the form of an emulsion was proposed in order to overcome the major problem associated with the production of alginate/chitosan hybridized fibers by wet spinning which is the formation of gels due to ionic interactions of the oppositely-charged molecules of alginate and chitosan when these two polymers are directly mixed. By this method, chitosan can be mixed in alginate fiber up to 10% w/w. The alginate/chitosan hybridized fibers showed spotty features of the chitosan-citrate complex micelles on the surface and the inside of the hybridized fibers. Preliminary studies demonstrated that the obtained chitosan-spotted alginate fibers showed great promises as carriers for drug delivery.

## บทคัดย่อ

อัญรัตน์ วัฒนพานิช : การพัฒนาเส้นใยอัลจิเนตซึ่งขึ้นรูปด้วยกระบวนการปั่นเปียกเพื่อ  
การนำไปประยุกต์ใช้เป็นวัสดุปิดแผล (Development of Wet-Spun Alginate Fibers for  
Wound Dressing Applications) อ. ที่ปรึกษา : รศ.ดร. รัตนา รุจิรวนิช รศ. ดร. พิชญ์ สุภผล และ  
ศ. ดร. เซอิจิ โทกुरะ 157 หน้า

เส้นใยอัลจิเนตซึ่งขึ้นรูปด้วยกระบวนการปั่นเปียกถูกพัฒนาให้มีคุณสมบัติที่ดีขึ้นเพื่อ  
การนำไปประยุกต์ใช้เป็นวัสดุปิดแผล การพัฒนาสมบัติเชิงกลรวมถึงสมบัติในการเสริมสร้างการ  
เจริญของเซลล์เนื้อเยื่อบริเวณบาดแผลของเส้นใยอัลจิเนต ทำได้โดยการกระจายเส้นใยระดับนาโน  
ของไคตินซึ่งเรียกว่าไคตินวิสเกอร์ ลงในเส้นใยอัลจิเนต จากการทดลองพบว่าการผสมไคติน  
วิสเกอร์ลงในเส้นใยอัลจิเนตในปริมาณน้อย ทำให้สมบัติการทนแรงดึงของเส้นใยเพิ่มขึ้น อีกทั้งยัง  
ช่วยเพิ่มความสามารถในการสลายตัวของเส้นใยเมื่อมีเอ็นไซม์ไลโซไซม์ด้วย การเตรียมเส้นใยอัล  
จิเนตที่มีสมบัติด้านจุลชีพทำได้โดยการเคลือบเส้นใยอัลจิเนตด้วยอนุภาคของเงินระหว่างการขึ้น  
รูปหรือการผสมเส้นใยระดับนาโนของไคโตซาน (ไคโตซานวิสเกอร์) ลงในสารละลายของอัลจิ  
เนตก่อนการขึ้นรูป ผลการศึกษาพบว่าอนุภาคของเงินมีการกระจายตัวดีขึ้นเมื่อใช้เงินในปริมาณ  
น้อยเคลือบลงบนเส้นใยอัลจิเนต เป็นเหตุให้เส้นใยอัลจิเนตซึ่งถูกเคลือบด้วยเงินในอัตราส่วน  
ดังกล่าวมีสมบัติเชิงกลที่ดีขึ้น ในขณะที่การผสมไคโตซานวิสเกอร์ลงในเส้นใยอัลจิเนต ส่งผลให้  
สมบัติการทนแรงดึงของเส้นใยผสมดังกล่าวเพิ่มขึ้นแต่ความสามารถในการยึดตัวของเส้นใยลดลง  
เมื่อเปรียบเทียบกับสมบัติด้านจุลชีพของเส้นใยผสมทั้งสองกับเส้นใยอัลจิเนตพบว่า เส้นใยผสมทั้ง  
สองนั้นสามารถยับยั้งจุลชีพได้ทั้งแบคทีเรียชนิดแกรมบวก (*Staphylococcus aureus*) และแกรม  
ลบ (*Escherichia coli*) ในขณะที่เส้นใยอัลจิเนตไม่มีสมบัติดังกล่าว จากนั้นเนื่องด้วยปัญหาการ  
จับตัวกันเป็นก้อนของสารละลายอัลจิเนตกับไคโตซานซึ่งเกิดจากความแตกต่างระหว่างประจุของ  
สารละลายทั้งสองก่อนการขึ้นรูป จึงมีการคิดค้นวิธีการใหม่ซึ่งช่วยเพิ่มปริมาณไคโตซานที่  
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สามารถแก้ไขได้โดยการใช้ไคโตซานในรูปของอิมัลชัน จากการใช้วิธีการดังกล่าวพบว่าสามารถ  
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ลักษณะเป็นคุ่มปรากฏอยู่ทั้งภายในและบนผิวของเส้นใย โดยเป็นคุ่มที่เกิดจากไมเซลล์ของ  
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ใยผสมที่ได้มีแนวโน้มที่ดีสำหรับการประยุกต์ใช้ในการปลดปล่อยยาอีกด้วย

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