

**PREPARATION AND CHARACTERIZATION OF CARBON BLACK
NANOPARTICLE-FILLED ELECTROACTIVE ELECTROSPUN
POLY(VINYL ALCOHOL) NANOFIBERS**

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ABSTRACT

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Electroactive polymer is the polymer which responds to an external electrical stimulation by displaying a significant shape or size displacement. In this work, carbon black (CB) nanoparticle-filled poly(vinyl alcohol) (PVA) nanofibers were developed to use as an electroactive polymer. Pristine PVA and CB-filled PVA nanofibers were successfully fabricated by electrospinning with the fiber sizes of about 85-647 and 169 nm, respectively. The deposition area, morphological appearance, and diameters of the as-electrospun pristine PVA fibers were investigated to study the effects of solution concentration, preparation with sonication, applied electrostatic potential, and collection distance. The fibers that were fabricated according to the following conditions, i.e. 10% w/v PVA concentration, 15 kV applied voltage, and 15 cm collection distance, were chosen for the further study of the effects of CB composition on the morphological appearance and diameters of the as-electrospun CB-filled fibers. These nanofibers were also characterized by other techniques to investigate the effect of CB composition on chemical structure, crystallinity, and thermal properties of resulting fibers. Finally, the as-spun CB-loaded fibers were developed as an electroactive material through the investigation of mechanical and electrorheological properties. Interestingly, the obtained fibers had good tensile properties and could respond to an external electrical stimulation by displaying an increase in the modulus.

บทคัดย่อ

สุรวุฒิ ช่วงโชติ : การเตรียมและการพิสูจน์เอกลักษณ์ของเส้นใยอิเล็กทรอนิกส์ทอปั่นตอบสนองต่อไฟฟ้าขนาดนาโนจากวัสดุผสมระหว่างพอลิไวนิลแอลกอฮอล์ และผงขนาดนาโนของคาร์บอนดำ (Preparation and characterization of carbon black nanoparticle-filled electroactive electrospun poly(vinyl alcohol) nanofibers) อ. ที่ปรึกษา : รศ.ดร. พิชญ์ สุภผล และ รศ.ดร. อนุวัฒน์ ศิริวัฒน์ 129 หน้า ISBN 974-9990-06-4

พอลิเมอร์ตอบสนองต่อไฟฟ้า คือ พอลิเมอร์ที่สามารถเปลี่ยนรูปร่างหรือย้ายตำแหน่งได้ เมื่อได้รับการกระตุ้นจากสนามไฟฟ้าภายนอก งานวิจัยนี้มุ่งที่จะพัฒนาวัสดุเส้นใยนาโนที่ตอบสนองต่อไฟฟ้าจากวัสดุผสมระหว่างพอลิไวนิลแอลกอฮอล์ และผงขนาดนาโนของคาร์บอนดำ โดยใช้การขึ้นรูปด้วยวิธีการปั่นเส้นใยด้วยไฟฟ้าสถิต ผลการทดลองพบว่าสามารถเตรียมเส้นใยพอลิไวนิลแอลกอฮอล์ และเส้นใยพอลิไวนิลแอลกอฮอล์ที่มีผงขนาดนาโนของคาร์บอนดำผสมอยู่ได้สำเร็จ โดยเส้นใยดังกล่าวมีขนาดเล็กอยู่ในช่วง 85-647 และ 169 นาโนเมตรตามลำดับ นอกจากนี้ยังมีการศึกษาผลของปัจจัยต่างๆ ที่มีต่อพื้นที่การเกิดบนวัสดุรองรับ ลักษณะ และขนาดของเส้นใยอิเล็กทรอนิกส์ที่เตรียมได้ ซึ่งประกอบด้วย ความเข้มข้นของสารละลาย การเตรียมสารละลายด้วยการสั่นอย่างรุนแรง ความต่างศักย์ที่ใช้เตรียมเส้นใย และระยะในการเก็บเส้นใย จากการทดลองดังกล่าวพบว่าความเข้มข้นของสารละลาย 10 เปอร์เซ็นต์โดยน้ำหนักต่อปริมาตร ศักย์ไฟฟ้า 15 กิโลโวลต์ และระยะในการเก็บเส้นใย 15 เซนติเมตรมีความเหมาะสมสำหรับใช้ในการเตรียมเส้นใยให้มีขนาดเล็กและสม่ำเสมอ จึงเลือกสภาวะดังกล่าวในการเตรียมเส้นใยผสมระหว่างพอลิไวนิลแอลกอฮอล์และผงขนาดนาโนของคาร์บอนดำ แล้วนำเส้นใยที่ได้ดังกล่าวไปวิเคราะห์เพื่อศึกษาผลของการเติมผงคาร์บอนดำที่มีต่อลักษณะและขนาดของเส้นใย รวมถึงโครงสร้างทางเคมี โครงสร้างผลึก และสมบัติทางความร้อนของเส้นใยด้วย สุดท้ายได้นำเส้นใยผสมดังกล่าวไปศึกษาความเป็นไปได้ที่จะใช้เป็นวัสดุตอบสนองต่อไฟฟ้าโดยการศึกษาสมบัติเชิงกลภายใต้สนามไฟฟ้า ผลการทดลองแสดงให้เห็นว่าเส้นใยผสมระหว่างพอลิไวนิลแอลกอฮอล์ และผงของคาร์บอนดำมีสมบัติเชิงกลที่ดี และสามารถตอบสนองต่อไฟฟ้าได้ โดยให้ค่าความแข็งแรงต่อการดึงสูงขึ้นเมื่ออยู่ภายใต้สนามไฟฟ้า

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