

**PREPARATION AND CHARACTERIZATION
OF POLYANILINE/NATURAL RUBBER COMPOSITE FIBERS**

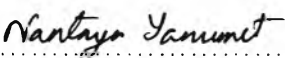
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A Thesis Submitted in Partial Fulfilment of the Requirements
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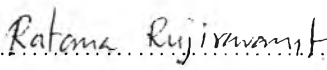
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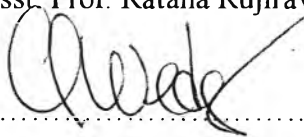
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By: Panu Sukitpaneent
Program: Polymer Science
Thesis Advisors: Asst. Prof. Ratana Rujiravanit
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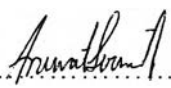
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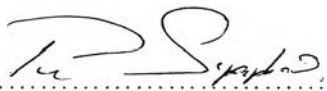

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ABSTRACT

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Polyaniline/natural rubber composite fibers were fabricated by a wet spinning method. Latex dopes for spinning contained three components, i.e. natural rubber (NR) latex, polyaniline (PANI) and sodium alginate (viscosity controller). PANI content in the composite fibers was varied from 0 to 10% (w/w). After extrusion through a spinneret, the neat fiber bundles were passed into two coagulation baths containing calcium chloride/methanol and methanol, respectively. The composite fiber bundles were immersed into an HCl solution to achieve the PANI emeraldine salt form (ES), the conducting state form. The effects of PANI content on the electrical conductivity and mechanical properties of the bundles of composite fibers were investigated. SEM micrographs of the cross-sectional morphology of the composite fiber bundles revealed that PANI particles were inhomogeneously distributed in the natural rubber matrix. When PANI content increased from 0 to 10% (w/w), the electrical conductivity of the fibers increased from 10^{-10} to 10^{-3} S/cm, whereas the tensile property decreased from 1 to 0.35 cN/tex. However, the elongation at break decreased from 820 to 600%, indicating that these composite fibers still retained the elastomeric property of the natural rubber for all compositions. The electrical conductivity of bundles of the composite fiber was preserved upon elongational deformation even if strains as large as 600% were applied. The bending deformation of the composite fiber under electric field demonstrated that the composite fibers can be further developed for soft actuator application.

บทคัดย่อ

ภาณุ สุกิจปาณีนิจ : การเตรียมและวิเคราะห์คุณสมบัติของเส้นใยคอมโพสิตระหว่างยางธรรมชาติและพอลิอะนิลีน (Preparation and Characterization of Polyaniline/Natural Rubber Composite Fibers) อ. ที่ปรึกษา : ผศ. ดร. รัตนา รุจิรวนิช และ รศ. ดร. คริสชอฟ เวเดอร์ 116 หน้า

เส้นใยคอมโพสิตระหว่างยางธรรมชาติและพอลิอะนิลีนสามารถเตรียมผ่านเทคนิคกระบวนการปั่นเส้นใยแบบเปียก โดยการอัดสารผสมระหว่าง นำยางธรรมชาติ สารละลายโซเดียมอัลจิเนต (สารเพิ่มความหนืด) และผงพอลิอะนิลีนในรูปสภาวะอิมเมอร์สชันเบส (สภาวะที่ไม่นำไฟฟ้าของพอลิอะนิลีน) ผ่านหัวรีดซึ่งประกอบด้วยรูฉีดเส้นใยจำนวน 30 รู ซึ่งแต่ละรูมีขนาดเส้นผ่านศูนย์กลาง 0.2 มิลลิเมตร และผ่านอ่างน้ำยาเคมีซึ่งประกอบด้วยสารละลายอิมตัวของแคลเซียมในเมทานอลเข้มข้นร้อยละ 5 และอ่างน้ำยาเคมีซึ่งประกอบด้วยเมทานอล หลังจากนั้นจึงนำเส้นใยที่ได้ไปผ่านกระบวนการได้ปโดยใช้สารละลายกรดไฮโดรคลอริก เพื่อเปลี่ยนสภาวะอิมเมอร์สชันเบสของพอลิอะนิลีนให้เป็นสภาวะอิมเมอร์สชันซอลท์ (สภาวะที่นำไฟฟ้าของพอลิอะนิลีน) ทั้งนี้ได้ทำการเตรียมเส้นใยที่มีปริมาณพอลิอะนิลีนร้อยละ 0, 0.5, 1, 2, 5, และ 10 โดยน้ำหนัก จากงานวิจัยนี้พบว่า เมื่อสัดส่วนปริมาณพอลิอะนิลีนภายในเส้นใยเพิ่มขึ้น ทำให้สมบัติการนำไฟฟ้าของเส้นใยคอมโพสิตเพิ่มขึ้น ในขณะที่เดียวกันก็ส่งผลให้สมบัติเชิงกลของเส้นใย กล่าวคือ ค่าความทนแรงดึงและค่าการยืดตัว ณ จุดขาดของเส้นใยมีแนวโน้มลดลง เส้นใยที่ผ่านกระบวนการได้ปจะมีสมบัติการนำไฟฟ้าที่สูงขึ้นอยู่ในระดับ 10^{-3} ซีเมนต์ต่อตารางเซนติเมตรและสมบัติเชิงกลที่ดีขึ้น จากการศึกษาเพิ่มเติมพบว่า ค่าสมบัติการนำไฟฟ้าของเส้นใยเพิ่มขึ้น เมื่อเส้นใยถูกดึงยืดออกภายใต้ระยะยืดตัวที่ร้อยละ 600 นอกจากนี้ยังได้นำเส้นใยคอมโพสิตดังกล่าวไปศึกษาสมบัติเชิงกลภายใต้สนามไฟฟ้า ผลการทดลองแสดงให้เห็นว่า เส้นใยคอมโพสิตระหว่างยางธรรมชาติและพอลิอะนิลีน สามารถแสดงการโค้งงอตอบสนองต่อสนามไฟฟ้าได้

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