

**PREPARATION OF BACTERIAL CELLULOSE SHEETS WITH
ELECTRICAL AND MAGNETIC PROPERTIES**



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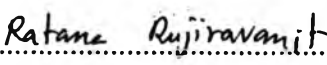
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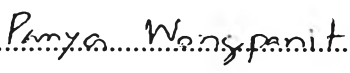

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ABSTRACT

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Keywords: Bacterial cellulose/ *Acetobacter xylinum*/ Polyaniline/ Magnetite particles

Polyaniline (PANI) was synthesized via chemical oxidative polymerization using ammonium persulfate as an oxidizing agent and in the presence of bacterial cellulose (BC) during the polymerization to obtain BC sheets with electrical properties. Magnetite particles (Fe_3O_4) were synthesized by co-precipitation method, using ammonia gas as precipitating agent and again in the presence of BC to obtain BC sheets with magnetic properties. The BC sheets were produced from *Acetobacter xylinum* TISTR 975. The chemical and physical characterization of resultant sheets were carried out using SEM, FT-IR, TG-DTA, XRD, two point probe electrometer, and VSM. SEM micrographs revealed that PANI covered the surfaces of the BC surface. Characteristic peaks of both the BC and PANI were observed in the FT-IR spectra of the BC sheets containing PANI. The TG-DTA curves showed the thermal stability of the BC sheets with PANI was increased as compared to that of the pure BC sheet. A maximum electrical conductivity of 6.17 S/cm was observed for the BC sheet with PANI polymerized by using an aniline monomer content of 30 %wt. Saturated magnetization of BC containing Fe_3O_4 (in the absence of PANI) increased from 3.14 to 18.38 emu g^{-1} with increasing the initial concentration of iron precursors from 0.05 to 0.20 M. Moreover, BC containing Fe_3O_4 both with and without the incorporating of PANI showed super-paramagnetic behavior with coercivity less than 100 Oe. This work introduced a facile method for the preparation of BC sheets with electrical and magnetic properties.

บทคัดย่อ

ปวีณา วงศ์สกุล : การเตรียมแผ่นเส้นใยเซลลูโลสที่สังเคราะห์จากเชื้อแบคทีเรียที่มีคุณสมบัติทางไฟฟ้า และทางแม่เหล็ก (Preparation of Bacterial Cellulose Sheets with Electrical and Magnetic Properties) อ. ที่ปรึกษา: รศ.ดร. รัตนา รุจิรวนิช และ ศ.ดร. ฮิโรชิ ทามูระ 99 หน้า

พอลิอะนิลีน (Polyaniline) และอนุภาคแม่เหล็กชนิดแม่เหล็กไนท์ (Magnetite particles, Fe_3O_4) ได้ถูกสังเคราะห์ขึ้น โดยให้องค์ประกอบดังกล่าว ติดอยู่บนแผ่นแบคทีเรียเซลลูโลส ซึ่งเป็นเส้นใยเซลลูโลสที่สังเคราะห์จากเชื้อแบคทีเรีย (*Acetobacter Xylinum*) เพื่อแก้ไขปัญหาในเรื่องของการขึ้นรูปของวัสดุทั้งสอง อีกทั้งทำให้ได้แบคทีเรียเซลลูโลส ที่มีทั้งคุณสมบัติทางไฟฟ้าและคุณสมบัติทางแม่เหล็กขึ้น พอลิอะนิลีนซึ่งเป็นองค์ประกอบที่ทำให้เกิดคุณสมบัติทางไฟฟ้า ถูกสังเคราะห์ขึ้นจากอะนิลีน โมโนเมอร์ โดยอาศัยปฏิกิริยา Oxidative polymerization ส่วนอนุภาคแม่เหล็กชนิดแม่เหล็กไนท์ซึ่งเป็นองค์ประกอบที่ทำให้เกิดคุณสมบัติทางแม่เหล็ก ถูกสังเคราะห์ด้วยวิธีการตกตะกอนด้วยเบส โดยใช้ Fe^{2+} และ Fe^{3+} เป็นสารตั้งต้น ในงานวิจัยนี้ได้ศึกษาถึงลักษณะทางสัณฐานวิทยา โครงสร้างทางเคมี ความเสถียรทางความร้อน สมบัติทางไฟฟ้า สมบัติทางแม่เหล็ก และการตอบสนองต่อสนามไฟฟ้าของวัสดุดังกล่าว ซึ่งจากการศึกษาลักษณะทางสัณฐานวิทยาโดยเทคนิค SEM ของแผ่นแบคทีเรียเซลลูโลสที่มีพอลิอะนิลีนอยู่ด้วยนั้น พบว่า พอลิอะนิลีนสามารถคลุมผิวของเส้นใยเซลลูโลสได้อย่างทั่วถึง อีกทั้งความหนาของชั้นพอลิอะนิลีนสูงขึ้น เมื่อปริมาณการใส่อะนิลีน โมโนเมอร์ในการสังเคราะห์สูงขึ้น ความเสถียรทางความร้อนสูงขึ้นเมื่อมีพอลิอะนิลีน หรือ อนุภาคแม่เหล็กไนท์อยู่บนแผ่นแบคทีเรียเซลลูโลส สำหรับการศึกษาสมบัติทางไฟฟ้าของนั้น พบว่า แผ่นแบคทีเรียเซลลูโลสที่มีพอลิอะนิลีนที่สังเคราะห์จากอะนิลีน โมโนเมอร์ 30% โดยน้ำหนัก มีค่าการนำไฟฟ้าสูงที่สุดที่ 6.17 s/cm และสมบัติทางแม่เหล็ก โดยเทคนิค VSM พบว่า ค่า Saturated magnetization, M_s ของแผ่นเส้นใยเซลลูโลสที่มีอนุภาคแม่เหล็กไนท์อยู่ด้วย จะมีค่าสูงขึ้นเมื่อความเข้มข้นของไอออน Fe^{2+} และ Fe^{3+} ที่ใช้ในการสังเคราะห์เพิ่มสูงขึ้น และพบอีกว่าทุกชิ้นงานมี hysteresis loop ที่เล็กมาก อีกทั้ง มีค่า coercivity; $H_c = \sim 59.51-82.26$ Oe ที่ต่ำ ซึ่งการสมบัติที่กล่าวมาข้างต้นนั้น จะเห็นได้ว่างานวิจัยนี้สามารถที่จะสังเคราะห์แผ่นของเส้นใยเซลลูโลสที่สังเคราะห์จากแบคทีเรียที่มีคุณสมบัติที่น่าสนใจ ที่เหมาะต่อการนำไปประยุกต์ใช้กับเทคโนโลยีขั้นสูงต่อไป

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