POLY(VINYLIDENE FLUORIDE)/BACTERIAL CELLULOSE NANOCOMPOSITE FILMS FOR TOUCH SENSOR APPLICATIONS

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ABSTRACT

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Flexible piezoelectric films of poly(vinylidene fluoride) (PVDF)/bacterial cellulose (BC) were successfully fabricated via solvent-casted and compression methods. The various weight percentage of BC (2.5-40 wt%) loading into PVDF matrix using dimethylformamide (DMF) as a solvent were studied on the basis of piezoelectric touch sensor. The crystalline phase of all PVDF/BC blend films were formed in both of α and β phase which mainly formed in piezoelectric β polymorph. The $PVDF_{90}BC_{10}$ was selected as a based nanocomposite to develop further due to this component demonstrated highest dielectric constant over other compositions at the frequency range of 10 MHz- 1 GHz and temperature of -50°C - 100°C. This research was firstly report the in-plane piezoelectric coefficient (d_{33}) of PVDF/BC blend films which as high as -11 pC/N. In order to achieve high piezoelectricity for piezoelectric touch sensor, the carboxyl multi-walled carbon nanotube (MWCNT) was introduced to enhance the d_{33} of $PVDF_{90}BC_{10}$. MWCNT has high ability to polarize along an applied electric field which yield to high dielectric constant about 72 at temperature about 80°C and frequency of 10 MHz. The addition of MWCNT 3 phr to $PVDF_{90}BC_{10}$ showed enhancing in d_{33} from -11 pC/N to -15 pC/N and exhibited highest remanent polarization (P_r) compared to other compositions. The combination of nano-network fiber implied a significant improving in thermal stability and dynamic mechanical properties due to intermolecular interaction among O- and F-atoms.

บทคัดย่อ

กมลชนก โอรักษ์ : ฟิล์มของวัสดุเชิงประกอบในระดับนาโนของพอลิไวนิลลิดีนฟลูออไรด์และแบคทีเรียเซลลูโลส สำหรับเซนเซอร์สัมผัส (Poly(vinylidene fluoride)/Bacterial Cellulose Nanocomposite Films for Touch Sensor Applications) อ. ที่ปรึกษา : ผศ.ดร. หทัยกานต์ มนัสปิยะ และ ศ.ดร. โมฮินิ เซน 93 หน้า

ฟิล์มเพียโซอิเล็กทริกแบบยืดหยุ่นเตรียมจากพอลิเมอร์ผสมระหว่างพอลิไวนิลลิดีนฟลูออไรด์และแบคทีเรียเซลลูโลส ถูกเตรียมโดยใช้การขึ้นรูปด้วยสารละลายและการบวนการอัดด้วยความร้อน วัสดุเชิงประกอบถูกเตรียมขึ้นโดยใช้สารละลายไดเมทิลฟอร์มาไมด์ในการช่วยให้แบคทีเรียเซลลูโลส กระจายตัวในเนื้อพอลิเมอร์หลัก ที่อัตราส่วนโดยน้ำหนักต่างๆ กัน เพื่อศึกษาสมบัติต่างๆ ที่เกี่ยวข้องการนำไปใช้ตรวจจับแรงสัมผัส พบว่าผลึกของพอลิไวนิลิดีนฟลูออไรด์ถูกจัดเรียง ในรูปแบบเบตามากกว่าแบบเอลฟา ซึ่งผลึกแบบเบตาสามารถแสดงสมบัติเพียโซอิเล็กทริกได้ดีที่สุด ฟิล์มของพอลิไวนิลลิดีนฟลูออไรด์และแบคทีเรียเซลลูโลส ในอัตราส่วน 90/10 ถูกนำมาใช้ศึกษาและปรับปรุงค่าไดอิเล็คทริกและเพียโซอิเล็ก โดยที่อัตราส่วนดังกล่าวแสดงค่าไดอิเล็กทริกสูงกว่าอัตราส่วนอื่นๆ ในช่วงความถี่ 10 MHz - 1GHz และช่วงอุณหภูมิ -50 ถึง 100 องศาเซลเซียส โดยค่าเพียโซอิเล็กทริก (d_{33}) ของฟิล์มเท่ากับ -11 pC/N เพื่อเพิ่มประสิทธิภาพ ฟิล์มจะต้องมีค่าเพียโซอิเล็กทริกที่สูง ในงานวิจัยนี้ ท่อนาโนคาร์บอนแบบผนังหลายชั้น ถูกนำมาใช้ในการเพิ่มค่า d_{33} ในพอลิเมอร์ผสมที่ต้องการศึกษา ซึ่งเป็นสารที่มีความสามารถในการโพลาไรซ์เมื่อถูกเหนี่ยวนำด้วยกระแสไฟฟ้า การเติมท่อนาโนคาร์บอนแบบผนังหลายชั้นทำให้เพิ่มค่าไดอิเล็กทริก สูงกว่าเมทริกถึง 9 เท่า จากการศึกษาพบว่า ปริมาณท่อนาโนคาร์บอนแบบผนังหลายชั้น 3 phr ส่งผลให้ค่า d_{33} สูงขึ้นจาก -11 เป็น -15 pC/N และค่าโพลาไรเซชันที่เหลืออยู่เมื่อไม่มีสนามไฟฟ้า มีค่าสูงขึ้นถึง 4 เท่า นอกจากนี้ การผสมเส้นใยโครงสร้างร่างแหในระดับนาโนของเซลลูโลสในสารผสม ยังเพิ่มความสามารถในการทนความร้อนและสมบัติเชิงกลพลวัต เนื่องจากแรงระหว่างโมเลกุลที่เกิดจาก อะตอมออกซิเจนและฟลูออรีน

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