DEVELOPMENT OF POLY(P-PHENYLENE)/CROSSLINKED POLY(ε-CAPROLACTONE) AS ELECTROACTIVE SHAPE MEMORY COMPOSITE

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ABSTRACT

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Electroactive shape memory composites are smart materials that change their shapes and recover their initial shapes in the presence of an applied electric field. In this work, the focus is on fabricating an electroactive shape memory composite consisting of iron (III) chloride doped poly(p-phenylene)(PPP)/crosslinked poly(ε-caprolactone) (cPCL) using benzoyl peroxide (BPO) as a crosslinking agent. In addition, thermal property, electrical conductivity, and electromechanical properties of the composite as a function of crosslinking ratio, doping level, and concentration of embedded PPP are investigated. The electromechanical properties show that 3%wt BPO cPCL gives the highest storage modulus response and electrical sensitivity. However, the electrical sensitivity decreases dramatically at 0.01%v/v of embedded PPP because of the increasing of initial storage modulus. Then start to increase with increasing the concentration of PPP which can be attributed to the increases of dipole moment induction in the presence of an external electrical stimulation.

บทคัดย่อ

ณภัทร จรูญรักษ์ : การเตรียมวัสดุเชิงประกอบจดจำรูปร่างที่ตอบสนองต่อสนามไฟฟ้าจากพอลิพาราฟีนิลีนและพอลิคาโปรแล็กโทน (Development of Poly(p-phenylene)/Crosslinked Poly(Ɛ-caprolactone) as Electroactive Shape Memory Composite) อาจารย์ที่ปรึกษา: ศ. ดร. อนุวัฒน์ ศิริวัฒน์ 126 หน้า

ในงานวิจัยนี้ได้ทำการศึกษาความเป็นไปได้ในการทำวัสดุเชิงประกอบที่ตอบสนองต่อสนามไฟฟ้าจากการผสมระหว่างพอลิคาโปรแล็กโทนซึ่งเป็นพอลิเมอร์กึ่งผลึกที่มีจุดหลอมเหลวต่ำ มีคุณสมบัติคล้ายยางและมีความยืดหยุ่นสูงกับอนุภาคพอลิพาราฟีนิลีนซึ่งเป็นคอนจุเกตเตดพอลิเมอร์ที่ง่ายต่อการสังเคราะห์และมีคุณสมบัตินำไฟฟ้า ในงานวิจัยนี้ไอออนคลอไรด์ถูกใช้เป็นสารโด๊ปเพื่อเพิ่มความมีขั้วและความสามารถในการนำไฟฟ้าให้กับพอลิพาราฟีนิลีนส่งผลทำให้วัสดุเกิดไดโพลโมเมนต์ได้ดีขึ้น นอกจากนี้ได้ทำการศึกษาผลกระทบของปริมาณของเบนโซอิลเปอร์ออกไซด์ซึ่งเป็นสารเชื่อมโยงเพื่อปรับปรุงคุณสมบัติเชิงกลของพอลิคาโปรแล็กโทน (0, 1, 3, 5, 7, และ 10% โดยน้ำหนัก) อัตราส่วนโมลของสารโด๊ปต่อพอลิพาราฟีนิลีนมอนอเมอร์ (uPPP, 1:30, 30:1, และ 100:1 dPPP) และปริมาณพอลิพาราฟีนิลีนที่ใส่ลงไปในวัสดุเชิงประกอบ (0.01, 0.05, 0.1, 0.5, และ 1.0% โดยปริมาตร) ต่อสมบัติทางความร้อนและการตอบสนองเชิงกลต่อสนามไฟฟ้า ผลการวิจัยพบว่าในกรณีของพอลิคาโปรแล็กโทนบริสุทธิ์ การตอบสนองเชิงกลต่อสนามไฟฟ้า ($\Delta G'$) และความไวต่อสนามไฟฟ้า ($\Delta G'/G'_0$) มีค่าสูงสุดเมื่อใช้สารเชื่อมโยงปริมาณร้อยละ 3 โดยน้ำหนักวัสดุเชิงประกอบที่ประกอบด้วยพอลิพาราฟีนิลีนปริมาณร้อยละ 0.01 โดยปริมาตร มีความไวต่อสนามไฟฟ้าต่ำลงเนื่องจากวัสดุมีความแข็งมากขึ้น อย่างไรก็ตามเมื่อใส่พอลิพาราฟีนิลีนมากขึ้นจะสามารถตอบสนองต่อสนามไฟฟ้าได้ดีขึ้นเนื่องจากปริมาณไดโพลโมเมนต์ที่ถูกเหนี่ยวนำในวัสดุภายใต้สนามไฟฟ้ามีมากขึ้น

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