

**ADMICELLAR POLYMERIZATION IN A CONTINUOUS STIRRED TANK  
REACTOR FOR SURFACE MODIFICATION OF SILICA: PROCESS  
OPTIMIZATION USING COMMERCIAL GRADE MIXED SURFACTANTS**

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**ABSTRACT**

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Silica is an alternative filler for use in rubber compounding. Unmodified silica, however, cannot directly form chemical bonds with rubber due to incompatibility between hydrophilic silica and hydrophobic rubber. Better compatibility can be achieved by admicellar polymerization. The present study examined the modification of amorphous precipitated silica, Hi-Sil<sup>®</sup>255, with a commercial grade mixed surfactant of a cationic surfactant, Arquad<sup>®</sup>T-50, and a nonionic surfactant, Teric<sup>®</sup>X-10. In addition, the effects of surfactant adsorbed:co-monomer (styrene-isoprene) adsolubilized ratio on adsolubilization and properties of rubber compound testing were investigated. The modified silica and synthesized copolymer were characterized by the BET, Particle Size Analyzer, TGA, GPC, AFM and Zeta potential meter techniques. The result revealed that the extent of the styrene-isoprene copolymer film and amount of copolymer formed on the silica particles increased with increasing surfactant adsorption and co-monomer adsolubilization. The admicellar polymerization process was able to increase the hydrophobicity of all modified silica by 60-90%. The compatibility between the rubber and modified silica was assessed by the improved mechanical performance of the composite material. All modified silica improved the overall rubber mechanical performance.

## บทคัดย่อ

นันทพร พิพิชวิทยา: การปรับผิวซิลิกาด้วยวิธีแอดไมเซลล์าร์พอลิเมอไรเซชันในเครื่องปฏิกรณ์แบบต่อเนื่อง: ผลกระทบของสารลดแรงดึงผิวเชิงการค้ำแบบผสม (Admicellar Polymerization in a Continuous Stirred Tank Reactor for Surface Modification of Silica: Process Optimization using Commercial Grade Mixed Surfactants) อ. ที่ปรึกษา: รศ. ดร. ปราโมช รังสรรค์วิจิตร, รศ. ดร. จอห์น เซอ โอ เฮเวอร์, รศ. ดร. สุเมธ ชวเดช, และ ดร.นุชนาฏ ณ ระนอง, 103 หน้า ISBN 974-9937-66-X

ซิลิกาเป็นสารเติมแต่งที่ใช้เป็นส่วนหนึ่งของยาง เพื่อปรับปรุงคุณสมบัติพิเศษ และเพิ่มความสามารถในการผสม แต่ซิลิกาที่ยังไม่ผ่านการปรับสภาพผิวจะไม่สามารถเกิดพันธะเคมีกับยางได้โดยตรงเนื่องจากพื้นผิวของซิลิกาไม่ชอบน้ำ อย่างไรก็ตามยางและซิลิกาสามารถเข้ากันได้ดีขึ้น โดยการปรับสภาพผิวของซิลิกาด้วยกระบวนการแอดไมเซลล์าร์พอลิเมอไรเซชัน โดยเครื่องปฏิกรณ์แบบต่อเนื่อง งานวิจัยนี้ศึกษาการปรับสภาพผิวของซิลิกา โดยใช้สารลดแรงดึงผิวเชิงการค้ำแบบผสมชนิดมีขั้วบวกคือ อาร์ควอด ที-50 และแบบไม่มีขั้วคือ เทอริก เอ็กซ์-10 เพื่อลดค่าใช้จ่ายในการปรับสภาพผิวซิลิกา จากการศึกษาพบว่าสัดส่วนโมลของการดูดซับของสารลดแรงดึงผิว ต่อ โมลของการแอดโซรึบิไลเซชันของสารอินทรีย์ผสม (สไตรีน-ไอโซพรีน) ที่ปริมาณการดูดซับของสารลดแรงดึงผิวต่างกันที่มีผลต่อคุณสมบัติยาง นอกจากนี้ปริมาณสไตรีน-ไอโซพรีนพอลิเมอร์มีมากขึ้น เมื่อปริมาณการดูดซับของสารลดแรงดึงผิวและปริมาณการแอดโซรึบิไลเซชันเพิ่มขึ้น กระบวนการแอดไมเซลล์าร์พอลิเมอไรเซชันสามารถปรับสภาพผิวของซิลิกาจากสภาพที่ชอบน้ำไปสู่สภาพที่ไม่ชอบน้ำได้ประมาณ 60-90% และจากผลการทดสอบคุณสมบัติยางที่ผสมกับซิลิกาที่ผ่านการปรับสภาพผิว พบว่ายางมีคุณสมบัติทางกลศาสตร์ดีขึ้น

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