# ฟิล์มไบโอฟังก์ชันนัลมัลทิเลเยอร์บนผิวซิลิกอนที่ติดด้วยพอลิแอคริลิกแอซิดบรัช

นางสาวสุดารัตน์ พุกบุญมี

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# BIOFUNCTIONAL MULTILAYER FILM ON SILICON SURFACE-TETHERED POLY(ACRYLIC ACID) BRUSHES

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A Thesis Submitted in Partial Fulfillment of the Requirements
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การประกอบฟิล์มแบบชั้นต่อชั้นนับเป็นวิธีที่มีประสิทธิภาพและมีขั้นตอนไม่ซับซ้อนในการดัดแปรพื้นผิวให้มีสมบัติตามต้องการ งานวิจัยนี้ใช้พอลิอะคริลิกแอซิด (พีเอเอ) บรัชที่ยึดติดบนพื้นผิวซิลิกอนด้วยพันธะโควาเลนท์เป็นสับสเตรทสำหรับการประกอบฟิล์มแบบชั้นต่อชั้นเพื่อเตรียมฟิล์มมัลทิเลเยอร์ของพอลิอิเล็กโทรไลท์ ได้แก่ ไคโตซาน พอลิอะคริลิกแอซิด และ พอลิ(10,12-เพนทาโคซาดิโนอิกแอซิด)เวสิคัล การริเริ่มปฏิกิริยาอะตอมทรานเฟอร์แรดิคัลพอลิเมอไรเซชันของเทอร์เทียรีบิวทิวอะคริเลตบนพื้นผิวตามด้วยปฏิกิริยาไฮโดรไลซิสในสภาวะกรด ทำให้ได้พีเอเอบรัชที่มีความหนาแน่นการกราฟท์สูงพอที่จะเหนี่ยวนำให้เกิดการยืดออกของโซ่พอลิเมอร์ ส่งผลให้ชั้นเดี่ยวที่ดูดซับมีความหนาตามไปด้วย ผลจากการทดลองแสดงให้เห็นว่าความหนาแต่ละชั้นและมัลทิเลเยอร์แปรผันเป็นสัดส่วนกับความหนาของพีเอเอบรัช ซึ่งสามารถเตรียมให้แต่ละชั้นมีความหนาได้มากถึง 10 นาโนเมตรเมื่อใช้ภาวะในการดูดซับที่เหมาะสม ข้อมูลจากการวิเคราะห์มุมสัมผัสและเอเอฟเอ็มบ่งบอกลักษณะการแยกชั้นของมัลติเลเยอร์ที่ประกอบขึ้น จากผลการศึกษาการดูดซับของโปรตีนพบว่าสามารถเปลี่ยนไบโอแอคติวิตีของฟิล์มมัลทิเลเยอร์ได้โดยการเปลี่ยนฟิล์มชั้นสุดท้ายที่ดูดซับ แนวทางในการวิจัยนี้เป็นประโยชน์อย่างยิ่งต่อการประยุกต์ใช้งานที่ต้องการฟิล์มที่เสถียรซึ่งมีความหนาในระดับนาโนเมตรโดยไม่ต้องใช้จำนวนรอบในการดูดซับหลายรอบ

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KEYWORD: POLYMER BRUSH/ POLY(ACRYLIC ACID)/ SURFACE-INITIATED POLYMERIZATION/ LAYER-BY-LAYER/ MULTILAYER

SUDARAT POOKBOONMEE: BIOFUNCTIONAL MULTILAYER FILM ON SILICON SURFACE-TETHERED POLY(ACRYLIC ACID) BRUSHES. THESIS ADVISOR: ASSISTANT PROFESSOR VORAVEE P. HOVEN, Ph.D. THESIS CO-ADVISER: DR. NUTTHA THONGCHUL 103 pp.

Layer-by-layer assembly of oppositely charged polyelectrolytes has been recognized as a powerful, yet simple strategy to engineer surfaces with specific properties. In this contribution, poly(acrylic acid) (PAA) brushes covalently tethered to the silicon surface was used as a substrate for layer-by-layer assembly of selected polyelectrolytes, chitosan, poly(acrylic acid) and poly(10,12-pentacosadiynoic acid) vesicles to generate multilayer films. Generated by surface-initiated atom transfer radical polymerization of *tert*-butyl acrylate followed by acid hydrolysis, the graft density of the PAA brushes was high enough to induce chain stretching allowing a thicker individual adsorbed layer to be formed. It was demonstrated that the thickness of each individual layer and multilayer varied in proportion to the thickness of the PAA brushes. An increment of up to 10 nm in thickness of the individual layer can be achieved under an appropriate adsorption condition. The contact angle and AFM data suggested that the assembled multilayer film was stratified. According to protein adsorption studies, the bioactivity of the multilayer film can be tailored by changing the last polyelectrolyte deposited. This approach offers a great benefit for applications which require fabrication of stable nanometer-thick film without having to use many cycles of deposition.

Field of study Petrochemistry and Polymer Science Student's signature Sudarat Pookboonmee
Academic year 2006 Advisor's signature Vp. Hoven
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# LIST OF ABBREVIATIONS

AFM : Atomic force microscopy
ATRP : Atom transfer radical polymerization
Å : Ångström = 0.1 nm
*t*-BA : tert-Butyl acrylate
$CDCl_3$ : Deuterated chloroform
CHI : Chitosan
CuBr : Copper (I) bromide
°C : Degree Celsius
$D_2O$ : Deuterium oxide
DP : Degree of polymerization
Eq. : Equation
GPC : Gel permeation chromatography
$k_{act}$ : The activation rate parameter
$k_{deact}$ : The deactivation rate parameter
LBL : Layer-by-Layer
MeOH : Methanol
$MgSO_4$ : Magnesium sulfate
$\overline{M}_n$ : Number average molecular weight
$\overline{M}_w$ : Weight average molecular weight
nm : nanometer
NMR : Nuclear magnetic resonance spectroscopy
PMDETA : *N, N, N′, N″, N″*-pentamethyldiethylenetriamine
PAA : Poly(acrylic acid)
PDI : Polydispersity Index
PCDA : 10,12-pentacosadiynoic acid
PEL : polyelectrolyte
PPCDA : poly 10,12-pentacosadiynoic acid
P*t*-BA : Poly(*tert*-butyl acrylate)

SAM : Self-assembled monolayer
SIP : surface-initiated polymerization
THF : Tetrahydrofuran