

PREPARATION OF SILVER NANOPARTICLE THIN FILMS FOR SENSING APPLICATIONS

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Department of Materials Science

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การเตรียมฟิล์มบางของอนุภาคนาโนซิลเวอร์สำหรับการประยุกต์ทางการรับรู้



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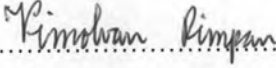
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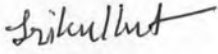
  
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อนุภาคนาโนซิลเวอร์สามารถเตรียมได้จากปฏิกิริยารีดักชันของซิลเวอร์ในเตรตด้วยไซ-  
เดียมโบโรไฮไดรด์ ในภาวะที่มีพอลิเล็กโทรไลต์ซึ่งทำหน้าที่เป็นสารจับอนุภาคชนิดของพอลิเล็ก-  
โทรไลต์ที่ใช้ ได้แก่ กลีโอสเตียมของพอลิเมทาครีแอต กรดกลีโอสเตียมของพอลิอะคริลิกแอต กรด  
ไซเดียมของพอลิ 4-สไตรีนซัลโฟนิคแอต ไซเดียมแอลจีเนต และกรดฮิวมิก โดยปรับเปลี่ยนความ  
เข้มข้นตั้งแต่ 0.1, 0.5, 1, 5 และ 10 มิลลิโมลาร์ สารละลายที่ได้ทั้งหมดแสดงแถบพลาสมอน ที่เข้ม  
ณ ความยาวคลื่น 400 นาโนเมตร ซึ่งเป็นการยืนยันการเกิดอนุภาคนาโนซิลเวอร์ การเตรียมฟิล์ม  
บางจากอนุภาคนาโนซิลเวอร์นี้ทำได้โดยใช้เทคนิคเลเยอร์บายเลเยอร์ ทั้งนี้ เวลาในการจุ่ม การเจือ  
จาง และแรงไอออไนซ์ของสารละลายต่างส่งผลต่อการเติบโตของฟิล์ม ผลของการวัดรอยบ่มระดับ  
นาโนแสดงให้เห็นว่าความแข็งของฟิล์มลดลงเมื่อความเข้มข้นของสารจับอนุภาคที่ใช้ในการเตรียม  
อนุภาคนาโนซิลเวอร์มีค่าต่ำ

การทดสอบสมบัติการรับรู้ของอนุภาคนาโนซิลเวอร์ทำในรูปแบบของสารละลาย และ  
ฟิล์มบาง โดยพบว่า เฉพาะฟิล์มที่เตรียมในภาวะที่ความเข้มข้นของสารจับอนุภาคเป็น 0.1 มิลลิโม-  
ลาร์เท่านั้นที่สามารถใช้สำหรับการรับรู้ต่อสารอินทรีย์ นอกจากนี้ ยังพบว่า ณ ความเข้มข้นนี้  
สารละลายของอนุภาคนาโนซิลเวอร์ที่จับด้วยไซเดียมแอลจีเนตมีความไวต่อสารอินทรีย์สูงสุด และ  
ฟิล์มของอนุภาคนาโนซิลเวอร์ชนิดนี้ แสดงการเปลี่ยนของสีจากเหลืองในน้ำเป็นแดงในเมทานอล  
หรือเอทานอล โดยการรับรู้ที่ดีที่สุดเกิดขึ้นเมื่ออัตราส่วนของแอลจีเนตต่อซิลเวอร์ในเตรตเป็น 0.1:1  
ในกรณีของการรับรู้ต่อสารฆ่าวัชพืช พบว่า สีของสารละลายอนุภาคนาโนซิลเวอร์ที่จับด้วยกรดฮิว-  
มิกเปลี่ยนแปลงจากสีเหลืองเป็นส้มแดง และม่วง เมื่อความเข้มข้นของสารฆ่าวัชพืช เพิ่มขึ้น นอก  
จากนี้ การปรับความไวต่อการรับรู้ของฟิล์มยังสามารถทำได้โดยการดัดแปรผิวของฟิล์มด้วยพอลิ  
เมอร์ที่เป็นพอลิแคตไอออนิก

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ลายมือชื่อนิสิต.....  
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## 487 38551 23 : MAJOR MATERIALS SCIENCE

KEY WORD: SILVER / NANOPARTICLES / LAYER-BY-LAYER / SENSORS / FILMS

Mr. STEPHAN THIERRY DUBAS : PREPARATION OF SILVER NANOPARTICLE THIN FILMS FOR SENSING APPLICATIONS. THESIS ADVISOR: ASSOCIATE PROFESSOR VIMOLVAN PIMPAN, Ph.D., 131 pp.

Silver nanoparticles were prepared by the reduction of silver nitrate with sodium borohydride in the presence of a polyelectrolyte acting as a capping agent. Different polyelectrolytes were used including poly(methacrylic acid, sodium salt), poly(acrylic acid, sodium salt), poly(4-styrene sulfonic acid-co-maleic acid, sodium salt), sodium alginate and humic acid. Their concentrations were varied from 0.1, 0.5, 1, 5 and 10 mM. All prepared solutions exhibited a strong plasmon band at the wavelength of 400 nm confirming the formation of silver nanoparticles. Layer-by-layer technique was used to deposit silver nanoparticles into thin films. The growth of these films was affected by the dipping time, the dilution and the ionic strength of the solution. Nanoindentation measurements revealed that the film hardness decreased when lower concentrations of capping agents were used in the preparation of the silver nanoparticles.

Sensing properties of silver nanoparticles were then investigated in the forms of solution and thin film. It was found that only nanoparticles prepared in the presence of 0.1 mM of capping agents could be used for organic compound sensing. It was also observed that at this concentration, alginate-capped silver nanoparticle solution had the highest sensitivity to organic compounds while its thin film displayed a strong color shift from yellow in water to red in methanol and ethanol. The best detection was achieved when the ratio of alginate:silver nitrate was 0.1:1. In the case of herbicide sensing, it was found that the color of humic acid-capped silver nanoparticle solution changed from yellow to orange red and purple with increasing herbicide concentration. Furthermore, an improvement of the sensing sensitivity of the film could be done by the modification of film surface with a layer of polycationic polymer.

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## LIST OF ABBREVIATIONS

PE	:	Polyelectrolyte
PEM	:	Polyelectrolyte multilayer layers
LbL	:	Layer-by- layer
PDADMAC	:	Poly(diallyldimethylammonium chloride)
CoPSS	:	Poly(styrene sulfonate-co-maleic acid, sodium salt)
Alginate	:	Sodium alginate
PMA	:	Poly(methacrylic acid sodium salt)
PAA	:	Poly(acrylic acid, sodium salt)
HA	:	Humic acid
PSS	:	Poly(styrene sulfonate, sodium salt)
PNO4VPI	:	Poly (N-octyl-4-vinyl pyridinium iodide)
SPEEK	:	Sulfonated poly(ether-ether ketone)
mM	:	milli Molar
V	:	Volts
$\mu\text{m}$	:	Micrometer
nm	:	nanometer
TEM	:	Transmission electron microscope
AFM	:	Atomic force microscope
LSPR	:	Localized surface plasmon resonance
UV-Vis	:	Ultra violet-visible