

Synthesis and Characterization of Nanographite and Graphene for pH Sensor

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หัวข้อวิทยานิพนธ์	การสังเคราะห์และการศึกษาลักษณะของนาโนแกรไฟต์และแกรฟีนสำหรับใช้เป็นเซนเซอร์ตรวจจับความเป็นกรดต่าง
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บทคัดย่อ

นาโนแกรไฟต์สามารถเตรียมได้โดยการโซนิกเกรฟไฟต์ในน้ำกลั่น เวลาที่ใช้ในการโซนิกที่แตกต่างกัน ซึ่งประกอบด้วย 3, 6, 12, 36 และ 72 ชั่วโมง จะส่งผลต่อความหนาของนาโนแกรไฟต์ เมื่อเวลาในการโซนิกมากขึ้นจะส่งผลให้สารแขวนลอยของนาโนแกรไฟต์มีความเป็นเนื้อเดียวกันและความเข้มข้นของนาโนแกรไฟต์ที่หาค่าเพิ่มขึ้น สารแขวนลอยที่เสถียรได้มาจากการโซนิกเป็นเวลา 36 และ 72 ชั่วโมง โดยแสดงให้เห็นเป็นสารละลายสีเทาเป็นเวลามากกว่า 3 เดือน แกรฟีนออกไซด์ซึ่งมีสีเหลืองน้ำตาลถูกเตรียมโดยวิธีของฮัมเมอร์ จากนั้นแกรฟีนออกไซด์จะถูกรีดิซ์โดยการเติมด้วยไฮดราซีน ไฮเดรตและส่งผลให้สารแขวนลอยกลายเป็นสีดำ ความหนาของและลักษณะทางสัณฐานวิทยาของนาโนแกรไฟต์และรีดิซ์แกรฟีนออกไซด์สามารถตรวจสอบได้โดยใช้ scanning electron microscopy, atomic force microscopy และ transmission electron spectroscopy ลักษณะทางแกรไฟต์ของนาโนแกรไฟต์และรีดิซ์แกรฟีนออกไซด์ศึกษาโดยใช้ UV-visible spectroscopy และ Raman spectroscopy ในการสร้างเซนเซอร์ตรวจจับความเป็นกรดต่างจะใช้นาโนแกรไฟต์ที่เตรียมจากการโซนิกเป็นเวลา 72 ชั่วโมง (อุปกรณ์ A) และรีดิซ์แกรฟีนออกไซด์ (อุปกรณ์ B) หยดลงบนอิเล็กโทรดและอบให้แห้งในเตาอบ (75°C) เพื่อฟอร์มตัวเป็นฟิล์มบนอิเล็กโทรด ค่าความต้านทานไฟฟ้าของอุปกรณ์ทั้งสองถูกวัดและเปรียบเทียบกันหลังจากสัมผัสกับของเหลวที่มีค่าพีเอชต่าง ๆ ในช่วง 1-14 ค่าความต้านทานไฟฟ้าของเซนเซอร์ทั้งสองมีค่าลดลงเมื่อค่าพีเอชสูงขึ้น โดยค่าความสามารถในการตรวจจับของเซนเซอร์ซึ่งมีค่า 220 และ 2.30 kΩ pH⁻¹ ได้มาจากเซนเซอร์ที่สร้างจากนาโนแกรไฟต์และรีดิซ์แกรฟีนออกไซด์ตามลำดับ

คำสำคัญ : แกรฟีน / วิธีฮัมเมอร์ / นาโนแกรไฟต์ / เซนเซอร์ตรวจจับความเป็นกรดต่าง / โซนิเคชัน

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Abstract

Nanographites were successfully prepared by sonicating of the bulk graphite in distilled water. Effect of different sonication times with 3, 6, 12, 36 and 72 hours on thickness of nanographite was reported. Longer time of sonication enhanced the suspension homogeneity and increased the concentration of exfoliated nanographite. The stable suspensions were obtained from 36 and 72 hours of sonication, which represented gray suspension for more than 3 months. The graphene oxide with yellow brown color was prepared by Hummers' method. Then, reduced graphene oxide was obtained by adding hydrazine hydrate and the suspension became black. The thickness and morphology of nanographite and reduced graphene oxide were investigated by scanning electron microscopy, atomic force microscopy and transmission electron spectroscopy. Graphitic characteristics of the nanographite and reduced graphene oxide were studied by UV-visible spectroscopy and Raman spectroscopy. To fabricate a pH sensor, nanographite prepared from 72 hours of sonication (device A) and reduced graphene oxide (device B) were dropped on the electrodes and dried in the oven (75°C) to form thin films on the electrodes. The electrical resistance of both devices was measured and compared after in contact with liquid of different pH values, ranging from 1 to 14. The electrical resistance of both devices decreased with increasing pH values. The sensitivity of 220 and 2.30 k Ω pH⁻¹ was obtained for nanographite- and reduced graphene oxide-based pH sensors, respectively.

Keywords : Graphene / Hummers' Method / Nanographite / pH Sensor / Sonication

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LIST OF SYMBOLS

nm	Nanometer
μm	Micrometer
$^{\circ}\text{C}$	Degree Celsius
mL	Milliliter
mg	Milligram
DI	Deionized
K	Kelvin
atm	Atmosphere
rpm	Round per minute
min	Minute
TPa	Terra Pascal
E	Energy of photon
h	Planck's constant
ν	Frequency
A	Absorbance
I_0	Intensity of light incident upon sample cell
I	Intensity of light leaving sample cell
C	Molar concentration of solute
L	Length of sample cell
ϵ	Molar absorptivity
I_D/I_G	Intensity ratio of the D and G bands
E_l	Excitation laser energy
eV	Electron volt
i_c	Current of capacitor
C	Capacitance
V_c	Voltage of capacitor
R	Resistance
V	Voltage
I	Current
ΔpH	pH resolution
σ_{max}	Maximum standard deviation
k	Sensitivity