ผลของสารโดปต่อสมบัติทางแสงและการนำไฟฟ้าของพอลิ(3-เฮกซิลไทโอฟีน)

นางสาววรรณา บรรณรักษ์กุล

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EFFECTS OF DOPING AGENTS ON OPTICAL AND CONDUCTIVE PROPERTIES OF POLY(3-HEXYLTHIOPHENE)

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งานวิจัยนี้เป็นการศึกษาการโดปพอลิ(3-เฮกซิลไทโอฟีน) ด้วยวิธีการต่างๆ ได้แก่ การโดปด้วยกรด การโดปด้วยตัวออกซิไดซ์ และการโดปแบบโซลวาโต-คอนโทรล แล้วนำผลิตภัณฑ์ที่ได้มาวิเคราะห์โดยใช้เทคนิค ทางสเปกโทรสโคปีต่างๆ จากนั้นจึงนำมาวิเคราะห์สมบัติการนำไฟฟ้าในสภาพสารละลายและฟิล์ม จากการทดลองพบว่า สามารถใช้กรดในการโดป พอลิ(3-เฮกซิลไทโอฟีน) เพื่อเพิ่มค่าการนำไฟฟ้าได้ทั้งในรูปแบบของสารละลายและแผ่นฟิล์ม จากการโดปด้วยตัวออกซิไดซ์พบว่า การผสมยูเรียไฮโดรเจนเปอร์ออกไซด์และกรดไตรฟลูออโรอะซิติกก่อนนำมาออกซิไดซ์ จะได้พอลิ(3-เฮกซิลไทโอฟีน)ซึ่งมีค่าการดูดกลืนแสงยูวี-วิสิเบิลที่ความยาวคลื่นสูงกว่าเดิม ส่วนการโดปแบบโซลวาโต-คอนโทรลด้วยกรดมีเทนซัลโฟนิก และไทโอฟีน จะสามารถขึ้นฟิล์มของพอลิเมอร์ที่ถูกโดปได้โดยไม่เกิดปัญหาการตกตะกอน ได้นำการคำนวณ เอซี-อินเด็กซ์ มาใช้เพื่อติดตามการเปลี่ยนแปลงการดูดกลืนแสงในช่วงยูวี-วิสิเบิลอันเนื่องมาจากการโดป ซึ่งสัมพันธ์กับความยาวคอนจูเกตของพอลิเมอร์ พบว่าสามารถใช้ในการติดตามการโดปได้ทั้งการใช้กรดและปฏิกิริยาออกซิเดชัน โดยค่าเอซี-อินเด็กซ์ที่ได้สอดคล้องกับผลจากการใช้ค่าความยาวคลื่นสูงสุดของยูวี-วิสิเบิล สเปกตรัม และค่าการนำไฟฟ้าอีกด้วย

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WANNA BANNARUKKUL: EFFECTS OF DOPING AGENTS ON OPTICAL AND CONDUCTIVE PROPERTIES OF POLY(3-HEXYLTHIOPHENE). THESIS ADVISOR: ASSIST. PROF. WORAWAN BHANTHUMNAVIN, Ph.D., THESIS COADVISOR: ASSIST. PROF. YONGSAK SRITANA-ANANT, Ph.D., 123 pp. ISBN 974-17-4083-2.

This research investigated various doping methods of poly(3-hexylthiophene) including acid, oxidative and, solvato-controlled doping. The doped products were subjected to many spectroscopic analysis and conductivity measurements in the form of either a solution or a film. The acid doping was found to increase the conductivity of both the solution and film of poly(3-hexylthiophene). For oxidative doping, premixed urea hydrogenperoxide and trifluoroacetic acid could oxidize poly(3-hexylthiophene) to yield the polymer with bathochromic shift of λ_{max}. Solvato-controlled doping with methanesulfonic acid and thiophene gave the film of dope polymer without pre-precipitation problem. The AC-index calculation was used for monitoring the change in UV-visible absorption induced by doping that could be related to the effective conjugation length of the polymer. It was found that AC-index calculation was applicable with the monitoring of acid and oxidative doping process. Their values corresponded well with the results from λ_{max} of UV-visible spectra and conductivity.

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LIST OF ABBREVIATIONS

[o]	: oxidation
°C	: degree celsius
μL	: microliter
μmol	: micromole
A	: absorbance
CA	: chloroacetic acid
$CDCl_3$	: deuterated chloroform
$CHCl_3$	: chloroform
CH_2Cl_2	: dichloromethane
CH_3CN	: acetonitrile
CH_3COOH	: acetic acid
cm^{-1}	: per centimeter
DCA	: dichloroacetic acid
dppe	: 1,2-bis(diphenylphosphino)ethane
$FeCl_3$	: ferric chloride
g	: gram
GPC	: gel permeation chromatography
HCl	: hydrochloric acid
HH	: head to head
H_2O_2	: hydrogen peroxide
hr	: hour
HT	: head to tail
IR	: infrared spectrophotometer
M_n	: number average molecular weight
M_w	: weight average molecular weight
MeOH	: methanol
mg	: milligram
min	: minute
mL	: milliliter

mmol	: millimole
MSA	: methanesulfonic acid
NaOH	: sodium hydroxide
nm	: nanometre
NMR	: nuclear magnetic resonance spectroscopy
P3AT	: poly(3-alkylthiophene)
P3HT	: poly(3-hexylthiophene)
ppm	: part per million
PT	: polythiophene
S	: siemen
TCA	: trichloroacetic acid
TFA	: trifluoroacetic Acid
THF	: tetrahydrofuran
TsOH	: toluene-4-sulfonic acid
$TsOH \cdot H_2O$	: toluene-4-sulfonic acid monohydrate
TT	: tail to tail
UHP	: urea Hydrogen Peroxide
UV	: ultra-violet