PIEZOELECTRIC ENHANCEMENT OF PVDF FILMS BY INDUCED INTERNAL BUBBLE SHAPES

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A Thesis Submitted in Partial Fulfilment of the Requirements
for the Degree of Master of Science
The Petroleum and Petrochemical College, Chulalongkorn University
in Academic Partnership with
The University of Michigan, The University of Oklahoma,
and Case Western Reserve University
2008

Thesis Title:	Piezoelectric Enhancement of PVDF Films by Induced Internal Bubble Shapes
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ABSTRACT

4972005063: Polymer Science Program
Ditthapun Suwansumpan: Piezoelectric Enhancement of PVDF Films by Induced Internal Bubble Shapes.
Thesis Advisors: Asst. Prof. Hathaikarn Manuspiya and Prof. Amar S. Bhalla 131 pp.
Keywords: Poly(vinylidene fluoride) / Microporous / Phase inversion /AZDC blowing agent / Dielectric properties / Piezoelectric coefficient

In this research, the effect of induced internal bubble shapes on dielectric behavior and piezoelectric properties in polyvinylidene fluoride (PVDF) was studied. The bubbles were created inside PVDF films by thermal phase inversion and AZDC blowing agent techniques. Subsequently, internal bubble shapes were observed using SEM and OM. The dielectric constant and the loss tangent of porous PVDF films were measured as a function of frequency range, 1 kHz-10 MHz, at room temperature by an impedance/gain-phase analyzer in different % porosities, sizes, structures, and shapes of bubbles. It was found that at high frequency the ellipsoid bubble shape showed more promising data, including a higher dielectric constant, less relaxation with frequency, and lower dielectric loss than spherical shaped. Also, the measured dielectric constant is fitted well with the Yamada model indicating 0-3 connectivity in PVDF/air bubble composites. Moreover, the ellipsoid shape can enhance the piezoelectric properties more than the spherical shape in PVDF films. Consequently, the PVDF with internal bubbles can be proposed as another candidate to use instead of ceramic-filled PVDF in lightweight piezoelectric applications.

บทคัดย่อ

ดิตถพันธ์ สุวรรณสัมพันธ์ : การเพิ่มค่าสัมประสิทธิ์เพียโซอิเล็คตริกของฟิล์มโพลิไวนิลลิดีนฟลูออไรด์โดยศึกษาผลของรูปร่างฟองอากาศภายใน Piezoelectric Enhancement of PVDF Films by Induced Internal Bubble Shapes) อ. ที่ปรึกษา ผศ.ดร.หทัยกานต์ มนัสปิยะ และ ศ.ดร. อมาร์ เอส บาล่าร์ 131 หน้า

ในงานวิจัยนี้ ได้ศึกษารูปร่างของฟองอากาศที่มีผลต่อพฤติกรรมไดอิเล็คตริก เฟอโรอิเล็คตริก และ เพียโซอิเล็คตริกของฟิล์มโพลิไวนิลลิดีนฟลูออไรด์(PVDF) ที่ถูกใส่ฟองอากาศเข้าไปข้างใน โดยใช้วิธี การกลับวัฏภาค (phase inversion) และ การเติมสารทำให้เกิดฟอง (blowing agent) ซึ่งโครงสร้างของคอมพอสิตจะถูกวิเคราะห์ด้วยกล้องจุลทรรศน์อิเล็กตรอนแบบส่องกราด (SEM) และกล้องจุลทรรศน์แบบแสง (OM) สำหรับค่าไดอิเล็คตริกและค่าการสูญเสียทางไดอิเล็คตริกของคอมพอสิตนี้จะถูกศึกษาในช่วงความถี่ (1 กิโลเฮิร์ท-10 เมกกะเฮิร์ท) ที่อุณหภูมิปกติ โดยมีอิทธิพลของ ปริมาณ, ขนาด, สัณฐานวิทยา และ รูปร่างของฟองอากาศที่แตกต่างกัน จากการทดสอบพบว่า ในช่วงความถี่ที่สูง ฟองอากาศในรูปแบบวงรี ให้ค่าไดอิเล็คตริกที่สูงขึ้น และให้ค่าการสูญเสียทางไดอิเล็คตริกที่น้อยกว่ารูปแบบวงกลม อีกทั้งฟองอากาศในรูปแบบวงรี ยังเพิ่มค่าสัมประสิทธิ์เพียโซอิเล็คตริกได้มากกว่ารูปแบบวงกลม นอกจากนี้แล้วยังได้พบว่า วัสดุคอมพอสิตระหว่างโพลิไวนิลลิดีนฟลูออไรด์และฟองอากาศนั้น เป็นการคอมพอสิตแบบ 0-3 โดยเทียบจากแบบสมการของยามาตะ ซึ่งวัสดุคอมพอสิตนี้ จะเป็นทางเลือกหนึ่งในการใช้งานทางเพียโซอิเล็คตริก ที่ต้องการน้ำหนักเบา ทนความร้อนและสารเคมีได้ดี

ACKNOWLEDGEMENTS

This thesis work is funded by the Petroleum and Petrochemical College, Polymer Processing and Polymer Nanomaterial Research Units, and the National Excellence Center for Petroleum, Petrochemicals, and Advanced Materials, Thailand.

First of all, I would like to express my profound gratitude to my advisors, Asst. Prof. Hathaikarn Manuspiya and Prof. Amar S. Bhalla for their invaluable support, encouragement, supervision, useful suggestions, valuable guidance, vital help and endless kindness throughout this research. Also, the author deeply thanks to all other committee members, Assoc. Prof. Rathanawan Magaraphan and Dr. Pitak Laoratanakul for taking time to serve on the committee and their valuable comments on thesis.

My special acknowledgement is expressed to Mr. Boonchana Mangkonkarn and Solvay Co, Ltd., for providing the PVDF materials to carry out this research. Gratitude is also extended to National Metal and Materials Technology Center (MTEC) for the electrical measurement and MTEC staffs for providing useful suggestion.

My sincere thanks go to all of the Petroleum and Petrochemical College's faculties who have tendered invaluable knowledge and go to the college staffs who give him invaluable assistance.

Memorable, the author would like to take this opportunity to thank all his PPC friends for their friendly assistance, cheerfulness, creative suggestions, and encouragement.

Last but not least, I warmly thank to all my family specially my father and my mother for their love, understanding and never lasting support during all these years. There are no words to express my gratitude to them and I love them for believing in me and never giving up on me.

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