

**FABRICATION OF CAPACITOR THIN FILM UTILIZING GREEN  
POLYMERS AND BARIUM STRONTIUM TITANATE NANOPARTICLES**

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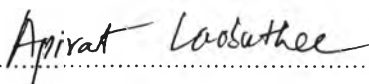


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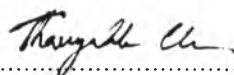
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## ABSTRACT

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Magnesium-doped barium strontium titanate powder with various mole ratio of strontium and magnesium ions ( $Ba_{1-x-y}Sr_xMg_yTiO_3$  when  $x = 0.3, 0.4, 0.5$  and  $y = 0, 0.005, 0.010, 0.020$ ) were prepared by a low-temperature sol-gel method to study their phase formation, frequency-dependent and temperature-dependent dielectric properties. Additionally, barium strontium titanate powder with strontium content of 30 mol% or  $Ba_{0.7}Sr_{0.3}TiO_3$  was incorporated in poly(butylene succinate) (PBS), matrix in various volume fraction of filler in order to improve dielectric properties of polymeric material. The solution mixing method was used to mix each compounds altogether, followed by compression molding to obtain thin-film of  $200\ \mu\text{m} - 300\ \mu\text{m}$ . Along with the determination of thermal, mechanical and dielectric properties at microwave frequency of PBS-composite. Furthermore, the experimental data of dielectric constant of PBS/BST composite as a function of BST function were predicted with 0-3 connectivity models. The dispersion state of PBS-composite were also investigated by using Scanning Electron Microscope (SEM). Finally, the PBS-composite thin films with good dielectric properties, flexibility, and processability are possible to be processed as a biodegradable thin film capacitor for high-frequency electronic devices.

## บทคัดย่อ

กิตติคุณ ปลั่งพงษ์พันธ์ : การเตรียมตัวเก็บประจุแบบฟิล์มบางจากพอลิเมอร์ที่เป็นมิตรกับธรรมชาติและผงแบเรียมสตรอนเทียมไทตาเนต (Fabrication of Capacitor Thin Film Utilizing Green Polymers and Barium Strontium Titanate Nanoparticles)

อ. ที่ปรึกษา : ผศ.ดร. หทัยกานต์ มนต์สปียะ และ ผศ.ดร.อภิรัตน์ เกาห์บุตรี 87 หน้า

ผงแบเรียมสตรอนเทียมไทตาเนต (BST) ได้ถูกนำมาเจือด้วยแมกนีเซียมในสัดส่วนของแบเรียม สตรอนเทียมและแมกนีเซียมที่แตกต่างกัน ( $Ba_{1-x-y}Sr_xMg_yTiO_3$ , โดยที่  $x = 0.3, 0.4, 0.5$  และ  $y = 0, 0.005, 0.010, 0.020$ ) โดยเตรียมจากกระบวนการโซล-เจลที่อุณหภูมิต่ำเพื่อศึกษาการเกิดเฟส (phase formation) สมบัติทางไดอิเล็กตริกเชิงความถี่และเชิงอุณหภูมิ นอกจากนี้ผงแบเรียมสตรอนเทียมไททาเนตที่มีสัดส่วนแบเรียมต่อสตรอนเทียม 70:30 ได้ถูกนำมาผสมกับพอลิบิวทิลีนซัคซิเนตในสัดส่วนต่างๆเพื่อปรับปรุงสมบัติทางไดอิเล็กตริกให้กับวัสดุพอลิเมอร์ซึ่งถูกเตรียมได้จากการผสมแบบละลาย จากนั้นนำไปขึ้นรูปด้วยวิธีการอัดขึ้นรูป (compression molding) เพื่อให้ได้แผ่นฟิล์มบางที่มีความหนาประมาณ 200 – 300 ไมครอน จากนั้นทำการศึกษาสมบัติทางความร้อน สมบัติเชิงกล สมบัติทางไดอิเล็กตริก และค่าคงที่ไดอิเล็กตริกที่เป็นฟังก์ชันของปริมาณของผงแบเรียมสตรอนเทียมไททาเนตในวัสดุคอมพอสิตของพอลิบิวทิลีนซัคซิเนตยังได้ถูกพยากรณ์โดยสมการทางทฤษฎีของวัสดุคอมพอสิตแบบ 0-3 นอกจากนี้ได้มีการศึกษาสภาพการกระจายตัวของผงแบเรียมสตรอนเทียมไททาเนตในวัสดุคอมพอสิตของพอลิบิวทิลีนซัคซิเนตโดยกล้องจุลทรรศน์อิเล็กตรอนแบบส่องกราด ทำยที่สุดแล้วสมบัติทางไดอิเล็กตริก ความยืดหยุ่น และความสามารถในการขึ้นรูปของวัสดุคอมพอสิตพอลิบิวทิลีนซัคซิเนต สามารถนำมาประยุกต์ใช้ในการผลิตตัวเก็บประจุที่เป็นลักษณะฟิล์มบางในย่านความถี่สูง

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## TABLE OF CONTENTS

	<b>PAGE</b>
Title Page	i
Abstract (in English)	iii
Abstract (in Thai)	iv
Acknowledgements	v
Table of Contents	vi
List of Tables	ix
List of Figures	x
List of Schematics	xiv
Abbreviations	xv
List of Symbols	xvi
 <b>CHAPTER</b>	
<b>I INTRODUCTION</b>	<b>1</b>
 <b>II THEORETICAL BACKGROUND AND LITERATURE REVIEW</b>	
2.1 Poly(Butylene Succinate)	4
2.2 Dielectric Materials	8
2.3 Polymer-Ceramic Composites	14
 <b>III EXPERIMENTAL</b>	
3.1 Materials	21
3.2 Equipment	21
3.3 Experimental Procedures	22

<b>CHAPTER</b>	<b>PAGE</b>
<b>IV PREPARATION AND CHARACTERIZATION OF MAGNESIUM-DOPED BARIUM STRONTIUM TITANATE VIA SOL-GEL METHOD</b>	
4.1 Abstract	25
4.2 Introduction	25
4.3 Experimental	26
4.4 Results and Discussion	29
4.5 Conclusions	49
4.6 Acknowledgements	50
4.7 References	50
<b>V DIELECTRIC AND MECHANICAL PROPERTIES OF POLY(BUTYLENE SUCCINATE) THIN-FILM COMPOSITE INCORPERATED WITH BARIUM STRONTIUM TITANATE POWDERS</b>	
5.1 Abstract	52
5.2 Introduction	52
5.3 Experimental	53
5.4 Results and Discussion	55
5.5 Conclusions	63
5.6 Acknowledgements	63
5.7 References	63
<b>VII CONCLUSIONS AND RECOMMENDATIONS</b>	<b>65</b>
<b>REFERENCES</b>	<b>69</b>
<b>APPENDICES</b>	
<b>Appendix A Lattice Parameter Calculations</b>	<b>72</b>

<b>Appendix B</b> Frequency-dependent Dielectric Properties of Magnesium-doped Barium Strontium Titanate Powder and PBS-Composite Thin Film	77
<b>Appendix C</b> Data Sheet of Poly(Butylene Succinate) Grade Blown Film Extrusion (AZ91TN)	79
<b>Appendix D</b> Breakdown Strength and Effects of Corona-poling of Poly(Butylene Succinate)/Barium Strontium Titanate Thin-film Composites on Dielectric Constant at Low-Frequency	80
<b>Appendix E</b> Experimental Data Fitting of Poly(Butylene Succinate)/Barium Strontium Titanate Thin-film Composites	81
<b>Appendix F</b> Poly(Butylene Succinate)/modified - Barium Strontium Titanate Composite Thin-film Characterizations	82
<b>CURRICULUM VITAE</b>	87



## LIST OF TABLES

TABLE		PAGE
<b>CHAPTER II</b>		
2.1	Chemical structure of the polymers in poly(alkylene dicarboxylate) family -	5
2.2	Properties of PBS compare to those of PLA and some common plastics	5
2.3	Comparative data of the investigations on polymer-ceramic composite	18
2.4	Values of thermal properties, dielectric constant and Impulse breakdown	19
2.5	Comparative data of the investigations on PBS-composite dielectric properties at room temperature	20
<b>CHAPTER IV</b>		
4.1	The overall mole ratio of barium ions, strontium ions, magnesium ions and titanium ions	27
4.2	Lattice parameters of $Ba_{1-x-y}Sr_xMg_yTiO_3$ powder and quantitative analysis of $Ba^{2+}$ , $Sr^{2+}$ , $Mg^{2+}$ , and $Ti^{4+}$	37
4.3	Crystallite size magnesium-doped barium strontium titanate particles calculated on 110 plane	38
4.4	Dielectric properties of magnesium-doped barium strontium titanate, $Ba_{1-x-y}Sr_xMg_yTiO_3$ powder were measured at 10 MHz	49
<b>CHAPTER V</b>		
5.1	Degradation temperature and %Residue of PBS-composite	56

## LIST OF FIGURES

<b>FIGURE</b>		<b>PAGE</b>
<b>CHAPTER II</b>		
2.1	Crystal structures of PBS of the a) $\alpha$ form and b) $\beta$ form.	7
2.2	The variation of the dielectric constant $\epsilon_r$ and the spontaneous polarization of $P_S$ with temperature for barium titanate.	7
2.3	The unit cell, the ion displacement and the temperature dependence of the structure of the unit cell of $BaTiO_3$ .	10
2.4	The effects on transition temperature by substituting $Ba^{2+}$ with $Sr^{2+}$ or $Pb^{2+}$ .	11
2.5	Dielectric properties of $Ba_{0.8}Sr_{0.2}TiO_3$ ceramic with different Mg-dopant Concentrations.	12
2.6	$Mg^{2+}$ content dependent of lattice constant of $Ba_{0.65-x}Sr_{0.35}Mg_xTiO_3$ ceramic.	12
2.7	The effect of $Mg^{2+}$ with different content on the perovskite $ABO_3$ structure	13
2.8	Ten connectivity patterns for a diphasic solid	14
2.9	Comparison of the frequency characteristic of dielectric constant and loss tangent of 30% $BaTiO_3$ /polymer composites	16
2.10	Dielectric constant of the composite material as the function of volume fraction of $BaTiO_3$	17
2.11	Dielectric constant of the PPS- $BaTiO_3$ composite material as the function of volume fraction of $BaTiO_3$	17
<b>CHAPTER III</b>		
3.1	Two-step thermal decomposition temperature profile	24

FIGURE	PAGE
<b>CHAPTER IV</b>	
4.1	The temperature profile of 2-step decomposition method. 28
4.2	FTIR-spectra of (a) Barium acetate (b) Strontium acetate (c) Magnesium acetate (d) Titanium-n-butoxide and (e) Barium strontium titanate gel. 30
4.3	TGA thermogram of barium strontium titanate, $Ba_{0.7}Sr_{0.3}TiO_3$ gel. 31
4.4	DTA thermogram of barium strontium titanate, $Ba_{0.7}Sr_{0.3}TiO_3$ gel. 31
4.5	FTIR-spectrum of barium strontium titanate gel. 32
4.6	FTIR-spectrum of barium strontium titanate powder. 33
4.7	SEM image of barium strontium titanate powder. 33
4.8	The X-Ray diffraction patterns of (a) barium strontium titanate gel and (b) barium strontium titanate powder. 34
4.9	XRD patterns of $Ba_{1-x-y}Sr_xMg_yTiO_3$ powder (where $x = 0.3$ and $y =$ (a) 0, (b) 0.005, (c) 0.010, (d) 0.020). 35
4.10	XRD patterns of $Ba_{1-x-y}Sr_xMg_yTiO_3$ powder (where $x = 0.4$ and $y =$ (a) 0, (b) 0.005, (c) 0.010, (d) 0.020). 35
4.11	XRD patterns of $Ba_{1-x-y}Sr_xMg_yTiO_3$ powder (where $x = 0.5$ and $y =$ (a) 0, (b) 0.005, (c) 0.010, (d) 0.020). 36
4.12	Frequency-dependent dielectric constant of $Ba_{1-x-y}Sr_xMg_yTiO_3$ powder (where $x = 0.3$ and $y = 0, 0.005, 0.010, 0.020$ ). 39
4.13	Frequency-dependent dielectric constant of $Ba_{1-x-y}Sr_xMg_yTiO_3$ powder (where $x = 0.4$ and $y = 0, 0.005, 0.010, 0.020$ ). 40

FIGURE	PAGE
4.14 Frequency-dependent dielectric constant of $\text{Ba}_{1-x-y}\text{Sr}_x\text{Mg}_y\text{TiO}_3$ powder (where $x = 0.5$ and $y = 0, 0.005, 0.010, 0.020$ ).	40
4.15 Frequency-dependent loss tangent of $\text{Ba}_{1-x-y}\text{Sr}_x\text{Mg}_y\text{TiO}_3$ powder (where $x = 0.3$ and $y = 0, 0.005, 0.010, 0.020$ ).	41
4.16 Frequency-dependent loss tangent of $\text{Ba}_{1-x-y}\text{Sr}_x\text{Mg}_y\text{TiO}_3$ powder (where $x = 0.4$ and $y = 0, 0.005, 0.010, 0.020$ ).	42
4.17 Frequency-dependent loss tangent of $\text{Ba}_{1-x-y}\text{Sr}_x\text{Mg}_y\text{TiO}_3$ powder (where $x = 0.5$ and $y = 0, 0.005, 0.010, 0.020$ ).	42
4.18 Temperature-dependent dielectric constant of $\text{Ba}_{1-x-y}\text{Sr}_x\text{Mg}_y\text{TiO}_3$ powder (where $x = 0.3$ and $y = 0, 0.005, 0.010, 0.020$ ).	43
4.19 Temperature-dependent dielectric constant of $\text{Ba}_{1-x-y}\text{Sr}_x\text{Mg}_y\text{TiO}_3$ powder (where $x = 0.4$ and $y = 0, 0.005, 0.010, 0.020$ ).	44
4.20 Temperature-dependent dielectric constant of $\text{Ba}_{1-x-y}\text{Sr}_x\text{Mg}_y\text{TiO}_3$ powder (where $x = 0.5$ and $y = 0, 0.005, 0.010, 0.020$ ).	44
4.21 Temperature-dependent loss tangent of $\text{Ba}_{1-x-y}\text{Sr}_x\text{Mg}_y\text{TiO}_3$ powder (where $x = 0.3$ and $y = 0, 0.005, 0.010, 0.020$ ).	45
4.22 Temperature-dependent loss tangent of $\text{Ba}_{1-x-y}\text{Sr}_x\text{Mg}_y\text{TiO}_3$ powder (where $x = 0.4$ and $y = 0, 0.005, 0.010, 0.020$ ).	46
4.23 Temperature-dependent loss tangent of $\text{Ba}_{1-x-y}\text{Sr}_x\text{Mg}_y\text{TiO}_3$ powder (where $x = 0.5$ and $y = 0, 0.005, 0.010, 0.020$ ).	46
4.24 Dielectric constant and lattice parameter relationship of $\text{Ba}_{1-x-y}\text{Sr}_x\text{Mg}_y\text{TiO}_3$ powder (which $x = 0.3$ and $y = 0, 0.5, 1.0, 2.0$ ).	47

FIGURE		PAGE
4.25	Dielectric constant and lattice parameter relationship of $Ba_{1-x-y}Sr_xMg_yTiO_3$ powder (which $x = 0.4$ and $y = 0, 0.5, 1.0, 2.0$ ).	48
4.26	Dielectric constant and lattice parameter relationship of $Ba_{1-x-y}Sr_xMg_yTiO_3$ powder (which $x = 0.5$ and $y = 0, 0.5, 1.0, 2.0$ ).	48

### CHAPTER V

5.1	Two-step thermal decomposition temperature profile..	54
5.2	SEM images of PBS-composite in various composition of BST powder (a) 0 wt% (b) 10 wt% (c) 20 wt% (d) 30 wt% (e) 40 wt% (f) 50 wt%.	56
5.3	TGA curves of neat PBS and PBS-composite samples.	57
5.4	Tensile strength of PBS-composite.	58
5.5	Percentage elongation at break of PBS-composite.	58
5.6	Young's modulus of PBS-composite.	59
5.7	Stress-strain curve of PBS-composite.	59
5.8	Frequency-dependent dielectric constant PBS-composite.	60
5.9	Frequency-dependent loss tangent PBS-composite.	61
5.10	Temperature-dependent dielectric constant of PBS-composite.	62
5.11	Temperature-dependent loss tangent of PBS-composite.	62

### CHAPTER VI

6.1	SEM image of surface treated BST/PBS composite a) non-treated b) Triethoxyvinyl silane-treated c) Ethylene glycol-treated and d) Propylene glycol-treated.	64
-----	--	----

**LIST OF SCHEMATICS**

<b>SCHEMATICS</b>	<b>PAGE</b>
<b>CHAPTER II</b>	
2.1 Preparation of polyesters by stepwise polycondensation	4
2.2 Flow chart of PBS synthesis	6
<b>CHAPTER III</b>	
3.1 Preparation of magnesium-doped barium strontium titanate powders.	23

## ABBREVIATIONS

BST Barium strontium titanate

PBS Poly(butylene succinate)

## SYMBOLS

$A$	Area
$a$	Weight of the sample in air
$b$	Weight of the sample immersed in deionized water
$c$	Weight of the damp sample after being wiped off excess water
$C$	Capacitance
$D$	Electric displacement
$D$	Distance between the plate
$D_{\text{water}}$	Density of deionized water
$E$	Electric intensity applied
$E_0$	Amplitude
$\tan \delta$	Loss tangent
$Q$	Charge
$Q$	Quality factor
$V$	Potential difference
$\alpha$	Total polarizability
$\alpha_c$	Electronic polarization
$\alpha_a$	Atomic polarization
$\alpha_o$	Dipole orientation polarization
$\epsilon_0$	Permittivity of free space ( $8.854 \times 10^{-12} \text{ C}^2/\text{m}^2$ or F/m)
$\epsilon'$	Dielectric constant
$\epsilon''$	Dielectric loss
$\epsilon$	Dielectric constant of the composites
$\epsilon_p$	Dielectric constants of the polymer matrix
$\epsilon_c$	Dielectric constants of the BST ceramic
$n$	Refractive index
$\phi$	Volume fraction
$\phi_c$	Volume fraction of the ceramic
$\phi_p$	Volume fraction of the polymer