


การสังเคราะห์และลักษณะสมบัติของเมมเบรน  $\text{La}_{1-x}\text{Sr}_x\text{Ga}_{1-y}\text{Fe}_y\text{O}_{3-\delta}$  : เพอร์อฟสไกต์



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ศูนย์วิทยทรัพยากร

จุฬาลงกรณ์มหาวิทยาลัย

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SYNTHESIS AND CHARACTERIZATION OF  $\text{La}_{1-x}\text{Sr}_x\text{Ga}_{1-y}\text{Fe}_y\text{O}_{3-\delta}$  PEROVSKITE MEMBRANE



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จุฬาลงกรณ์มหาวิทยาลัย

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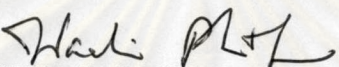
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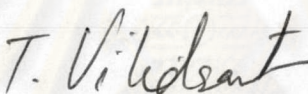
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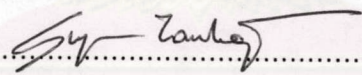
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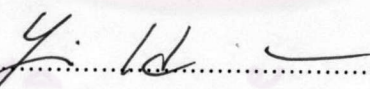
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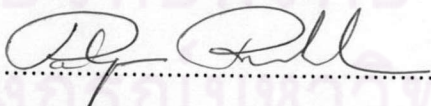
  
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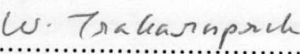
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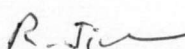
  
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เพอโรฟสไกต์ชนิด  $\text{ABO}_3$  ที่มี แลนทานัม แบเรียม สทรอนเทียม เหล็ก โคบอลต์ หรือ แกลเลียม  
ได้ถูกสังเคราะห์ด้วยวิธีซิเทรตประยุกต์ ที่ pH 9 พบว่าผงเพอโรฟสไกต์ชนิด  $\text{La}_{0.6}\text{Sr}_{0.4}\text{Ga}_{0.2}\text{Fe}_{0.8}\text{O}_{3-\delta}$   
แสดงโครงสร้างซิงเกิลเฟสทั้งก่อนและหลังแคลซิเนชัน ดังนั้น  $\text{La}_{1-x}\text{Sr}_x\text{Ga}_{1-y}\text{Fe}_y\text{O}_{3-\delta}$  ที่มี x เท่ากับ 0.2,  
0.4 และ 0.6 และ y เท่ากับ 0.2, 0.4, 0.6 และ 0.8 ได้ถูกสังเคราะห์ และวิเคราะห์ลักษณะสมบัติโดย  
เอ็กซ์เรย์ดิฟแฟรกชัน ผลการทดลองแสดงให้เห็นว่า แลนทานัมแกลเลตเพอโรฟสไกต์ 5 ชนิด จาก 12  
ชนิด ได้แก่  $\text{La}_{0.8}\text{Sr}_{0.2}\text{Ga}_{0.5}\text{Fe}_{0.5}\text{O}_{3-\delta}$ ,  $\text{La}_{0.8}\text{Sr}_{0.2}\text{Ga}_{0.4}\text{Fe}_{0.6}\text{O}_{3-\delta}$ ,  $\text{La}_{0.8}\text{Sr}_{0.2}\text{Ga}_{0.2}\text{Fe}_{0.8}\text{O}_{3-\delta}$ ,  
 $\text{La}_{0.6}\text{Sr}_{0.4}\text{Ga}_{0.2}\text{Fe}_{0.8}\text{O}_{3-\delta}$  และ  $\text{La}_{0.4}\text{Sr}_{0.6}\text{Ga}_{0.2}\text{Fe}_{0.8}\text{O}_{3-\delta}$  มีโครงสร้างซิงเกิลเฟสทั้งก่อนและหลังแคลซิเน  
ชัน ยิ่งไปกว่านั้น ปริมาณของเซคันดรีเฟส เพิ่มขึ้น เมื่อปริมาณของ สทรอนเทียมใน  
 $\text{La}_{1-x}\text{Sr}_x\text{Ga}_{0.4}\text{Fe}_{0.6}\text{O}_{3-\delta}$  และ  $\text{La}_{1-x}\text{Sr}_x\text{Ga}_{0.2}\text{Fe}_{0.8}\text{O}_{3-\delta}$  มากกว่า 0.2 และ 0.6 ตามลำดับ ที่ pH ในช่วง  
1.36 ถึง 9.27  $\text{La}_{0.6}\text{Sr}_{0.4}\text{Ga}_{0.2}\text{Fe}_{0.8}\text{O}_{3-\delta}$  ที่มีโครงสร้างซิงเกิลเฟสเกิดขึ้นได้ก่อนแคลซิเนชัน เพราะฉะนั้น  
pH ไม่มีผลต่อโครงสร้างและตัวแปรแลตทิส อนุภาคละเอียดของผงที่แคลไซน์ มีขนาดอนุภาคเฉลี่ย 1.7  
ไมโครเมตรที่ pH 1.36 และ 0.56-0.60 ไมโครเมตร ที่ pH ในช่วง 3.39-9.27 และมีค่าตัวแปรแลตทิส  
3.9 อังสตรอม เมมเบรนของ  $\text{La}_{0.6}\text{Sr}_{0.4}\text{Ga}_{0.2}\text{Fe}_{0.8}\text{O}_{3-\delta}$  เมื่อใช้บายเดอร์ และ เมมเบรนของ  
 $\text{La}_{0.4}\text{Sr}_{0.6}\text{Ga}_{0.4}\text{Fe}_{0.6}\text{O}_{3-\delta}$  เมื่อไม่ใช้บายเดอร์ ได้ถูกเตรียม และซินเทอร์ ที่อุณหภูมิ 1,250 ถึง 1,380  
องศาเซลเซียส เป็นเวลา 10 ชั่วโมง เมมเบรนทั้งสองชนิด ยังคงมีโครงสร้างคิวบิกหลังจากทำซินเทอร์  
แล้ว โดยมีความหนาแน่นสัมพัทธ์ 80 และ มากกว่า 90 เปอร์เซ็นต์ ตามลำดับ เมมเบรนที่ความหนา  
แน่นต่ำของ  $\text{La}_{0.6}\text{Sr}_{0.4}\text{Ga}_{0.2}\text{Fe}_{0.8}\text{O}_{3-\delta}$  สามารถเพิ่ม เปอร์เซ็นต์ของก๊าซออกซิเจนในอากาศ ได้ถึง 45  
เปอร์เซ็นต์ ที่อุณหภูมิ 900 องศาเซลเซียส ในกรณีของเมมเบรนที่มีความหนาแน่นสูงของ  
 $\text{La}_{0.4}\text{Sr}_{0.6}\text{Ga}_{0.4}\text{Fe}_{0.6}\text{O}_{3-\delta}$  อัตราการเพอร์มิเอตของก๊าซออกซิเจน มีค่าสูงถึง 1.5 ลูกบาศก์เซนติเมตร (ที่ภาวะ  
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ลายมือชื่อนิสิต .....จินดา ยืนยงชัยวัฒน์.....  
ลายมือชื่ออาจารย์ที่ปรึกษา .....ศุภวรรณ ตันตยานนท์.....  
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MS. JINDA YEYONGCHAIWAT : SYNTHESIS AND CHARACTERIZATION OF

La<sub>1-x</sub>Sr<sub>x</sub>Ga<sub>1-y</sub>Fe<sub>y</sub>O<sub>3-δ</sub> PEROVSKITE MEMBRANE.

THESIS ADVISOR : ASSOC. PROF. SUPAWAN TANTAYANON

THESIS COADVISOR : PROF. YI HUA MA

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Several La, Ba, Sr, Fe, Co, or Ga-containing ABO<sub>3</sub>-based perovskites had been synthesized by a modified citrate method at pH 9. It was found that La<sub>0.6</sub>Sr<sub>0.4</sub>Ga<sub>0.2</sub>Fe<sub>0.8</sub>O<sub>3-δ</sub> powder exhibited the single-phase structure both with and without calcination. Therefore, La<sub>1-x</sub>Sr<sub>x</sub>Ga<sub>1-y</sub>Fe<sub>y</sub>O<sub>3-δ</sub> where x = 0.2, 0.4, and 0.6; y = 0.2, 0.4, 0.6, and 0.8 were synthesized and characterized by the X-ray diffraction. The results indicated that 5 of 12 lanthanum gallate perovskites, i.e., La<sub>0.8</sub>Sr<sub>0.2</sub>Ga<sub>0.5</sub>Fe<sub>0.5</sub>O<sub>3-δ</sub>, La<sub>0.8</sub>Sr<sub>0.2</sub>Ga<sub>0.4</sub>Fe<sub>0.6</sub>O<sub>3-δ</sub>, La<sub>0.8</sub>Sr<sub>0.2</sub>Ga<sub>0.2</sub>Fe<sub>0.8</sub>O<sub>3-δ</sub>, La<sub>0.6</sub>Sr<sub>0.4</sub>Ga<sub>0.2</sub>Fe<sub>0.8</sub>O<sub>3-δ</sub>, and La<sub>0.4</sub>Sr<sub>0.6</sub>Ga<sub>0.2</sub>Fe<sub>0.8</sub>O<sub>3-δ</sub> showed the single-phase structure both with and without calcination. Furthermore, the amount of the secondary phase increased when the amount of Sr in La<sub>1-x</sub>Sr<sub>x</sub>Ga<sub>0.4</sub>Fe<sub>0.6</sub>O<sub>3-δ</sub> and La<sub>1-x</sub>Sr<sub>x</sub>Ga<sub>0.2</sub>Fe<sub>0.8</sub>O<sub>3-δ</sub> was higher than 0.2 and 0.6, respectively. At pH range of 1.36-9.27, the formation of La<sub>0.6</sub>Sr<sub>0.4</sub>Ga<sub>0.2</sub>Fe<sub>0.8</sub>O<sub>3-δ</sub> with single-phase structure was obtained even before calcination. Therefore, the pH had insignificant effect on the structure and lattice parameter of this perovskite. The fine particle of calcined powders was obtained with the average particle size 1.70 μm at pH 1.36 and 0.56-0.60 μm at pH range between 3.39-9.27, and with a lattice parameter about 3.9 Å. The La<sub>0.6</sub>Sr<sub>0.4</sub>Ga<sub>0.2</sub>Fe<sub>0.8</sub>O<sub>3-δ</sub> membrane with binder and La<sub>0.4</sub>Sr<sub>0.6</sub>Ga<sub>0.4</sub>Fe<sub>0.6</sub>O<sub>3-δ</sub> membrane without binder were prepared and sintered at 1,250-1,380°C for 10 hours. Both membranes remained the cubic structure after sintering with the relative density 80% and higher than 90%, respectively. The undensed La<sub>0.6</sub>Sr<sub>0.4</sub>Ga<sub>0.2</sub>Fe<sub>0.8</sub>O<sub>3-δ</sub> membrane could enrich the oxygen in air up to 45% at 900°C. In case of the densified La<sub>0.4</sub>Sr<sub>0.6</sub>Ga<sub>0.4</sub>Fe<sub>0.6</sub>O<sub>3-δ</sub> membrane, the oxygen permeation rate as high as 1.5 cm<sup>3</sup>(STP)/cm<sup>2</sup>.min at 925°C was achieved.

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 Field of study...Chemical Technology..... Advisor's signature... *Supawan Tantayanon*.....  
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ศูนย์วิจัยทรัพยากร  
จุฬาลงกรณ์มหาวิทยาลัย

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$\delta$	Non-stoichiometry of oxygen in mole formula
$\sigma_e$	Electronic conductivity
$\sigma_i$	Ionic conductivity
$\sigma_{tot}$	Electrical conductivity
<b>BSCF</b>	Perovskite containing Ba, Sr, Co, and Fe
<b>BSCGF</b>	Perovskite containing Ba, Sr, Co, Ga, and Fe
<b>BSGF</b>	Perovskite containing Ba, Sr, Ga, and Fe
<b>LBCF</b>	Perovskite containing La, Ba, Co, and Fe
$L_c$	Characteristic length
<b>LSCF</b>	Perovskite containing La, Sr, Co, and Fe
<b>LSF</b>	Perovskite containing La, Sr, and Fe
<b>LSGF</b>	Perovskite containing La, Sr, Ga, and Fe
<b>LSGM</b>	Perovskite containing La, Sr, Ga, and Mg
<b>MAL</b>	Malic acid
<b>MICE</b>	Mixed ionic and electronic conductivity
<b>ODH</b>	Oxalyl dihydrazide
$P'_{O_2}$	Partial pressure of oxygen at higher pressure
$P''_{O_2}$	Partial pressure of oxygen at lower pressure
<b>SCF</b>	Perovskite containing Sr, Co, and Fe
<b>SEM</b>	Scanning electron microscope
$t$	Tolerance number
$T_c$	Calcination temperature
<b>TFTA</b>	Tetra formal tri azine
$T_s$	Sintering temperature
<b>XRD</b>	X-ray diffraction