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DESIGN AND CONSTRUCTION OF MICROWAVE-PECVD AND
PRELIMINARY CHARACTERISTICS OF SYNTHESISED
POLYCRYSTALLINE DIAMOND FILM

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A Thesis Submitted in Partial Fulfillment of the Requirements
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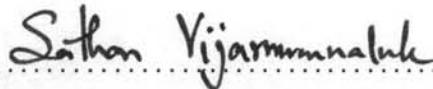
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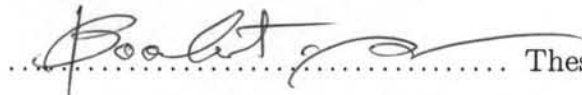


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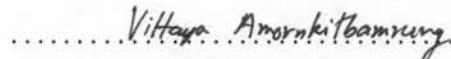
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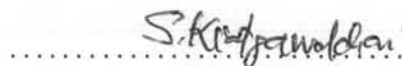
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ในงานวิจัยนี้ได้ออกแบบและสร้างระบบตกสะสมไอเชิงเคมีด้วยคลื่นไมโครเวฟขนาดกะทัดรัด ระบบโดยรวมแบ่งออกได้เป็นสองส่วน คือ ระบบภาชนะสุญญากาศ และระบบให้พลังงาน ท่อนำคลื่นอนุกรมเรียบรูปสี่เหลี่ยมแบบ WR340 ถูกออกแบบและสร้างขึ้นเพื่อใช้เป็นท่อนำคลื่นไมโครเวฟในโหมด TE_{10} เสาอากาศทองเหลืองถูกใช้เป็นตัวเปลี่ยนโหมด TE_{10} ในท่อนำคลื่นรูปสี่เหลี่ยม เป็นโหมด TM_{011} ในโพรงรูปทรงกระบอกด้วยความถี่เรโซแนนซ์ขนาด 2.45 จิกะเฮิร์ตซ์ ระบบตกสะสมไอเชิงเคมีด้วยคลื่นไมโครเวฟที่สร้างขึ้นสามารถสังเคราะห์ฟิล์มเพชรบนแผ่นรองรับซิลิกอนได้ ที่ความดันขณะตกสะสมคงที่ ผู้วิจัยพบว่าที่อัตราส่วนของมีเทนต่อไฮโดรเจน 1 เปอร์เซ็นต์ จะพบลักษณะเฉพาะของโครงสร้างแบบเพชรที่มีรูปแบบชัดเจน ทั้งนี้พิจารณาจากค่าความกว้างที่ความสูงครึ่งมีค่าน้อยที่สุด ในการทดลองที่อัตราส่วนของมีเทนต่อไฮโดรเจนคงที่ ที่มีเทน 1 เปอร์เซ็นต์ และความดันขณะตกสะสม 10 ทอร์ ผู้วิจัยไม่พบการมีอยู่ของโครงสร้างแบบเพชรที่มีรูปแบบชัดเจนในฟิล์ม ในขณะที่ความดันขณะตกสะสม ที่ 30 40 และ 50 ทอร์ พบการมีอยู่ของโครงสร้างแบบเพชรที่มีรูปแบบชัดเจนในฟิล์ม ผู้วิจัยพบว่าเงื่อนไขที่ดีที่สุดซึ่งพบการตกสะสมของฟิล์มทั่วแผ่นรองรับและพบลักษณะเฉพาะของโครงสร้างแบบเพชร ที่อัตราส่วนของมีเทนต่อไฮโดรเจน 1 เปอร์เซ็นต์ ความดันขณะตกสะสม 30 ทอร์ กำลังคลื่นไมโครเวฟ 450 วัตต์ และอุณหภูมิแผ่นรองรับ 430-470 องศาเซลเซียส

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NOPPORN RUJISAMPHAN : DESIGN AND CONSTRUCTION OF
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We have designed and constructed a compact chemical vapor deposition using microwave plasma reactor. The system can be divided into two main parts; a vacuum chamber, and a power coupling modules. Aluminium rectangular waveguide WR340 was designed and constructed to guide the wave with TE_{10} mode. The brass antenna was used to convert the TE_{10} mode in WR340 waveguide into the TM_{011} mode in cylindrical resonator. Chemical vapor deposition diamond films have been successfully deposited on silicon substrates. At fixed pressure of 30 Torr, the well-faceted with lower full width at half maximum of diamond characteristic was found at low methane concentration (1%). At fixed methane concentration of 1% and deposition pressure of 10 Torr, we did not find diamond characteristic peak while at 30, 40, and 50 Torr, well-faceted films with good diamond characteristic were found. We found that the deposition at methane concentration of 1%, pressure of 30 Torr, microwave power of 450 watt, and substrate temperature of 430-470 C is the optimum condition in the range of our study yielding uniform film with distinct diamond characteristic.

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LIST OF SYMBOLS

ϵ_0	Permittivity of free space (8.854×10^{-12} F/m)
μ_0	Permeability of free space ($4\pi \times 10^{-7}$ H/m)
c	Velocity of light in vacuum (2.98×10^8 m/s)
eV	Electronvolt (1.602×10^{-19} J)
TE	Transverse electric, no electric field component in the direction of propagation
TM	Transverse magnetic, no magnetic field in the direction of propagation
λ_g	Wavelength of the microwave in the waveguide
f_c	Cutoff frequency
α_{mn}	Zero of Bessel functions of the first kind