



2018 年奈尺尺度技術與材料研討會  
**Nanometer-Scale Technology and Materials  
Symposium 2018**

會議手冊



2018 年 12 月 14 日

# 2018 年奈尺尺度技術與材料研討會

## Nanometer-Scale Technology and Materials Symposium 2018

為促進奈尺尺度技術與奈尺尺度材料相關領域之研究與學術交流，並協助人才之培育，自 2005 年起大葉大學每年舉辦本研討會，藉由相關研究之發表與討論分享，更加充實與增進彼此的知識。

舉辦時間：2018 年 12 月 14 日（周五）

舉辦地點：大葉大學工學大樓六樓會議廳 H613 室

主辦單位：大葉大學材料科學與工程學系、電機工程學系

指導單位：行政院教育部

議程主席：宋皇輝

籌備委員：宋皇輝、李得勝、陳昭翰、范榮權、姚品全、李世鴻、黃俊杰、李義剛、廖芳俊、賴峰民、連水養、吳宛玉、王偉凱、歐信良

大會邀請演講：

◎郭華丞 教授（國立中興大學 物理學系、奈米科學研究所）  
**超導量子電腦的現況與展望**

◎陳坤麟 副教授（國立中興大學 物理學系、奈米科學研究所）  
**磁性奈米粒子的生醫應用簡介**

◎柯宗憲 副教授（國立彰化師範大學 電子工程學系）  
**Optoelectrical properties of Ni-doped and laser-annealed MoS<sub>2</sub>**

◎羅夢凡 教授（國立中央大學 物理學系）  
**Reactions on supported nanoclusters: a model-system study of catalysis**

工作團隊：鄭州良、柳育騏、梁秭璋、江典霖、許家豪、高英傑、陳宏齊、林育詩、林仕昕、許筑旻

聯絡人：

陳昭翰 助理教授

51591 彰化縣大村鄉學府路 168 號

大葉大學 材料科學與工程學系、電機工程學系

電話：(04) 851-1888 轉 2195

E-mail: jhchen@mail.dyu.edu.tw

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# 研討會議程

時間	項目	
09:00 ~ 09:20	報到/張貼壁報展示	
09:20 ~ 09:30	開幕致詞	
09:30 ~ 10:20	L1	邀請演講：郭華丞 教授（國立中興大學 物理學系、奈米科學研究所） 超導量子電腦的現況與展望
10:20 ~ 10:30	休息	
10:30 ~ 11:20	L2	邀請演講：陳坤麟 副教授（國立中興大學 物理學系、奈米科學研究所） 磁性奈米粒子的生醫應用簡介
11:20 ~ 12:10	L3	邀請演講：柯宗憲 副教授（國立彰化師範大學 電子工程學系） Optoelectrical properties of Ni-doped and laser-annealed MoS <sub>2</sub>
12:10 ~ 14:00	午餐/壁報展示	
14:00 ~ 14:50	L4	邀請演講：羅夢凡 教授（國立中央大學 物理學系） Reactions on supported nanoclusters: a model-system study of catalysis
14:50 ~ 15:00	休息	
15:00 ~ 15:15	O1	300 mm 矽晶圓片於平坦度 10 奈米以下磊晶製程模擬 國立中央大學 機械工程學系 王士賓
15:15 ~ 15:30	O2	深度置信網路在影像分類之應用 大葉大學 電機工程學系 鄭旭盛
15:30 ~ 15:40	閉幕	

# 邀請演講摘要

# 超導量子電腦的現況與展望

郭華丞

Watson Kuo

國立中興大學物理學系、奈米科學研究所  
40227 臺中市南區興大路 145 號

*Department of Physics and Institute of Nanoscience  
National Chung Hsing University, Taichung 40227, Taiwan*

## 摘要

近年來量子電腦的進展突飛猛進，各國政府和大企業相繼投入資金和人力進行相關技術的研發。目前超導的量子處理器技術最為成熟，也是Google和IBM等企業所發展的核心技術。IBM Q也將量子運算發展為雲端服務，使用者可以在全球各地透過網路登入使用他們的量子處理器。我將介紹超導量子處理器的發展歷史與現況，並且以最新的量子處理器架構來說明量子狀態的操控，量子位元間的耦合以及量子狀態的讀取。目前科學界已經開始使用小型量子處理器進行量子計算，未來可能的應用領域包括人工智慧的運算加速，化學與製藥的模擬計算，加密金鑰的破解等。

# 磁性奈米粒子的生醫應用簡介

陳坤麟

Kuen-Lin Chen

國立中興大學物理學系、奈米科學研究所  
40227 臺中市南區興大路 145 號

*Department of Physics and Institute of Nanoscience  
National Chung Hsing University, Taichung 40227, Taiwan*

## 摘要

磁性奈米粒子由於其獨特的可操控性，已被廣泛的應用於不同的領域。近年來隨著人類壽命越來越長以及環境惡化等因素，生醫相關的議題相當受到關注與重視，磁性奈米粒子因其獨特性與良好的生物相容性，也開始被應用於生醫的相關研究上，如：磁熱治療、藥物傳輸、磁振影像增益、免疫檢測……等等。本次演講將針對磁性奈米粒子的基本特性以及一些生醫方面的應用來進行簡介，希望讓聽眾對於磁性奈米粒子能有基本的認識。

# 論文宣讀摘要



# 300 mm 矽晶圓片於平坦度 10 奈米以下磊晶製程模擬

王士賓<sup>1</sup> 胡杰<sup>1</sup> 陳志臣<sup>1</sup> 塗俊欽<sup>2</sup> 陳亮欽<sup>2</sup>

<sup>1</sup>國立中央大學機械工程學系

<sup>2</sup>中德電子材料股份有限公司

## 摘要

化學氣相沉積法(chemical vapor deposition)在半導體薄膜生長製程中已是常見之方法。針對 10 奈米以下半導體製程所需之 12 吋磊晶晶圓改善平坦度，其中關鍵技術為：1.超均勻之磊晶薄膜 2.矽晶圓基材與磊晶薄膜的形狀匹配。本研究採用多重物理量有限元素分析軟體 (COMSOL Multiphasic)建立磊晶製程，係使用應用材料 Centura®常壓磊晶反應腔體進行熱場、流場、物種傳輸模擬分析，比較以不同之進氣流量配比(Accuset)、承座載盤溫度變化(Susceptor)、流線趨勢(stream line)對於薄膜生長速率(Growth rate)之影響。

本研究首先建立起三維物理模型，當氫氣與三氯矽烷(Trichlorosilane)同時通入反應腔體時，三氯矽烷與氫氣會隨著溫度變化產生化學表面吸附反應。當製程溫度為 1110°C 時不同進氣流量配比與石英腔體上蓋尺寸將影響磊晶薄膜的形狀與薄膜沉積速率。由模擬與實驗結果發現，隨著承座載盤溫上升(1100°C ~1120°C)，與增加中心入口流量配比(Inner)、兩側入口流量配比(Outer)，將使得在未旋轉情況下的晶圓中心附近長率提升。另外由速度場分析得出，磊晶薄膜的形狀會隨著不同進氣流量配比之流線趨勢而有所不同。

**關鍵詞：**三氯矽烷，磊晶薄膜，數值模擬

## Numerical Analysis in the Planarization 10 nm of 300 mm Silicon Wafer Epitaxial Process

Shih-Bin Wang<sup>1</sup>, Chieh Hu<sup>1</sup>, Jyh-Chen Chen<sup>1</sup>, Chun-Chin Tu<sup>2</sup>, and Liang-Chin Chen<sup>2</sup>

<sup>1</sup>*Department of Mechanical Engineering, National Central University,  
300 Chung-Ta Road, Chung-Li, Taoyuan 32001, Taiwan*

<sup>2</sup>*Taisil Electronic Materials Corp., Hsinchu 30077, Taiwan*

### Abstract

Chemical vapor deposition is a common method in semiconductor thin film growth processes. The planarization is improved for 12-inch epitaxial wafers required for semiconductor processes below 10 nm. The important technologies are I. Ultra-uniform epitaxial thin film. II. The wafer substrate is matched with the shape of the epitaxial film. In this study, the multi-physics finite element analysis software (COMSOL Multiphasic) was used to establish the epitaxial process system. The applied materials Centura® atmospheric pressure epitaxy reaction chamber was used to simulate the thermal field, flow field, species transfer, and the different flow rates were compared. The effect is studied include of the accuset, the susceptor temperature, and the streamline on the film growth rate.

In this study, a three-dimensional physical model was first established. When hydrogen and trichlorosilane enter the reaction chamber at the same time, trichloromethane and hydrogen will react with temperature to produce a chemical surface adsorption reaction. When the process temperature is 1110°C, the different inlet flow ratio and the size of the quartz chamber cover will affect the shape of the epitaxial film and the film deposition rate. From the simulation and experimental results, it is found that the deposition rate increased with the increase of the susceptor temperature and accuset on the case without rotation. In addition, the velocity field analysis shows that the shape of the epitaxial film will vary with the trend of different intake flow ratios.

**Key words:** Trichlorosilane, Epitaxial thin film, Numerical simulation

# 深度置信網路在影像分類之應用

胡大湘 鄭旭盛 白思芸

大葉大學電機工程學系  
51591 彰化縣大村鄉學府路 168 號

## 摘要

近年來基於監督式學習的深度類神經網路在影像分類獲得極佳的辨識率，然而該網路在訓練中極度仰賴巨量的訓練數據，以致於運算時間過久、網路過於複雜與該辨識率異常突出之缺點，為此，淺層類神經網路的相關研究有逐漸熱門之跡象。本研究以深度置信網路且在mnist資料庫實驗得知，其該網路所辨識率與常見的深度類神經網路相比略為相同，但在訓練的時間與複雜度遠勝於深度類神經網路。在未來，我們將會結合知識蒸餾與動態在線學習方式，讓網路能達成靈活性強與初步的自主學習之目的。

**關鍵詞：**深度置信網路，受限玻爾茲曼機，影像分類，PyTorch

## Image Classification of Deep Belief Networks

Ta-Hsiang Hu, Hsu-Sheng Cheng, and Szu-Yun Pa

*Department of Electrical Engineering, Da-Yeh University,  
168 University Road, Dacun, Changhua 51591, Taiwan*

### Abstract

In recent years, deep neural networks based on supervised learning has obtained an excellent recognition rate in image classification. However, it is relies heavily on the huge amount of training data in training, resulting in excessive computing time, too complicated network and unusual recognition rate. The shortcomings, for this reason, the related research on shallow neural networks have become a hot trend. In this paper, the deep belief networks and the mnist dataset experiment show that the recognition rate of the network is same as that of the deep neural networks, but the training time and complexity are far better than it. In the future, we will combine knowledge distillation and dynamic online learning to enable the network to achieve flexibility and initial self-learning.

**Key words:** deep belief networks, restricted Boltzmann machine, image classification, PyTorch

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## 壁報發表編號

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石墨烯塗佈於銅箔對 A6061 鋁合金真空硬銲性質研究

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「GRP-金屬」異材膠合之耐鹽霧性能改進研究

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以溶膠—凝膠法製備  $MgAl_2O_4$  及其特性之研究

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以反射光譜測量透明薄膜之研究

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鐵鉬鎳合金的磁滯曲線隨成長溫度變化的影響

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以非對稱式交流電泳沉積石墨烯薄膜之研究

**P18**

石墨烯之電泳沉積及表面研究

# 壁報論文摘要

# 添加石墨烯對「Cu-Ti」異質材料擴散接合的 機械性質及抑菌性能研究

李義剛<sup>1</sup>、\*陸瑀岑<sup>2</sup>、許念柔<sup>2</sup>、蔡明勳<sup>3</sup>、李道寒<sup>4</sup>

<sup>1</sup>大葉大學材料科學與工程學系 <sup>2</sup>大葉大學醫療器材設計與材料學士學位學程

<sup>3</sup>大葉大學食品暨應用生物科技學系 <sup>4</sup>長庚醫院

(科技部計畫編號：NSC 101-2623-E-212-001-D)

## 摘要

本研究主要係利用銅-鈦共晶反應之擴散效應進行兩異質材料最佳接合參數設計的技術開發和探討，並觀察添加石墨烯對銅-鈦擴散接合的銲縫影響。研究結果顯示，Ti-6Al-4V鈦合金和無氧銅的最佳擴散接合銲接參數為：878°C持溫30分鐘，可獲得最高剪切強度約123.9 MPa。若添加適量的石墨烯，不僅對銲縫的硬度分佈不會有太大影響，剪切強度仍可獲得8.3%的提升。同時，由顯微組織的觀察發現，石墨烯的添加可以有效降低析出物的產生。由熱傳導試驗可以得到，藉由石墨烯添加確實可以改善銲縫的熱傳導率，自無添加石墨烯的4.5°C/min提升至添加石墨烯的5.5°C/min。另外，由抑菌實驗結果得知：Cu與Ti皆為優秀的抑菌金屬；當隨試件體積上升，抑菌率有明顯上升的趨勢。而且，添加石墨烯亦無顯著地降低銲縫的抑菌能力。

**關鍵詞：**異質接合、石墨烯、熱傳分析、抑菌性。

## The Study on Mechanical Properties and Bacteriostatic Properties of Adding Graphene on “Cu-Ti” Diffusion Bonding

I-Kon Lee<sup>1</sup>, \*Yu-Tsen Lu<sup>2</sup>, Nian-Rou Shiu<sup>2</sup>, Ming-Shiun Tsai<sup>3</sup>, and Tao-Han Lee<sup>4</sup>

<sup>1</sup>Department of Materials Science and Engineering, Da-Yeh University

<sup>2</sup>Program for Design and Materials for Medical Equipment and Devices, Da-Yeh University

<sup>3</sup>Department of Food Science and Biotechnology, Da-Yeh University

<sup>4</sup>Chang Gung Memorial Hospital

MOST Project NO. NSC 101-2623-E-212-001-D

## Abstract

This study mainly uses the diffusion effect of copper-titanium eutectic reaction to develop and discuss the optimal welding parameters design of two different materials, and observes the effect of adding graphene on the weld of copper-titanium diffusion bonding. The results show that the optimal diffusion bonding parameters of Ti-6Al-4V alloy and oxygen-free copper are holding temperature at 878°C for 30 minutes, the highest shear strength is about 123.9 MPa. If appropriate amount of graphene is added, it won't only have a great influence on the hardness of the weld, but the shear strength can still be increased by 8.3%. At the same time, it was found from the observation of the microstructure that the addition of graphene can effectively reduce the generation of precipitates. It can be obtained from the thermal test that the thermal conductivity of the weld can be improved by the addition of graphene, from 4.5°C/min without adding graphene to 5.5°C/min with addition of graphene. In addition, it was found from the results of bacteriostatic experiments that both Cu and Ti were excellent antibacterial metals; when the volume of the test specimen increased, the bacteria ratio increased significantly. Moreover, the addition of graphene didn't obviously reduce the bacteriostatic ability of the weld.

**Key words:** Diffusion bonding, Graphene, Thermal test, Bacteriostatic

# 石墨烯塗佈於銅箔對A6061鋁合金真空硬銲性質研究

王柏元、李義剛

大葉大學材料科學與工程學系  
51591 彰化縣大村鄉學府路 168 號

## 摘要

真空硬銲過程中，銲縫內會產生共晶反應，兩者之間介面會產生具有低強度和高電阻的脆性金屬間化合物(IMC)，當添加微量石墨烯時，發現到銲縫內部生成大量金屬間化合物，但種類大幅減少，提高添加量至 0.03 wt.%時，則會因為石墨烯的阻隔導致銲縫內部反應減少產生孔洞。但添加石墨烯具有提高熱傳導效率的影響，在兩種添加量皆有發現，且銲縫兩端皆沒有產生明顯溫度差。

**關鍵詞：**石墨烯、真空硬銲、金屬間化合物

## Study on Vacuum Brazing Properties of A6061 Aluminum Alloy Coated with Graphene on Copper Foil

Bo-Yuan Wang and I-Kon Lee

*Department of Materials Science and Engineering, Da-Yeh University,  
168 University Road, Dacun, Changhua 51591, Taiwan*

### Abstract

During the vacuum brazing process, a eutectic reaction occurs in the weld, and a brittle intermetallic compound (IMC) with low strength and high electrical resistance is produced between the two interfaces. When a trace amount of graphene is added, the inside of the weld is found. A large number of intermetallic compounds, but the type is greatly reduced, and when the addition amount is increased to 0.03 wt.%, the internal reaction of the weld is reduced due to the barrier of graphene to cause voids. However, the addition of graphene has the effect of improving the heat transfer efficiency, and both of them are found, and no significant temperature difference is produced at both ends of the weld.

**Key words:** graphene, vacuum brazing, intermetallic compounds



# 「GRP/金屬」異材膠合之耐鹽霧試驗性能改進研究

李義剛<sup>1</sup>、王秀哲<sup>2</sup>、\*王晟宇<sup>1</sup>、洪定勝<sup>3</sup>

<sup>1</sup>大葉大學材料科學與工程學系

<sup>2</sup>大葉大學醫療器材設計與材料碩士學位學程

<sup>3</sup>大葉大學醫療器材設計與材料學士學位學程

## 摘要

異材接合是指將不同性質的材料使用適合的方式進行接合，使用的接合方式包含：銲接、膠合、樁接、螺栓……等等。異材接合的目的為，同時使用兩個或兩個以上的材料之性能，這時接合方式將是重點，根據不同的接合方式皆會得到不同的強度。本次使用的接合方式為膠合，使用具有黏附性的膠體，塗覆均勻在材料的表面，再進行相互接合，膠體可使兩種材料固定成為一體。

本研究係探討將不同表面粗糙度的低碳鋼與GRP使用結構膠、結構膠-界面膠、結構膠-石墨烯等三種不同的做法進行異材接合，並進行鹽霧試驗(24 hr-120 hr)來比較在模擬海洋環境的加速老化測試，試件將進行後續的壓剪強度測試及破斷面分析。

經實驗後發現：在破斷面的觀察發現，界面膠的接合性比石墨烯好，且鹽霧後的鋼-界面膠(石墨烯)接合處並無觀察到鹽霧的侵入。表面粗糙度的大小對石墨烯-結構膠的壓剪強度有明顯的影響，但在界面膠-結構膠試片中則不明顯。在120 hr的鹽霧試驗後，兩者壓剪強度分別下降16%和22%；其中間層與基底金屬的接合處未觀察到間隙腐蝕的現象。

**關鍵詞：**異材接合、石墨烯、界面膠、鹽霧試驗、表面粗糙度

## Study on Improvement of Salt Spray Resistance Performance of “GRP/Metal” Dielectric Bonding

I-Kon Lee<sup>1</sup>, X.Z. Wang<sup>2</sup>, Cheng-Yu Wang<sup>1</sup>, and Ding-Sheng Hong<sup>3</sup>

<sup>1</sup>*Department of Materials Science and Engineering, Da-Yeh University*

<sup>2</sup>*Master program for design and materials for medical equipment and devices, Da-Yeh University*

<sup>3</sup>*Bachelor program for design and materials for medical equipment and devices, Da-Yeh University*

### Abstract

“Different material joining” means joining materials of different properties in a suitable manner, using joining methods including: welding, gluing, splicing, bolting, etc. The purpose of the dissimilar material joining is to use the properties of two or more materials at the same time. In this case, the joining method will be the key point, and different strengths will be obtained according to different joining methods. The joining method used in this time is gluing, using an adhesive colloid, coating uniformly on the surface of the material, and then joining each other, and the colloid can fix the two materials into one body.

This study explores the different materials of different surface roughness of low carbon steel and GRP using structural adhesive, structural adhesive-interface adhesive, structural adhesive-graphene and other three different methods, and salt spray test (24 hr-120 hr) Comparing the accelerated aging test in the simulated marine environment, the test piece will be subjected to subsequent compression-shear strength test and fracture-section analysis.

After the experiment, it was found that the interfacial adhesion was better than graphene in the fracture section, and no salt mist intrusion was observed at the joint of the steel-interface gel (graphene) after the salt spray. The surface roughness has a significant effect on the compressive shear strength of graphene-structural adhesives, but not in the interface adhesive-structural adhesive test strips. After the 120 hr salt spray test, the compressive shear strength decreased by 16% and 22%, respectively; no crevice corrosion was observed at the joint between the intermediate layer and the base metal.

**Key words:** Dielectric Bonding graphene, interface gel, salt spray test, surface roughness

# 以溶膠—凝膠法製備 $MgAl_2O_4$ 及其特性之研究

張莉毓 王怡雯 黃思瑜

國立屏東科技大學機械工程系  
91201 屏東縣內埔鄉老埤村學府路 1 號

## 摘要

本研究利用溶膠—凝膠法製備鎂鋁尖晶石( $MgAl_2O_4$ )，探討摻雜不同濃度Mn，經由750°C煅燒後之結構分析。經X-ray繞射分析(XRD)、掃描式電子顯微鏡分析(SEM)、穿透式電子顯微鏡分析(TEM)該材料之微結構與性質，並探討相同溫度下不同摻雜比例的Mn對 $MgAl_2O_4$ 結構與性質之影響。

由XRD分析得知， $MgAl_2O_4$ 結果顯示在煅燒溫度750°C持溫2小時的條件下，就可以形成 $MgAl_2O_4$ 六方尖晶石結構(Fd3m, 227)，且純的 $MgAl_2O_4$ 的晶粒大小為16.19 nm，隨著Mn摻雜比例升高從1 mol%到10 mol%，晶粒尺寸分別為15.35 nm-15.96 nm，有愈來愈大的趨勢，因此適量的摻雜錳有助於抑制晶粒的成長。

**關鍵詞：**溶膠—凝膠法， $MgAl_2O_4$ ，摻雜錳

## Preparation and characterization of $MgAl_2O_4$ by Sol-Gel Method

Lay Gaik Teoh, Yi-Wen Wang, and Si-Yu Huang

*Department of Mechanical Engineering, National Pingtung University of Science and Technology,  
One Shuefu Road, Neipu, Pingtung 91201, Taiwan.*

### Abstract

In this experiment, magnesium-aluminate spinel ( $MgAl_2O_4$ ) were prepared by sol-gel method. XRD, SEM, and TEM were used to characterize the microstructure of the samples. The effect of the additive of Mn and the calcination temperature (750°C) on the microstructure of  $MgAl_2O_4$  are also investigated in this study.

XRD analysis showed that hexagonal spinel structure (Fd3m, 227) of  $MgAl_2O_4$  were formed after calcined at 750°C for 2 hours, and the grain size of pure  $MgAl_2O_4$  was 16.19 nm. As the amount of Mn doping ratio increases from 1 mol% to 10 mol%, the grain size ranges from 15.35 nm to 15.96 nm, which is a trend of increasing. Therefore, an appropriate amount of doped manganese contributes to the suppression of grain growth.

**Key words:** Sol-gel,  $MgAl_2O_4$ , Mn Doped

# 以溶膠—凝膠法製備 $\text{CaAl}_2\text{O}_4$ 及其特性之研究

張莉毓 黃資庭 李晉言

國立屏東科技大學機械工程系  
91201 屏東縣內埔鄉老埤村學府路 1 號

## 摘要

本研究利用三嵌段兩性共聚物F127作為天然模板，以溶膠—凝膠法合成 $\text{CaAl}_2\text{O}_4$ ，硝酸鋁與硝酸鈣為前驅物，及硝酸鈾為摻雜Ce的來源。經X-ray繞射分析、掃描式電子顯微鏡和紫外光—可見光光譜儀分析該材料之微結構與性質，並探討 $950^\circ\text{C}$ 煅燒溫度及不同Ce摻雜量對 $\text{CaAl}_2\text{O}_4$ 的結構與性質影響。

由XRD分析得知， $\text{CaAl}_2\text{O}_4$ 為尖晶石結構，並發現在摻雜時亦有 $\text{CeO}_2$ 之雜峰形成。由SEM觀察得知，可以發現有鈣之析出物，並且顆粒大小分佈不均之現象。最後PL分析得知 $\text{CaAl}_2\text{O}_4$ 之發光強度最強。並且由CIE色度坐標得知為藍色光譜。

**關鍵詞：**溶膠—凝膠法，鋁酸鈣、摻雜鈾

## Preparation and characterization of $\text{CaAl}_2\text{O}_4$ by Sol-Gel Method

Lay Gaik Teoh, Zi-Ting Huang, and Chin-Yen Lee

*Department of Mechanical Engineering, National Pingtung University of Science and Technology,  
One Shuefu Road, Neipu, Pingtung 91201, Taiwan.*

### Abstract

In this study, the triblock amphoteric copolymer F127 was used as a natural template, and the sol-gel method was used to prepare  $\text{CaAl}_2\text{O}_4$ . Aluminium nitrate, calcium nitrate and cerium nitrate (dopant) as precursors. The microstructure and properties of the materials were analyzed by X-ray diffraction analysis, scanning electron microscope and UV-vis spectrometer. The effect of Ce and calcination temperature  $950^\circ\text{C}$  to the structure and properties will also be investigated.

XRD analysis showed that  $\text{CaAl}_2\text{O}_4$  was a spinel structure, and it was found that a peak of  $\text{CeO}_2$  was appeared during doping. It was also observed by SEM that a precipitate of calcium was found and the particle size distribution was less uniform. Finally, PL analysis showed that  $\text{CaAl}_2\text{O}_4$  had the strongest luminescence intensity. And it is known as the blue spectrum by the CIE chromaticity coordinates.

**Key words:** sol-gel method,  $\text{CaAl}_2\text{O}_4$ , Ce doping

# 以溶膠—凝膠法製備 $\text{ZnAl}_2\text{O}_4$ 及其特性之研究

張莉毓 韋伯勳 李晉言

國立屏東科技大學機械工程系  
91201 屏東縣內埔鄉老埤村學府路 1 號

## 摘要

本研究利用三嵌段兩性共聚物F127作為天然模板製備 $\text{ZnAl}_2\text{O}_4$ ，摻雜不同比例Mn，使用溶膠-凝膠法，經由 $900^\circ\text{C}$ 和 $950^\circ\text{C}$ 煅燒後而生成螢光粉。經X-ray繞射分析、掃描式電子顯微鏡、穿透式電子顯微鏡分析該材料之微結構與性質，並探討不同的煅燒溫度及摻雜比例對 $\text{ZnAl}_2\text{O}_4$ 結構與性質之影響。

由XRD結果得知 $\text{ZnAl}_2\text{O}_4$ 為尖晶石結構Fd3m空間群，並發現在煅燒 $900^\circ\text{C}$ 時會有ZnO之雜峰出現。由SEM觀察 $\text{ZnAl}_2\text{O}_4$ 表面型態發現，在未摻雜與摻雜Mn之 $\text{ZnAl}_2\text{O}_4$ 皆有團聚的現象，並隨著煅燒溫度愈高，粒子之間的團聚愈明顯。由TEM  $d$ 值更進一步證實摻雜0.1 mol% Mn之 $\text{ZnAl}_2\text{O}_4$ 屬於 $\text{ZnAl}_2\text{O}_4$ 之尖晶石結構。

**關鍵詞：**溶膠—凝膠法、鋁酸鋅、摻雜錳

## Preparation and Characterization of $\text{ZnAl}_2\text{O}_4$ Phosphors by Sol-Gel Method

Lay Gaik Teoh, Bo-Shiun Wei, and Chin-Yen Lee

*Department of Mechanical Engineering, National Pingtung University of Science and Technology,  
One Shuefu Road, Neipu, Pingtung 91201, Taiwan.*

### Abstract

In this study,  $\text{ZnAl}_2\text{O}_4$  was prepared by sol-gel method with a copolymer F127 as a natural template, doped with different amounts of Mn, and calcined at  $900^\circ\text{C}$  and  $950^\circ\text{C}$ . The microstructure and properties of the material were analyzed by X-ray diffraction analysis, scanning electron microscopy and transmission electron microscopy. The effects of the calcination temperatures and the additive of Mn on the structure and properties of  $\text{ZnAl}_2\text{O}_4$  were also investigated.

XRD results showed that  $\text{ZnAl}_2\text{O}_4$  was a spinel structure and Fd3m space group, but peaks related to isolated ZnO were observed after calcination at  $900^\circ\text{C}$ . The surface morphology of  $\text{ZnAl}_2\text{O}_4$  was observed by SEM. It were found that the undoped and Mn-doped  $\text{ZnAl}_2\text{O}_4$  agglomerated, and the higher the calcination temperature, the more agglomerated between the particles. The  $d$  value of TEM confirmed that Mn-doped  $\text{ZnAl}_2\text{O}_4$  (doped with 0.1 mol%) was cubic  $\text{ZnAl}_2\text{O}_4$  spinel structure

**Key words:** sol-gel method,  $\text{ZnAl}_2\text{O}_4$ , Mn doping

# 以溶膠—凝膠法製備 $\text{LaAlO}_3$ 及其特性之研究

張莉毓 余尚恩 羅國竣

國立屏東科技大學機械工程系  
91201 屏東縣內埔鄉老埤村學府路 1 號

## 摘要

本實驗製備樣品粉末之方法為溶膠—凝膠法，以三嵌段兩性共聚物F-127做為有機分子模板，再分別以硝酸鋁、硝酸鏷及硝酸鈾做為 $\text{LaAlO}_3$ 及摻雜元素Ce離子(0.01 mol%)之前驅物，經製程溫度 $950^\circ\text{C}$ 煅燒後獲得 $\text{LaAlO}_3$ 樣品粉末，最後經由X-Ray 繞射分析(XRD)、掃描式電子顯微鏡(SEM)、穿透式電子顯微鏡(TEM)等材料分析來探討其結構及性質。

由XRD分析結果得知利用溶膠—凝膠法於 $950^\circ\text{C}$ 以上即可合成出 $\text{LaAlO}_3$ ，其晶粒大小為34.83 nm，屬於三方晶系中之菱面體。且摻雜量為0.01 mol%時，其晶粒卻稍微大於純 $\text{LaAlO}_3$ 樣本，推測其原因為此濃度之Ce離子的摻雜量太少不足以產生抑制，或者以其他的形式存在於晶格外，因此主體晶體之晶粒成長沒受到抑制。

**關鍵詞：** 鋁酸鏷、溶膠—凝膠法、鈾摻雜

## Preparation and characterization of $\text{LaAlO}_3$ by Sol-Gel Method

Lay Gaik Teoh, Shang-En Yu, and Guo-Chun Luo

*Department of Mechanical Engineering, National Pingtung University of Science and Technology,  
One Shuefu Road, Neipu, Pingtung 91201, Taiwan.*

### Abstract

$\text{LaAlO}_3$  and Ce doped  $\text{LaAlO}_3$  were prepared by sol-gel process with a triblock copolymer F-127 as an organic template, and aluminum nitrate, lanthanum nitrate and cerium nitrate (doped with 0.01 mol%) as precursors. The synthesized products then calcined at  $950^\circ\text{C}$ . X-Ray diffraction analysis (XRD), scanning electron microscopy (SEM) and transmission electron microscopy (TEM) were used to characterize the microstructure of the samples.

XRD analysis showed that  $\text{LaAlO}_3$  could be synthesized by the sol-gel method for  $950^\circ\text{C}$  calcination. The grain size was about 34.83 nm, which was rhombohedra of the trigonal system. When the addition of dopant was 0.01 mol%, the crystal grains were slightly larger than the pure  $\text{LaAlO}_3$  sample. It was presumed to be due to the fact that the doping amount of Ce ion is not enough to inhibit the grain growth, or exist in other form outside the crystal lattice, so the grain growth of the main crystal is not suppressed.

**Key words:**  $\text{LaAlO}_3$ , Sol-Gel method, Ce-doped

# 氧化奈米多孔矽作為緩衝層改善碳化矽/矽異質接面結構 與元件之特性

吳坤憲 鄭傑安

南臺科技大學光電工程系  
71005 臺南市永康區南台街 1 號

## 摘要

本論文中研究使用氧化奈米多孔矽作為緩衝層來降低碳化矽與矽兩種材料間因熱膨脹係數差異與晶格不匹配的影響，改善製作於矽基板上之碳化矽光檢測元件之特性。經由掃描式電子顯微鏡(SEM)與X光繞射儀(XRD)的量測分析得知，沉積在氧化奈米多孔矽作為緩衝層的碳化矽薄膜具有更好的薄膜品質以及結晶性，異質接面缺陷密度大幅減少；對紫外光亦具有較高的光響應度，同時對可見光至紅外光的響應大幅地衰減。製作於緩衝層上之碳化矽光檢測器具很高的光/暗電流比，顯示氧化奈米多孔矽緩衝層可大幅改善碳化矽/矽異質接面元件之性能。

**關鍵詞：**氧化奈米多孔矽，碳化矽，緩衝層，異質接面

## Oxidized Nanoporous Silicon as Buffer Layers for Improving the Characteristics of SiC/Si heterojunction Devices

Kuen-Hsien Wu and Chieh-An Cheng

*Department of Electro-Optical Engineering, Southern Taiwan University of Science and Technology, One Nan-Tai Street, Yung Kang, Tainan 71005, Taiwan*

### Abstract

In this study, oxidized nano-porous Si (ONPS) was proposed as the buffer layer to overcome the problems coming from the large lattice mismatch and difference of thermal expansion coefficient between SiC and Si and to improve the performance of SiC photodetectors fabricated on Si substrates. From the analysis by SEM and XRD, it is found that SiC films deposited on ONPS buffer layers have better crystallinity and film quality than those formed directly on Si substrates. Most importantly, the as-deposited SiC films exhibit high ultra-violet (UV) photoresponses with greatly suppressed visible-to-infrared responses. The fabricated SiC-ONPS-Si photodiodes obtained high photo-to-dark current ratio for UV light, indicating ONPS buffer layers can effectively improve the SiC/Si heterojunction devices.

**Key words:** oxidized nano-porous Si, silicon carbide, buffer layer, heterojunction

# 具「矽(核)/氧化矽(殼)」奈米顆粒的氧化多孔矽薄膜 之製備與光導電特性分析

吳坤憲 鄭傑安

南臺科技大學光電工程系  
71005 臺南市永康區南台街1號

## 摘要

本研究中先以電化學蝕刻技術在矽基板製備奈米多孔矽薄膜，然後再以特定製程參數之快熱氧化法將奈米多孔矽層轉成具有均勻分布的「矽(核)/氧化矽(殼)」奈米顆粒之氧化奈米多孔矽薄膜。實驗結果顯示，這種特殊的氧化奈米多孔矽薄膜對短波長光具有很高的光響應性，當入射光波長為375 nm時，其光響應度達80 mA/W；以所製備的氧化奈米多孔矽薄膜作為光吸收層所製作的光二極體元件，其光/暗電流比可達40倍以上。吾人將此光導電性歸因於薄膜中的「矽(核)/氧化矽(殼)」奈米顆粒，論文中提出一個載子多重穿過程來解釋光電流形成的機制。

**關鍵詞：**奈米多孔矽，奈米顆粒，光導電度，光響應度

## Preparation and Photoconductive Characteristics of Oxidized Nanoporous Silicon with “Si-core/SiO<sub>x</sub>-shell” Nanoparticles

Kuen-Hsien Wu and Chieh-An Cheng

*Department of Electro-Optical Engineering, Southern Taiwan University of Science and Technology, One Nan-Tai Street, Yung Kang, Tainan 71005, Taiwan*

### Abstract

In this study, nano-porous silicon (NPS) thin films were prepared on silicon substrates by use of an electrochemical etching technique. The NPS layers were then transformed into oxidized NPS (ONPS) films that were embedded with uniformly distributed “Si-core/SiO<sub>x</sub>-shell” nanoparticles through a rapid-thermal-oxidation (RTO) method with specific oxidation parameters. Experimental results show that the as-prepared ONPS thin films display high photoconductivity when responding to ultra-violet (UV) light. For the incident light of 375-nm, the ONPS films get a high photoresponsivity of 80 mA/W. Photodiodes fabricated with the ONPS films as the light-absorption layers obtain a large photo-to-dark ratio up to 40. A tentative model in which carriers transport between the core-shell nanoparticles by multi-tunneling mechanism was proposed to explain the generation of photocurrent.

**Key words:** nano-porous silicon, nanoparticles, photoconductivity, photoresponsivity

# 化學氣相傳輸法成長氧化鎵奈米柱並應用於 深紫外光偵測器之研究

張漢威<sup>1</sup>、歐信良<sup>2\*</sup>、李浚瑜<sup>2</sup>、張鈞喻<sup>3</sup>、郭楷元<sup>3</sup>、黃柏嘉<sup>3</sup>、林源倍<sup>1</sup>

<sup>1</sup> 國立交通大學電控工程研究所

<sup>2</sup> 大葉大學醫療器材設計與材料學士學位學程

<sup>3</sup> 大葉大學材料科學與工程學系

(MOST 107-2218-E-212 -001)

\*E-mail: slo@mail.dyu.edu.tw

## 摘要

本研究利用化學氣相傳輸法在藍寶石基板上製備氧化鎵奈米柱。實驗過程中，使用電子束蒸鍍先鍍上一層奈米金薄膜(Au)當作催化劑，反應源材料為氧化鎵粉末，並且將之與碳粉混合(碳粉用來還原的作用)。成長過程中通入氬氣(100 sccm)與氧氣(5~40 sccm)的混合氣體，氬氣與氧氣分別做為載氣及反應氣體，而粉末的加熱溫度為900~950°C。最後使用黃光微影、電子束蒸鍍……等製程在氧化鎵奈米柱上製備金屬電極，製作出「金屬-半導體-金屬」(metal-semiconductor-metal, MSM)深紫外光偵測器。由SEM與XRD量測結果可得知，如果沒有添加Au催化劑，無論是在哪種成長條件下，氧化鎵是傾向薄膜成長的。然而當Au催化劑加入後，氧化鎵能夠很容易地以奈米柱的型態成長在基板上。本研究將氧化鎵奈米柱製作成MSM光偵測器，同樣成長條件下製備的氧化鎵，有添加Au催化劑所製備的氧化鎵奈米柱光偵測器具有較低的暗電流值(與沒有添加Au催化劑所製備的氧化鎵相比)，這應該是氧化鎵奈米柱同時具有較大的表面積與較高的結晶性所導致。

**關鍵詞：**化學氣相傳輸、氧化鎵、奈米柱、深紫外光偵測器

## Ga<sub>2</sub>O<sub>3</sub> nanorods grown by the chemical vapor transport method for deep ultraviolet photodetector

### Abstract

In this research, the Ga<sub>2</sub>O<sub>3</sub> nanorods were grown on sapphire substrate in a high-temperature tube furnace system by the chemical vapor transport method. For the growth of Ga<sub>2</sub>O<sub>3</sub> nanorods, the Ga<sub>2</sub>O<sub>3</sub> powders are used as the source material. In addition, the argon and oxygen are employed as the carrier and reaction gases, respectively. The e-beam evaporated Au film is employed as the catalyst for the growth of Ga<sub>2</sub>O<sub>3</sub> nanorods. Various growth temperatures (900°C and 950°C) and oxygen flow rates (5, 10, 20 and 40 sccm) are used to grow the Ga<sub>2</sub>O<sub>3</sub> nanorods. Crystal quality of Ga<sub>2</sub>O<sub>3</sub> nanostructures is investigated by x-ray diffraction (XRD). In order to understand the growth mechanism of Ga<sub>2</sub>O<sub>3</sub> nanostructures, scanning electron microscopy (SEM) and transmission electron microscopy (TEM) are used. Furthermore, the Ga<sub>2</sub>O<sub>3</sub> nanorods prepared with various growth parameters are used as the active layers of metal-semiconductor-metal deep ultraviolet (DUV) photodetectors (PDs). Based on the experimental results, the Ga<sub>2</sub>O<sub>3</sub> always exhibits the film-type morphology without the Au catalyst during the growth. However, after adding the Au catalyst, the Ga<sub>2</sub>O<sub>3</sub> nanorods are easily formed. On the other hand, the crystal quality of Ga<sub>2</sub>O<sub>3</sub> is obviously improved with the addition of Au catalyst. In comparison to the PD fabricated with the film-type Ga<sub>2</sub>O<sub>3</sub>, the PD with the Ga<sub>2</sub>O<sub>3</sub> nanorods possesses a much lower dark current. These results reveal that the Ga<sub>2</sub>O<sub>3</sub> nanorods are highly potential for photodetector applications.

**Key words:** chemical vapor transport, Ga<sub>2</sub>O<sub>3</sub>, nanorod, deep ultraviolet photodetector



# 以反射光譜測量透明薄膜之研究

林育詩 宋皇輝

大葉大學材料科學與工程學系  
51591彰化縣大村鄉學府路168號

## 摘要

本研究主要探討如何利用分析薄膜反射光譜，以獲得透明薄膜之厚度與折射率等參數。實驗首先以光譜儀量測薄膜反射率譜線，再利用多重反射干涉理論得到的反射率對波長關係。再藉由適當的分析步驟可從中解算出適當的薄膜折射率以及其厚度，使其對應之反射光譜可良好吻合實驗結果。

**關鍵詞：**透明薄膜，折射率，干涉，薄膜厚度

## Study of Transparent Thin Film Properties by Reflectance Spectroscopy

Yu-Shi Lin and Huang-Huei Sung

*Department of Materials Science and Engineering, Da-Yeh University,  
168 University Road, Dacun, Changhua 51591, Taiwan*

### Abstract

This study focuses on how to analyze the reflection spectrum of a transparent thin film to obtain parameters such as the thickness and refractive index of the film. Firstly, the reflectance spectrum were measured by a UV-VIS spectrometer, and then obtained reflectance data were analyzed through the multiple reflection interference theory. The refractive index and thickness of the film can be calculated by an appropriate analysis step, so that the corresponding reflection spectrum can be well matched to the experimental results.

**Key words:** transparent film, refractive index, interference, film thickness

# 以 LPCVD 成長多向性氧化鋅奈米柱研究

鄭州良<sup>1</sup> 柳育騏<sup>1</sup> 宋皇輝<sup>1,2</sup>

<sup>1</sup>大葉大學醫療器材設計與材料碩士學位學程

<sup>2</sup>大葉大學材料科學與工程學系

## 摘要

本研究是先利用射頻磁控濺鍍機(RF magnetron Sputter)，在 SiO<sub>2</sub> 基板上成長出氧化鋅薄膜當作晶種層，再利用低壓化學氣相沉積(Low-pressure CVD, LPCVD)方法，在氧化鋅薄膜上成長出氧化鋅奈米柱。先利用氧化鋅靶在濺鍍機中將 SiO<sub>2</sub> 基板鍍上氧化鋅薄膜，再以鋅粉末揮發為蒸氣源，在低壓的石英爐中進行成長。在過程中，通入氬氣與氧氣，分別做為攜帶氣體與反應氣體。本實驗是透過調整氬氣或調整氧氣的通入量、基板位置等條件，控制成長出不同分佈及形貌的氧化鋅奈米柱，並以光致發光、XRD、掃描式電子顯微鏡觀察成長樣品之表面形貌與結構。

**關鍵詞：**低壓化學氣相沉積、氧化鋅、奈米柱

## Growth of multi-directional zinc oxide nano-pillars by LPCVD

Zhou-Liang Zheng<sup>1</sup>, Yu-Chi Liu<sup>1</sup>, and Huang-Huei Sung<sup>1,2</sup>

<sup>1</sup>Master Program for Design and Materials for Medical Equipment and Devices, Da-Yeh University

<sup>2</sup>Department of Materials Science and Engineering, Da-Yeh University  
168 University Road, Dacun, Changhua 51591, Taiwan

### Abstract

In this research, a RF magnetron Sputter was used to deposit a zinc oxide film on SiO<sub>2</sub> substrate as a seed layer, and then a low-pressure CVD (LPCVD) method was used to grow the zinc oxide nanorods on the prepared substrate. The SiO<sub>2</sub> substrate is first plated with a zinc oxide film in a sputtering machine using a zinc oxide target, and then the zinc powder is volatilized into a vapor source, and grown in a low-pressure quartz furnace. In the process, argon gas and oxygen gas are introduced as carrier gas and reaction gas, respectively. In this experiment, the conditions of growing zinc oxide nanorods were controlled by the flowing rate of the argon and oxygen, and the position of substrates. The crystallinity of the grown samples were examined by the X-ray powder diffraction spectrometer. The distributions, surface morphology and structure of the nanorods were observed by scanning electron microscopy. Finally, the band gaps of the sample were studied by the photoluminescence.

**Key words:** Low-pressure chemical vapor deposition, ZnO, nanorod

# 鐵鉬鎳合金的磁滯曲線隨成長溫度變化的影響

范榮權 陳則樸 蔡育哲

大葉大學電機工程學系  
51591 彰化縣大村鄉學府路 168 號

## 摘要

磁性物質用於磁通閘的研究已有若干年的歷史，這些物質可以作為量測低磁場的元件，最常用的是量測地球的磁場，利用磁性物質的磁飽和特性，將地球的磁場從磁性物質中排開，並切割線圈，產生電訊號，藉此攫取地球磁場的強度。本文研究鐵鉬鎳合金的磁滯特性，利用振動樣品磁力計的儀器量取磁滯曲線，分析不同的成長溫度下磁飽和磁場、殘磁及矯頑力，並由X光繞射實驗可分析鐵鉬鎳合金的結晶結構，可以發現有兩相合金的組成（ $\text{Fe}_2\text{Ni}_3$ 、 $\text{MoNi}$ ），因此造成磁滯曲線中飽和磁場隨成長溫度有不規則的現象發生。

**關鍵詞：**磁性物質，磁滯曲線，磁通閘，X光繞射

## The Effect of Hysteresis in Fe-Mo-Ni alloy on growth temperature

Jung-chuan Fan, Che-Pu Chen, and Yu-Che Tsai

*Department of Electrical Engineering, Da-Yeh University,  
168 University Road, Dacun, Changhua 51591, Taiwan*

### Abstract

Magnetic materials have been used in flux gate research for several years. These materials can be used as a device for measuring low magnetic fields. The most useful example is to measure the magnetic field of the earth. Using the magnetic saturation characteristics of the magnetic material, the magnetic field of the earth is driven out from the magnetic material, and induced an electrical signal by a pick up coil. The electrical signal value indicates the strength of the Earth's magnetic field. In this paper, the hysteresis characteristics of Iron-Molybdenum-Nickel alloys are studied. The hysteresis curve of the vibrating sample magnetometer is used to analyze the magnetic saturation magnetic field, residual magnetism and coercive force at different growth temperatures. From the X-ray diffraction experiment, the crystal structure of the iron-molybdenum-nickel alloy can be analyzed. There are two phase compositions ( $\text{Fe}_2\text{Ni}_3$ ,  $\text{MoNi}$ ) determined in this alloy. It indicates that causes a reason of irregular phenomenon in the hysteresis curve of the saturation magnetic field with growth temperature.

**Key words:** magnetic material, hysteresis curve, flux gate, X-ray diffraction

# 應用深度學習於合成孔徑雷達影像的辨識

陳木松 陳言愷

大葉大學電機工程學系  
51591 彰化縣大村鄉學府路 168 號

## 摘要

圍棋程式AlphaGo深度學習的成功事例是機器學習的重要突破，而神經網路是機器學習演算法最常用的模型，它模擬生物的神經連結分析學習大量的資料，所以具備強大的學習能力，也可以完成複雜的圖型辨識等應用。由於深層卷積神經網路更兼具處理二維影像資料與特徵擷取的能力，所以本研究將運用卷積神經網路於合成孔徑雷達影像的地物辨識。但受限於遙測影像的頻譜，如果地物的分佈有重疊交錯，可能造成影像中的像素可能包含有不同類別的地表覆蓋物。為進一步提高卷積神經網路對合成孔徑雷達影像的辨識率，本研究嘗試增加類別分離性度量於誤差函數，希望(1)相同聚類內的距離平方和最小化，而且(2)不同聚類間的距離平方和最大化，以增加地物分類辨識的有效性。最後本文應用深度學習於手寫數字資料庫辨識，與舊金山灣區的影像辨識，以驗證研究成果。

**關鍵詞：**深度學習，合成孔徑雷達影像，卷積神經網路

## Application of Deep Learning in Recognition of Synthetic Aperture Radar Image

Mu-Song Chen and Yen-Kai Chen

*Department of Electrical Engineering, Da-Yeh University, Dacun, Changhua 51591, Taiwan*

### Abstract

The success of the computer program AlphaGo applies the deep learning algorithm that plays the board game Go. This is a big event in the history of machine learning. Among the deep learning structure, the convolutional neural network (CNN) is the most popular one with the ability for classification of complex land classification tasks. In the study, the CNN is applied for the recognition of Synthetic Aperture Radar (SAR) Image. Due the limited spectrum and resolution, the general distributions of the earth's surface are easily overlapped or combined with different features. To solve this problem with the CNN, this study intends to increase the class separation for different classes. In this sense, the distance Within-cluster is minimized as well as the distance Between-cluster is also maximized. Simulation results confirm the validity of the proposed methods.

**Key words:** Deep learning, Synthetic Aperture Radar Image, Convolutional neural network

# 氧化鋁絕緣層溫度變化製備與量測

許家豪<sup>1</sup> 梁秭瑋<sup>1</sup> 宋皇輝<sup>1,2</sup>

<sup>1</sup>大葉大學醫療器材設計與材料碩士學位學程

<sup>2</sup>大葉大學材料科學與工程學系

51591 彰化縣大村鄉學府路 168 號

## 摘要

本研究以電場輔助在低溫下，將金屬鋁薄膜氧化成氧化鋁絕緣層。利用電阻絲熱蒸鍍在玻璃基板成長厚度約10 nm的金屬鋁薄膜，透過石英爐管控制樣品溫度，以電壓源提供固定電壓，透過觀察數位電流表的電流的變化，監測氧化鋁層的形成。實驗中固定電壓為0.5 V，溫度控制在80°C至200°C間。利用監測到的電阻變化分析成長過程的氧化層厚度變化。

**關鍵詞：**氧化鋁，熱蒸鍍，薄膜厚度，低溫

## Preparation and measurement of temperature change of alumina insulation

Jia-Hao Hsu<sup>1</sup>, Zih-Wei Liang<sup>1</sup>, and Huang-Huei Sung<sup>1,2</sup>

<sup>1</sup>Master Program for Design and Materials for Medical Equipment and Devices, Da-Yeh University

<sup>2</sup>Department of Materials Science and Engineering, Da-Yeh University

168 University Road, Dacun, Changhua 51591, Taiwan

## Abstract

In this study, an electric field was used to enhance the oxidation of metal aluminum films at low temperature. The thickness of the metal aluminum films were about 10 nm which were grown on glass substrates by the resistive thermal evaporation. During oxidation, the temperature of the sample was controlled by a quartz furnace tube, and the electric field was provided by a voltage source. The formation of the aluminum oxide layer was monitored by observing the change of the current through a ammeter. In the experiment, the provided voltage was fixed at 0.5 V, and the temperature was controlled between 80°C and 200°C. We study the growth of the oxidation layers though the resistance variation during the deposition.

**Key words:** Alumina, Thermal evaporation, membrane thickness, Low temperature

# AC 磁滯曲線與 DC 磁滯曲線特性之研究

范榮權 陳則樸 蔡育哲

大葉大學電機工程學系  
51591 彰化縣大村鄉學府路 168 號

## 摘要

磁滯曲線是研究磁性物質最直接的方式，從磁滯曲線瞭解磁性物質的飽和磁場、殘磁量及矯頑磁場，從數據分析可判斷物質的磁化現象。鐵磁性物質具有非常強烈的磁滯特性，因此可以製造永久磁鐵或者電磁鐵，端看磁滯迴路的矯頑力大小，越小越適合用於電磁鐵的鐵芯。本文利用鐵鉬鎳合金探討磁滯曲線的特性，利用振動樣品磁力計量測鐵鉬鎳磁性物質的 DC 磁滯曲線，分析並判斷樣品的飽和磁場及矯頑力，再利用磁場微擾的方式量測出 AC 磁滯曲線，從 AC 磁滯曲線的量測中可以看出與 DC 磁滯曲線息息相關，DC 的磁滯曲線的微分曲線為 AC 的磁滯曲線，AC 磁滯曲線的極值處為矯頑力的強度大小，因此可由磁場的微擾方式直接量測出鐵鉬鎳合金的磁滯特性。

**關鍵詞：**磁性物質，磁滯曲線，磁通閥，磁場微擾

## Study on Characteristics of AC Hysteresis and DC Hysteresis

Jung-chuan Fan, Che-Pu Chen and Yu-Che Tsai

*Department of Electrical Engineering, Da-Yeh University  
168 University Road, Dacun, Changhua 51591, Taiwan*

### Abstract

The hysteresis curve is the most useful method to study magnetic materials. The hysteresis curve is used to determine the saturation magnetic field, residual magnetic flux and coercive magnetic field of magnetic materials. From the analysis of the measurement data, the magnetization phenomenon of the material can be determined. The ferromagnetic substance has a very strong hysteresis characteristic, so that a permanent magnet or an electromagnet can be defined in these magnetic properties. The coercive force of the hysteresis loop presents an importantly parameter. The smaller value of coercive force is the more suitable for the core of the electromagnet. In this paper, the characteristics of the hysteresis curve are investigated by using iron-molybdenum-nickel alloy. The DC hysteresis curve of the FeMoNi magnetic material is measured by the Vibrating Sample Magnetometer, and the saturation magnetic field and coercive force of the sample are analyzed by the DC hysteresis. The AC hysteresis curve is measured by the magnetic field perturbation method. It can be understood that the AC hysteresis curve is very closely related to the DC hysteresis curve. AC hysteresis curve is approximately to match the differential of DC hysteresis curve. The extreme value of the AC hysteresis curve can be indicated the strength of the coercive force. It indicates that the hysteresis characteristics of the iron-molybdenum-nickel alloy can be directly measured by the perturbation of the magnetic field.

**Key words:** magnetic material, hysteresis curve, flux gate, magnetic field perturbation

# 以非對稱式交流電泳沉積石墨烯薄膜之研究

陳喬毅<sup>1</sup> 王聖傑<sup>1</sup> 姚品全<sup>2,3\*</sup>

<sup>1</sup>大葉大學醫療器材設計與材料碩士學位學程

<sup>2</sup>大葉大學材料科學與工程學系

<sup>3</sup>大葉大學環境工程學系

51591 彰化縣大村鄉學府路 168 號

\*pcyao@mail.dya.edu.tw

## 摘要

本研究以天然石墨粉為原料，以改良式哈莫法(Modified Hummer method)，配製石墨烯懸浮液。電泳沉積石墨烯薄膜於導電玻璃(Indium Tin Oxide, ITO)上。為探討電場模式對電泳沉積(Electrophoretic Deposition, EPD)薄膜的影響，分別使用正弦波、三角波、方波等不同波形之非對稱式交流電源(Asymmetric ac Electric Field)。並與傳統的直流電泳沉積(dc-EPD)結果比較。

**關鍵詞：**石墨烯、電泳沉積

# 石墨烯之電泳沉積及表面研究

周祖璇<sup>1</sup> 江至程<sup>2</sup> 姚品全<sup>2,3\*</sup>

<sup>1</sup> 大葉大學醫療器材設計與材料學士學位學程

<sup>2</sup> 大葉大學材料科學與工程學系

<sup>3</sup> 大葉大學環境工程學系

51591 彰化縣大村鄉學府路 168 號

\*pcyao@mail.dya.edu.tw

## 摘要

本實驗利用電泳沉積法，將所製備的石墨烯(Graphene)披覆在導電玻璃基板(TCO)上，觀察樣品表面與型態，及其抑菌之效果。

**關鍵詞：**石墨烯、電泳沉積