

# 行政院國家科學委員會專題研究計畫 期中進度報告

## 總計畫(2/3)

計畫類別：整合型計畫

計畫編號：NSC91-2120-E-002-010-

執行期間：91年08月01日至92年10月31日

執行單位：國立臺灣大學材料科學與工程學研究所

計畫主持人：林唯芳

共同主持人：韋文誠，林清富，張哲政

報告類型：精簡報告

處理方式：本計畫可公開查詢

中 華 民 國 92 年 5 月 26 日

## 行政院國家科學委員會專題研究計畫進度報告

計畫名稱： 奈米光粒子合成, 能隙晶體結構製作與應用-總計劃

計畫編號： NSC 91-2120-E-002-010

執行期限： 91/08/01~92/07/31

計畫主持人: 林唯芳

執行機構： 台灣大學材料科學與工程研究所

### 摘要

本計劃是三年整合型計劃，共分四項子計劃，此為第二年進度報告。本年度成果計有國際專利申請案 2 件，SCI 論文 7 篇，非 SCI 論文 6 篇，國際會議論文 13 篇，國內會議論文 14 篇，科技新聞特報 5 件，總共有 5 位博士生、12 位碩士生參與本計畫研究，248 位學生選修奈米學程。二年累積成果計有國際專利申請案 3 件，SCI 論文 11 篇，非 SCI 論文 7 篇，國際會議論文 19 篇，國內會議論文 25 篇，科技新聞特報 6 件，總共有 11 位博士生、27 位碩士生參與本計畫研究，346 位學生選修奈米學程。

**關鍵字：** 奈米粒子, 發光二極體, 光晶體, 自組性, AFM

本計劃是三年整合型計劃，執行期間由 90 年 8 月起至 93 年 7 月止。計劃的主要目標是製備主動性的光晶體，並開發其應用。本計劃的組織圖，示於圖 1。總計劃由本人主持，子計劃一由韋文誠教授主持，子計劃二由張哲政教授主持，子計劃三由林唯芳教授主持，子計劃四由林清富教授主持。

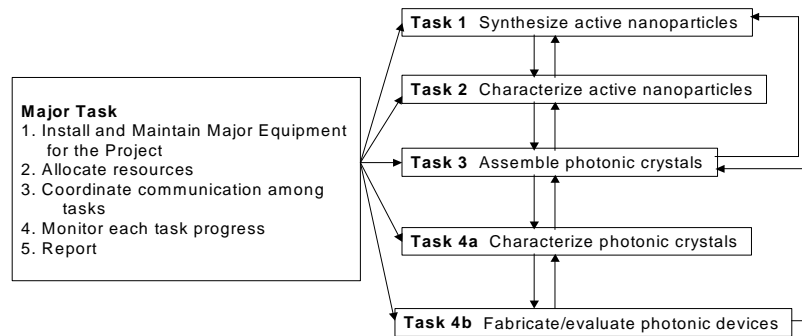


Figure 1 Organization of the Project. Vertical integration among tasks to achieve our goal effectively

總計劃的主要任務如下：

1. 設置及維護主要研究設備
2. 尋求及建立資源
3. 召開會議追蹤各子計劃間的進展並促進各子計劃間的溝通
4. 向國科會及外界報告研究成果及人才訓練

目前各項任務的進度分別討論如下：

### 1. 設置及維護主要研究設備

我們這個研究群本年度採購儀器包括可以分析液體樣品的 AFM 副件及三項分析奈米顆粒的儀器。其中 HPLC-GPC 可以分離並純化奈米顆粒，壹台 Zelta potential meter 測試奈米顆粒等電位，壹台粒徑分析儀測試奈米粒尺寸。其外貌如下列圖所示。(The file size of the figures are too large for the e-form of report. If you are interested in the figures, please contact the author).

### 2. 尋求資源及建立資源

我們建立了一個奈米材料的網站，將我所開奈米材料課程（一學期，3 學分課程）的講義上網供學生及一般有興趣者下載參考，網站並登載最新國內外奈米材料科技發展的消息，其網站為 <http://www.mse.ntu.edu.tw/%7Efrontier>. 目前有

54 位學生選修。我為本校工學院奈米學程的策劃及推行委員，共已有 346 位學生在此學程中學習。

### 3. 召開會議追蹤各子計劃間的進展並促進各子計劃間的溝通

目前已召開 2 次會議(2-15-03, 5-24-03)討論本科技全世界的最新發展，各子計劃的進展情況及設備方面需求。各子計劃間溝通良好，合作密切。

### 4. 向國科會及外界報告研究成果及人才訓練

本研究群的研究工作及成果已受到國內外奈米界的重視，其中有 1 項最特出的事件。以自組成 Au-C60 材料製作單電子電晶體論文 (C. S. Wu, C. D. Chen, S. M. Shih and W. F. Su, “Single-Electron Transistors and Memory Cells with Au Colloidal Islands,” Applied Physics Letters, 81(24), 4595 (2002))，投稿美國物理學會發行的 Appl. Phys. Lett 雜誌，在出版的前一天 (December 9, 2002) 就受到英國 Institute of Physics 的訪問。另外還連續兩個國際科技組織訪問我們(nanotechweb and gateway high tech on-line)，可見我們研究的重要性及新穎性。表 1 列出研究成果及人才訓練狀況總結，詳細資料列於參考文獻及附件中。

#### (1) Accomplishments

表 1 研究成果

Task	Year	SCI	Non	International	Local	Patent	News	Training		
	年 度	Paper	SCI Paper	Conference Paper	Conference Paper	Application	Release	Ph.D	M.S.	Nano- program
main	91	0	0	1	3	0	0	0	1	248
	90	0	0	1	1	0	0	0	1	98
1	91	1	0	2	2	0	0	1	2	0
	90	0	0	1	1	0	0	1	2	0
2	91	2	3	0	0	0	0	0	2	0
	90	0	0	0	2	0	0	0	2	0
3	91	2	0	2	3	0	3	2	2	0

	90	3	1	3	4	1	0	4	7	0
4	91	2	3	8	6	2	2	2	5	2
	90	1	0	1	3	0	1	1	3	0
<b>Sub</b>	91	<b>7</b>	<b>6</b>	<b>13</b>	<b>14</b>	<b>2</b>	<b>5</b>	<b>5</b>	<b>12</b>	<b>248</b>
<b>Total</b>	90	<b>4</b>	<b>1</b>	<b>6</b>	<b>11</b>	<b>1</b>	<b>1</b>	<b>6</b>	<b>15</b>	<b>98</b>
<b>Total</b>		<b>11</b>	<b>7</b>	<b>19</b>	<b>25</b>	<b>3</b>	<b>6</b>	<b>11</b>	<b>27</b>	<b>346</b>

## (2) Publications List

List papers and patents including authors, title and name of journal (meeting proceeding) in the following:

### (A) Research Papers

#### a. SCI

##### *Task 1*

1 T. W. Chen B. Y. Yu, and W. J. Wei, "Ostwald ripening of SiO<sub>2</sub> particles in Stober's Process," submitted to J. Am. Ceram. Soc. 2003

##### *Task 2*

1. J.-Y. Miao, D. W. Hwang, C.-C. Chang, S.-H. Lin, L.-P. Hwang, (2003), "Uniform Carbon Spheres of High Purity Prepared on Kaolin by CCVD", Diamond and Related Materials, in press.

2. C.-C. Chang, M.-C. Shu, (2003) "The Chemical Origin of Defects on Silicon Dioxide Exposed to Ethanol", J. Phy. Chem. in press.

##### *Task 3*

1. R.-M. Ho, H.-W. Fan, Y.-W. Chiang, F.-H. Lin, C.-C. Lin and B.-H. Huang "Nanopatterned Templates from Oriented Polystyrene-Poly(L-lactide) Diblock Copolymer Thin Films" Adv. Mat., submitted (2003).

2.C. S. Wu, C. D. Chen, S. M. Shih and W. F. Su, "Single-Electron Transistors and Memory Cells with Au Colloidal Islands," Applied Physics Letters, 81(24), 4595 (2002)

##### *Task 4*

1. Ching-Fuh Lin, Eih-Zhe Liang, Sheng-Ming Shih, and Wei-Fang Su, "The significance of surface for CdS nanoparticles," Jpn. J. Appl. Phys. 42(6A), pp.L610-L612, **2003**

## **b. Non-SCI**

### ***Task 2***

1. C.-C. Chang, I.-J. Huang, (2002), "The Decomposition of tBAA on the Silicon Surface", in "Mechanisms of Surface and Microstructure Evolution in Deposited Films and Film Structures", J. Sanchez, Jr.; J. G. Amar; R. Murty; G. Gilmer, Eds.; 12.
2. I.-J. Huang, K. Chen, C.-C. Chang, (2002), "Copper Thin-Film Technology and Precursor Decomposition Processes", Chemistry. 60, 419.
3. C.-H. Lung, W.-H. Hung, Y.-W. Yang, S.-M. Peng, C.-C. Chang, (2002), "Bonding Geometry of Atomic Metal Chain Complex on GaN(0001)", Synchro. Rad. Res, Center Rep. II, 118.

### ***Task 4***

1. Peng-Fei Chung, Ting-Wien Su, Ching-Fuh Lin, Miin-Jang Chen, and Wei-Fang Su, "Nano-structured Metal-Oxide-Semiconductor Devices for Efficient Band-edge Electroluminescence," SPIE, Proceedings, Vol. 4654, 2002.
2. Eih-Zhe Liang, Ching-Fuh Lin, and Wei-Fang Su, "CdS Nanoparticles Light-emitting Diode on Si", SPIE, Proceedings, Vol. 4641, 2002.
3. Eih-Zhe Liang, Ching-Fuh Lin, Sheng-Ming Shih, and Wei-Fang Su, "The significant influence of surface states on the electroluminescence of CdS nanoparticles," Proceedings of SPIE, Vol. 4808, pp. 156-164, 2002

## **C. Conference papers**

### **Local**

#### ***Main Task***

- 1.林唯芳,"分子奈米材料與應用,"國科會奈米科技系列研討會奈米材料(1), 奈米國家型計畫辦公室, March 28, 2003, p.47-71 (INVITED)
- 2.林唯芳,"分子奈米材料及其應用," 國科會工程處奈米高分子研發成果推廣發表會, March 12, 2003, p.23 (INVITED)
- 3.林唯芳," 有機無機奈米混成材料," 91 年 10 月 24 日奈米混成材料技術之應用與發展研討會, Part.II p.1-48 (INVITED)

#### ***Task 1***

1. B. Y. Yu and W. J. Wei, "Synthesis of Mono-dispersive SiO<sub>2</sub> Core/TiO<sub>2</sub> shell particles," 中國材料學會 2002 年年會, 台北, 台灣大學, 11/22-23 (2002)
2. W. Wei and T. W. Chen, "Ripening of SiO<sub>2</sub> particles in Stober's process," 中國顆粒學會 2002 年年會暨海峽兩岸顆粒技術研討會, 廣西桂林, 11/3-11/7/2002

#### ***Task 3***

1. 林唯芳, "分子奈米材料及其在元件上的應用(Molecular Nanomaterials and Their Device Application)," Jan 18, 2003 高分子研討會(INVITED)
2. 林唯芳, "Nanoparticles apply on electroluminescence devices," 91年10月9日醇鹽及溶凝膠應用技術研討會 (INVITED)
3. 范慧雯, 何榮銘, 林助傑 "剪切誘導定位 PS-PLLA—奈米圖案成形技術" 第二十六屆高分子研討會, 台南, (2003).

#### ***Task 4***

1. Eih-Zhe Liang, Ching-Fuh Lin, Sheng-Ming Shih, and Wei-Fang Su, 'Electroluminescence and temperature effect of CdS nanoparticles on Si wafer,' Optics and Photonics Taiwan'01, KaoShiuang, Taiwan, Paper TA4-2, 2001.
2. Hsin-Hong Hsieh, Ching-Fuh Lin, and Wei-Fang Su, "Using nanoparticles in the oxide layer of metal-oxide-silicon structure to generate efficient electroluminescence on Si," Optics and Photonics Taiwan'01, KaoShiuang, Taiwan, Paper TA4-6, 2001.
3. Hsin-Hong Hsieh, Ching-Fuh Lin, and Wei-Fang Su, "Using nanoparticles in the oxide layer of metal-oxide-silicon structure to generate efficient electroluminescence on Si," Optics and Photonics Taiwan'01, KaoShiuang, Taiwan, Paper TA4-6, 2001.
4. 林唯芳, 韋文誠, 張哲政, 何榮銘, 林清富, "奈米光粒子合成, 能隙晶體結構製作與應用" 2002 奈米科技學術研討會, 台灣大學, 台北, 2002。
5. C. F. Lin, S. M. Shih, W. F. Su, H. K. Yuan, C. Y. Liu, J. H. Tsai, E. Z. Liang, "Investigation on the electrical and optical properties of Gold/SiO<sub>2</sub> nanoparticles mixture," "2002 奈米科技學術研討會, 台灣大學, 台北, 2002。
6. E. Z. Liang, C. F. Lin, S. M. Shih, W. F. Su, "CdS-nanoparticle light-emitting-diode on Si," 2002 奈米科技學術研討會, 台灣大學, 台北, 2002。

#### **International**

##### ***Main Task***

1. 林唯芳, "Molecular Nanomaterials and Their Nanodevice Applications 分子奈米材料及其奈米元件的應用," 全球華人材料奈米技術論壇 Dec. 11-13., 2002 (INVITED)

##### ***Task 1***

1. B. Y. Yu and W. J. Wei, "Investigation on assembly and spectroscopic properties of photonic bandgap crystals with mono-dispersive SiO<sub>2</sub>/TiO<sub>2</sub> particles," 105<sup>th</sup> Annual Meeting and Exposition of Am. Ceram. Soc., Nashville, TN, USA, April 27-30m 2003
2. J. F. Li, W. H. Yu, C. S. Chen, and W. J. Wei, "Modeling nanosized colloidal particle interactions with Brownian Dynamics using discrete element method," Nanotech 2003, The nanotechnology conference and trade show, Feb. 23-27, San

Francisco, USA, 2003

### *Task 3*

1. Wei-Fang Su, Jiang-Fong Li and Ron-Ming Ho, "Bismuth Titanate Nanoparticle Dispersed Polyacrylate Smart Material," *Polymer Preprints* 2002 , 43 ( 2 ) , 1218-1219
2. R.-M. Ho, H.-W. Fan, Y.-W. Chiang and F.-H. Lin "*Shear-induced Orientation of PS-PLLA Microstructures in Thin Films*" Contributed Paper at Polymer Processing Society International Meeting, Taipei, Taiwan, 2003.

### *Task 4*

1. Eih-Zhe Liang , Ching-Fuh Lin and Wei-Fang Su, "Electroluminescence and Spectral Shift of CdS Nanoparticles on Si Wafer", IEEE-NANO'2001, Maui, Hawaii, USA, October, 2001.
2. Ching-Fuh Lin, Peng-Fei Chung, Miin-Jang Chen, and Wei-Fang Su, "SiO<sub>2</sub>-Nanoparticles Enhancing Si Band-Edge Electroluminescence to Nearly Lasing Actions, "IEEE-NANO'2001, Maui, Hawaii, USA, October, 2001.
3. Ching-Fuh Lin, Peng-Fei Chung, Miin-Jang Chen and Wei-Fang Su, "Nearly Lasing Actions from Nanoparticle-Modified Metal-Oxide-Semiconductor Structure on Si," 14<sup>th</sup> Annual Lasers and Electro Optics Society Meeting (LEOS2001), Paper ThT 3, San Diego, California, November, 2001.
4. Eih-Zhe Liang, Ching-Fuh Lin, Sheng-Ming Shih, and Wei-Fang Su, "Electroluminescence of CdS nanoparticles on Si," 2000 Fall MRS meeting, Boston, Massachusetts, 2001.
5. Peng-Fei Chung, Ting-Wien Su, Ching-Fuh Lin, Miin-Jang Chen, and Wei-Fang Su, "Nano-structured Metal-Oxide-Semiconductor Devices for Efficient Band-edge Electroluminescence," Photonics West 2002, Paper 4654-17, San Jose, USA, 2002.
6. Eih-Zhe Liang, Ching-Fuh Lin, and Wei-Fang Su, "CdS Nanoparticles Light-emitting Diode on Si", Photonics West 2002, Paper 4641-20, San Jose, USA, 2002.
7. Ching-Fuh Lin, Eih-Zhe Liang, and Ting-Wien Su, Hsing-Hung Hsieh, Wei-Fang Su, Miin-Jang Chen, "Light Sources for Photonic Circuitry Based on Si," CLEO2002, Paper JThB, Long Beach CA, USA, 2002.
8. Eih-Zhe Liang, Ching-Fuh Lin, Sheng-Ming Shih and Wei-Fang Su, "The significant influence of surface states on the electroluminescence of CdS nanoparticles," International Symposium on Optical Science and Technology (SPIE's Annual Meeting), Seattle, Washington, USA, 11 July 2002.



## **Patents**

### **Application filed**

#### *Task 4*

1. 林清富，林唯芳，梁奕智，蘇亭偉“利用奈米粒子提高發光效率之金氧矽結構”，專利正在申請中。美國，台灣，日本，歐洲(英國、德國、法國或歐盟)。
2. 林唯芳，林清富“具有發光奈米粒子之發光二極體”，美國，台灣，日本，歐洲專利正在申請中

## Appendix I –Press 1

Original Message -----

From: "Eric Smalley" <[esmalley@trnmag.com](mailto:esmalley@trnmag.com)>

To: <[chiidong@phys.sinica.edu.tw](mailto:chiidong@phys.sinica.edu.tw)>

Sent: Friday, December 20, 2002 7:16 AM

Subject: Press inquiry about memory cells paper

> Dr. Chen,

>

> I'm working on a story for Technology Research News ([www.trnmag.com](http://www.trnmag.com)) about your Applied Physics Letters paper "Single-electron transistors and memory cells with Au colloidal islands" and I'd like to ask you a few questions. I should mention that we write for a general, non-technical audience. First, could you email the paper to me?

>

> Please briefly describe in simple terms what you have accomplished.

>

> How exactly does it work? Can you describe it so I can picture it?

>

> What do the single-electron transistors consist of?

>

> What are gold colloidal islands?

Gold colloidal islands are gold nanoparticles. Their size is about 14 nm. They are synthesized by reducing tetrachloro auric acid with sodium citrate.

>

> What are the "C60 derivatives"?

They are prepared by reacting propyl 2-aminoethyl disulfide with C60, so the C60 containing sulfur group. We call them C60 derivatives. They can link to Au electrodes in the device fabrication step.

>

> How does the parts work together to make memory?

>

> What parts are made using electron-beam lithography, and what parts using material synthesis?

>

> What is the potential memory density?

>

- > What are the advantages to your method in terms of device performance and/or manufacturability?
- >
- > What was the technical or conceptual breakthrough that allowed this to work?
- >
- > How could this research be applied practically? Even further down the road, what types of uses might it have or eventually lead to?
- >
- > What are the technical challenges that have to be addressed in order to make this work practically?
- >
- > Considering only technological issues, how soon will practical applications be possible? (I'm just looking for a rough timeframe like 2 to 5 years, 10 to 20 years, etc.)
- >
- > What are the next steps in your research? What are you ultimately aiming for?
- >
- > What is the source of funding for this research?
- >
- > What is your job title?
- >
- > Is there anything else you would like to say?
- >
- > Also, do you have any images and/or diagrams that I could use with this story?
- >
- > Thanks for your time.
- >
- > Best regards,
- > Eric Smalley
- > -----
- > Eric Smalley
- > Editor
- > Technology Research News
- > [esmalley@trnmag.com](mailto:esmalley@trnmag.com)
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- > [www.trnmag.com](http://www.trnmag.com)
- > [www.trnmag.com/newswire.html](http://www.trnmag.com/newswire.html)

## Press 2

Dear Dr Chen

>

> I am the editor of nanotechweb.org, a new website from the Institute of Physics Publishing that serves the global nanotechnology community. I saw your paper on 'Single-electron transistors and memory cells with Au colloidal islands' in Applied Physics Letters, and I am interested in writing a news story for nanotechweb.org about your work. I would be grateful if you could answer the following questions as soon as possible:

>

> - why did you decide to pursue this approach?

>

> - what's significant about your findings?

>

> - what challenges did you have to overcome to achieve the results?

>

> - what are the potential applications of your work?

>

> - how will you be taking your research forward?

>

> In addition, if you have one available, please forward a high-resolution electronic photograph to go along with the story - for example, a picture of the research team at work in the lab, or some of your results. Please include a caption saying what or who the photo shows.

>

> Thankyou very much for your help, I look forward to hearing from you soon

> Best regards

> Liz

-----  
> Dr Liz Kalaugher

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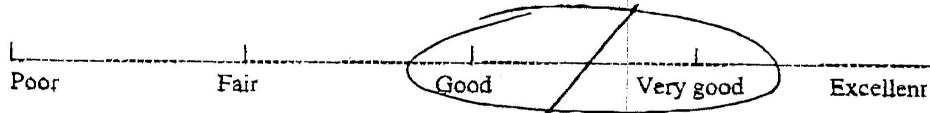
> website: <http://nanotechweb.org>

> -----

>

**Appendix II**-Comments from the editor of Appl. Phys. Lett

**II. OVERALL RATING:**



**III. REMARKS:**

This paper is a nice piece of work and should be published as is. I enjoyed reading it. There are a few minor typographical errors in the text which I have circled.

**IV. RECOMMENDATION:**

- |  |                                     |                                     |
|--|-------------------------------------|-------------------------------------|
|  | As is .....                         | <input type="checkbox"/>            |
| 1. Publish in Applied Physics Letters  | With optional revision .....        | <input checked="" type="checkbox"/> |
|  | With mandatory revision (minor) ... | <input type="checkbox"/>            |
| 2. Reconsider for Applied Physics Letters after mandatory revision (major) ..... |                                     | <input type="checkbox"/>            |
| 3. Check if you want to see the revised version .....                            |                                     | <input type="checkbox"/>            |
| 4. Reject .....  |                                     | <input type="checkbox"/>            |
| 5. Recommend referral to another journal .....                                   |                                     | <input type="checkbox"/>            |

Name of Journal Suggested: \_\_\_\_\_

(A recommendation to publish in the *Journal of Applied Physics* should be made in a positive statement of justification addressed to the Editors, Journal of Applied Physics, on a separate sheet)