行政院國家科學委員會專題研究計畫　成果報告

台灣聯合大學系統奈米製作暨分析核心設施中心(3/3)

計畫類別：整合型計畫
計畫編號：NSC94-2120-M-009-006-
執行期間：94 年 08 月 01 日至 95 年 11 月 30 日
執行單位：國立交通大學電子工程學系及電子研究所

計畫主持人：李建平
共同主持人：徐子民，韋光華，林登松

報告類型：完整報告

處理方式：本計畫可公開查詢

中　華　民　國 95 年 5 月 29 日

奈米國家型科技計畫
核心設施重要成果表

1. 計畫背景：

計畫主持人及共同主持人（PI and Co-PIs）：

計畫主持人 PI　　：李建平教授 (Chien-Ping Lee)
共同主持人 Co-PI　：韋光華教授 (K.H. Wei)
林登松教授(D.S. Lin)
徐子民教授(T.M. Hsu)

研究題目（Project Title）：

台灣聯合大學系統奈米製作暨分析核心設施中心
Core facility for nanofabrication and nano characterization of The University System of Taiwan (UST)

主持人執行機構（Organization、institution）：

國立交通大學 (National Chiao Tung University)

全程計畫執行期限（Project period）：

92 年 8 月 1 日至 95 年 7 月 31 日(August 1, 2003 to July 31, 2006)

分年經費（Budget for each year）：

92 年(2003)：48, 500, 000
93 年(2004)：37, 780, 300
94 年(2005)：30, 000, 000

2. Goals of the project. （Don't exceed 300 words.）

We have promised to make our facility

1. A first class research facility that can accommodate researchers from different disciplines in nanoscience.
2. A service center with technical expertise that can help people do first class research.
3. A platform for collaborative research.
4. A research center that science takes priority over everything else.

What do we do to achieve these goals?

1. Expertise build-up: every engineer is trained and required to understand the capability of the equipment he is responsible and is able to use the equipment at it's full potential. The resident postdocs are active researchers in areas which are closely tied to the equipment he is responsible.
2. Membership system requires commitment from each user for a long-term partnership.
3. Efficient management and clear user rules.
4. Reasonable fees without compromise in service.
5. We don' t like bureaucracy and we don't allow bureaucracy.

3. Please list all the departments and number of people supported by this project.

NCTU' facility	
Dept. of Electronics Engineering：	6
Dept. of Photonics：	4
Institute of Physics：	3
Dept. of Electrophysics：	2
Dept. of Materials Science and Engineering：	11
Dept. of Applied Chemistry：	5
Institute of Environmental Engineering：	1
Institute of Molecular Sciences：	1
Institute of Nanotechnology：	1
Mechanical Engineering：	1
NTHU：	13
Chung Cheng Institute of Technology：	1
National Taiwan University Science and Technology：	1
National Changhua University of Education：	1
ITRI：	3
Total	
Professors	41
Graduate Students	372
NCU's facility	
Electrical Engineering:	10
Institute of Optical Sciences:	11
Physics:	4
Mechanical of Optics Photonics:	1
Chemical & Material Engineering	1
Institute of Optical Sciences	2
Total	
Professors	29
Graduate Students	245

4. Outstanding scientific achievements and six most important publications by the facility、highly skilled technician recruited/incubated. （Don't exceed 500 words.）

NCTU:

1. KW Sun, JW Chen, B.C. Lee, CP Lee and AM Kechiantz, "Carrier capture and relaxation in InAs quantum dots" Nanotechnology, 16(9): 1530-1535 (2005)
2. K. W. Sun, A. Kechintz, B. C. Lee and C. P. Lee, "Ultra fast carrier capture and relaxation in modulation doped InAs quantum dots", Appl. Phys. Lett., **88**, 163117 (2006)

3. Z. C. Lin, W. H. Hsieh, C. P. Lee, and Y. W. Suen, "Mobility asymmetry in InGaAs/InAlAs hetrostructures with InAs quantum wires", submitted to APL
4. Chia-Hung Chou, So-Lin Hsu, Siao-Wei Yeh, Hsu-Shen Wang and Kung-Hwa Wei, "Enhanced Luminance and Thermal Properties of Polyphenylenevinylene Copolymer Presenting Side-Chain-Tethered Silsesquioxane Units", *Macromolecules* 2005, ASAP article.
5. Yi-An Chang, Hao-Chung Kuo, Ya-Hsien Chang, and Shing-Chung Wang, "Improved photoluminescence of 1.26 μ m InGaAs/ GaAs quantum wells assisted by Sb surfactant and indium-graded intermediate layers" Applied Physics Letters 87, 061908 (2005)
6. Chih-Chiang Kao, Y. C. Peng, H. H. Yao, J. Y. Tsai, Y. H. Chang, J. T. Chu, H. W. Huang, T. T. Kao, T. C. Lu, H. C. Kuo, and S. C. Wang, "Fabrication and performance of blue GaN-based vertical-cavity surface emitting laser employing AIN/ GaN and Ta2O5/SiO2 distributed Bragg reflector" Applied Physics Letters 87, 081105 (2005)

NCU:

JOURNAL:

1. W.-S. Liu, H. Chang, Y.-S. Liu, and J.-I. Chyi, "Pinhole-Like Defects in Multi-Stack 1.3 μm InAs Quantum Dot Laser", J. Appl. Phys., 2006. (accepted)
2. W.-H. Chang, W.-Y. Chen, H.-S. Chang, T.-P. Hsieh, J.-I. Chyi, and T.-M. Hsu, "Efficient Single Photon Sources based on Low Density Quantum Dots in Photonic Crystal Nanocavities", Phys. Rev. Lett. **96**, 117401, 2006.
3. T.-P. Hsieh, H.-S. Chang, W.-Y. Chen, W.-H. Chang, Tzu Min Hsu, N.-T. Yeh, W.-J. Ho, P.-C. Chiu, and J.-I. Chyi, "Growth of Low-Density InGaAs Quantum Dot for Single Photon Source by Metal-Organic Chemical Vapor Deposition", Nanotechnology **17**, 512, 2006.
4. T.-P. Hsieh, N.-T. Yeh, P.-C. Chiu, W.-H. Chang, T. M. Hsu, W.-C. Ho, and J.-I. Chyi, "1.55 μm Emission from InAs Quantum Dots Grown on GaAs", Appl. Phys. Lett. **87**, 151903, 2005.
5. W.-H. Chang, W.-Y. Chen, H.-S. Chang, T. M. Hsu, T.-P. Hsieh, J.-I. Chyi, "Optical Emission from Individual InGaAs Quantum Dots in Single-Defect Photonic Crystal Nanocavity", J. Appl. Phys., 98, 034306, 2005.
6. T.-P. Hsieh, P.-C. Chiu, Y.-C. Liu, N.-T. Yeh, W.-C. Ho, and J.-I. Chyi, "Selective Growth of InAs Quantum Dots on Patterned GaAs", J. Vac. Sci. Tech. B, 23(1), 262-266, 2005.
7. W.-H. Chang, H.-Y. Chen, H.-S. Chang, W.-Y. Chen, T. M. Hsu, T.-P. Hsieh, J.-I Chyi, and N.-T. Yeh, "Electroreflectance Studies of InAs Quantum Dots with InxGa1-xAs Capping Layer Grown by Metal-Organic Chemical Vapor Deposition", Appl. Phys. Lett. 86, 131917, 2005.
8. W.-Y. Chen, W.-H. Chang, H.-S. Chang, T. M. Hsu, C,-C, Lee, C.-C. Chen, P.G. Luan, J.-Y. Chang, T.-P. Hsieh and J.-I. Chyi, "Enhanced Light Emission from InAs Quantum Dots in Single-Defect Photonic Crystal Microcavities at Room Temperature", Appl. Phys. Lett. 87, 071111, (2005)
9. W.-S. Liu and J.-I. Chyi, "Optical Properties of InAs Quantum Dots with InAlAs/InGaAs Composite Matrix", J. Appl. Phys., 97, 024312, 2005.

5. List the number of personnel trained by the training courses and the number of certificates granted.

Equipment	Training	Qualify	Users
Supported By NSC			
Cyro-TEM High-resolution transmission electron microscope	54	17	23
Field Emission TEM High-resolution transmission electron microscope	40	3	11
Precision Ion Polishing System	84	4	6
Low Temperature / High Magnetic Field System	Will be open on June 2006		
ICP-RIE System of III-V Compound Device Production	15	5	7
MBE Veeco Gen II MBE	7	7	7
Field Emission Scanning Electron Microscope	30	5	16
Sb based molecular beam epitaxy	On deliver, will be set-up before Nov 2006		
Supported By MOE and NCTU			
E-beam Lithography System	31	22	28
Atomic Force Microscope	45	28	16
High Resolution X-Ray Diffractometer	58	16	19
DUV Mask Aligner	8	8	8

6. Compare with other core facilities in the world.（Don’t exceed 500 words.）

We have set up a membership system for each of the center’s instruments. By paying a membership fee, the user (the project principal investigator) can get a fixed amount of machine time. When applying for membership, the user is required to provide a NSC’s account number. If the application is approved, the membership fee will be automatically transferred to our center’s account. The lab member has the right to be trained as an operator of the instrument he wants to use. In this way, we establish a long-term partnership with each user. Currently we have a total of 64 lab members. We also provide paid service for those who do not want to be lab members and those who are in industry. The response from the users for our system has been very positive.

It should be mentioned that our users come from many different universities and research organization and with a very diverse research background. So this center is truly an interdisciplinary nano research center. Although we accommodate so many users, we don’t comprise the quality of the service. It should be also mentioned, because of the diversification of the requirement, our operators and engineers are trained to work with many different kinds of samples and to keep the machine in the tip-top condition. The new equipment put in service recently does not have enough usage data yet. The statistics will be added as time goes by.

The web page of our center was designed to be very user friendly. Anybody can very easily find the information he needs in terms of using the center’s facility. All the rules, the fees and the information of each instrument are clearly described in our center’s website. The users can download the application forms. Once we receive an application, we will respond within 4 days. Once become a member, the user can reserve the machine time using our online reservation system. We believe effective management is one of the keys for the success of our center.

7. Please list all items, levels, applicants, applicant institutes and use hours of all equipments to show service achievements of core facilities.

Jan 2005 – April 2006

Equipment	Grade	Applicants	Applicant Institutes	Use Hours
Supported by：NSC				
1. Cyro-TEM High-resolution transmission electron microscope	B	K.W. Wei	Center for Nano Science & Technology,NCTU	910.71
1-1 Precision Ion Polishing System	B	K.W. Wei	CNST NCTU	37.78
2. FE-TEM High-resolution transmission electron microscope	B	K.W. Wei	CNST NCTU	154.5
3. Low Temperature / High Magnetic Field System	A	C.P. Lee	CNST NCTU	Will be open on June 2006
4. ICP-RIE System of III-V Compound Device Production	B	C.P. Lee	CNST NCTU	258
6. MBE Veeco Gen II MBE	A	C.P. Lee	CNST NCTU	940
7. Sb based molecular beam epitaxy	C	T.M. Hsu	CNST NCU	on delivery
8. Field Emission Scanning Electron Microscope (Include E-beam Lithography System)	A	T.M. Hsu	CNST NCU	43
Supported by：MOE and NCTU				
1. E-beam Lithography System	B	C.P. Lee	CNST NCTU	2336.15
2. Atomic Force Microscope	B	C.P. Lee	CNST NCTU	1571.12
3. High Resolution X-Ray Diffractometer	B	K.W. Wei	CNST NCTU	1164.42
4. DUV Mask Aligner	B	C.P. Lee	CNST NCTU	71.25

8. Please list efforts your facility has implemented to make sure you have achieved your goal that the facility is open to all and it has been used very efficiently.

- We have implemented a new online reservation system. All members can make reservations through our website. The real time machine availability and the rules are clearly posted on the web.
- We have raised the membership fee for our members to reflect the cost of machine maintenance. The feedbacks from our users have been very positive and the number of members is steadily increasing.
- We have acquired a new lab space in the Solid State Electronics Building. We are setting up a new nanophotonics lab. The goal is to have a state of the art nano imaging and spectroscopy lab.
- Regular user meetings have been conducted to encourage communications with users.
- Thanks to the effort from all of our technical staff, we have achieved nearly zero downtime for all our machines.
- We have collaborated with NDL and set up a low temperature lab. The lab is up and running. We have invited Prof. Suen Yuen-Wu to head the lab and lead the research effort. A magneto-optical measurement system will be installed in the later half of this year.