Cooperative Research Centre for the Developm

The continued improvements in modern semiconductor optoelectronic and electronic devices and integrated circuits over the last several decades contribute to the emergence of the Information Age. The 90s have witnessed an unprecedented explosion in the handling of information. This trend is expected to continue with an accelerated pace as we enter the 21st century.

The processing of information can, in general, be divided into six different categories: information generation, information detection, information amplification, information transmission, information processing and information display.

In line with the rapid development of the information industry, the PolyU has established The Cooperative Research Centre for the Development of III-V Nitride Optoelectronic Components. The objective of the Centre is to conduct applied research to develop III-V nitride-based optoelectronic devices for applications in the information industry.

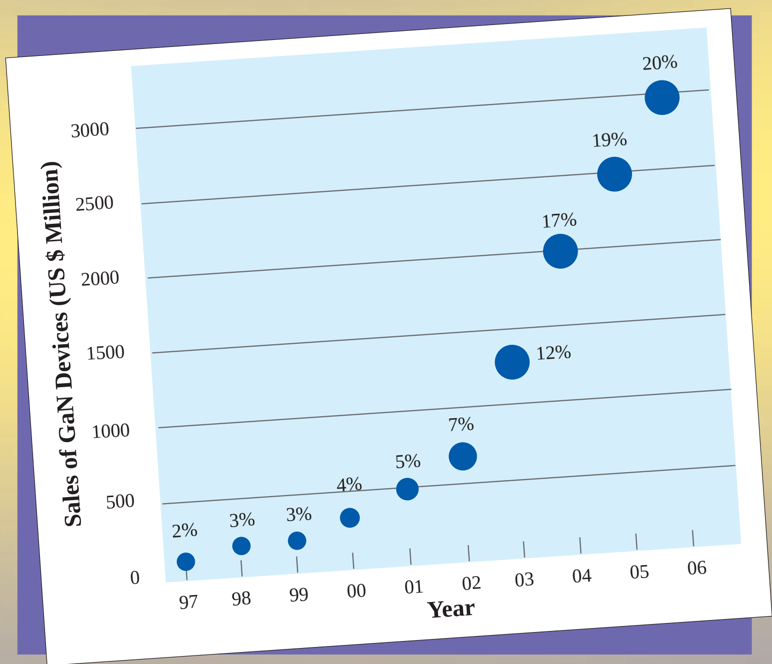
The continued growth in the information industry will have a significant impact on the market for optoelectronic and high-speed electronic devices and circuits. Of the different compound semiconductor devices, the III-V nitride family is projected to have the highest growth rate over the next decade. A study by *Strategies Unlimited*, a consulting firm in the US, has projected the growth of gallium-nitride-based devices from a mere 2% in 1997 to 20% market share of the total compound semiconductor sales with an estimated volume of US$3 billion by 2006, as shown in the figure on the right.

The growth of the gallium nitride market is mainly driven by the demand for blue and green Light Emitting Diodes (LED) and blue lasers. The LED market is projected to experience significant growth in the coming years. Approximately 14 billion LEDs were shipped in 1997, with a value of around US$2 billion, and the majority of them were used for display applications. With its popularity growing everyday, *Strategies Unlimited* predicted that the LED display market would exceed US$3 billion by 2001. Full colour displays require red, blue and green LEDs.

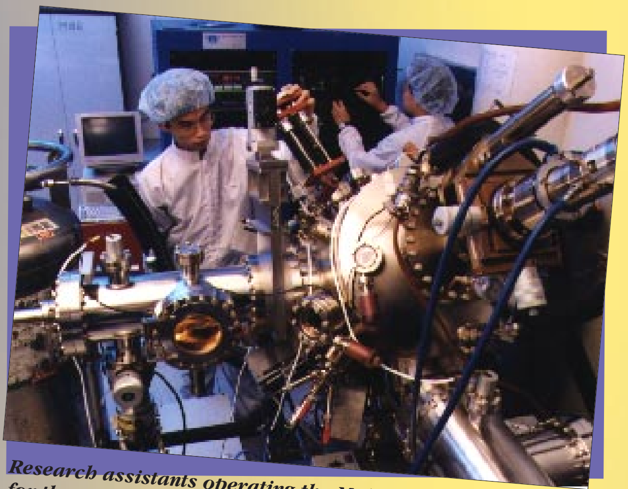
The development of gallium nitride blue LEDs in 1993 is a significant milestone in display technology. In particular, gallium nitride technology is highly relevant to the flat panel display industry in Hong Kong, which accounts for approximately 20% (US$1.8 billion) of the world market. LEDs are used for backlighting behind Liquid Crystal Display (LCD) panels. The most attractive features about LEDs are their fast switching time and long lifetime.

Hong Kong is in a unique geographical location. With Pearl River Delta and in fact, the Chinese mainland right at her doorsteps, Hong Kong has all the potential factors to become the forefront product research and development centre for the Region. Although a good number of Asian countries have suffered from the recent financial crisis, many still project the Region to re-establish itself as one of the highest growth areas in the world. Hong Kong is already a financial powerhouse in the Region. However, it is clear from the recent financial woes that Hong Kong also needs to revitalize its industries to become competitive again.

The Cooperative Research Centre, with funding support from the Research Grants Council, The Hong Kong Polytechnic University and *ASM Assembly Automation Limited*, aims to meet the challenges for the development III-V nitride-based optoelectronic devices such as blue LEDs, ultraviolet detectors and lasers. The team consists of staff members and graduate students and research assistants from PolyU's Department of Electronic and Information Engineering. In addition to **Dr. Charles Surya**, who is the principal investigator of the Centre, also involved in the programme are Prof. Joshua Wong, Dr. Alex Wai and Mr. K.Y. Tong, who are experts in the area of



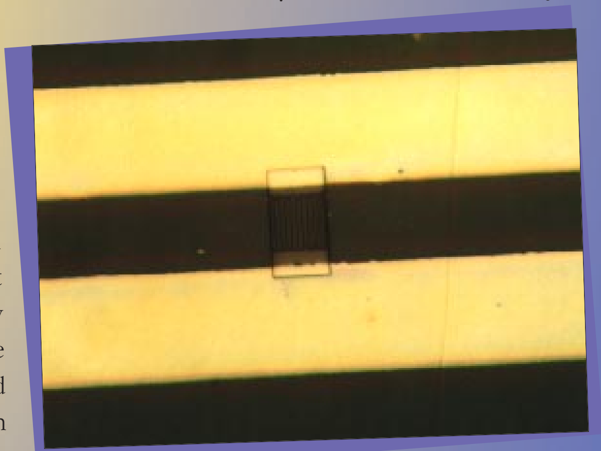
ent of III-V Nitride Optoelectronic Components



Research assistants operating the Molecular Beam Epitaxy for the growth of gallium nitride thin films.

photonics technology and thin film growth. Besides working closely together for the development of the technology, the team has ongoing collaborative efforts with the Laboratory for Laser Energetics of the University of Rochester, New York and Fudan University of China. The University of Rochester is known for their premier work in the field of ultra fast optoelectronics.

The most crucial first step for the Centre is to master the techniques for the growth of high-quality gallium nitride films. To help accomplish this task the Centre has established a Molecular Beam Epitaxy specially designed for the deposition of III-V nitride materials. The team has invested substantial effort in improving the materials in the past months and is encouraged to finally see some positive results from the hard work. A gallium-nitride-based ultraviolet detector has been fabricated successfully. The detector is being characterized by Professor T.Y. Hsiang of the Laboratory for Laser Energetics and the Electrical and Computer Engineering Department of the University of Rochester, and has been found to exhibit a response time as short as 500 picosecond. There is still a long way from accomplishing the quality of a marketable product but the team strongly believes that this will not be too distant a day from now.



A metal-semiconductor-metal photo detector fabricated in the Cooperative Research Centre.

電子產品微型化

高密度幼線路板

香港工業及產品已進入高科技發展的時代，隨著市場的需要，許多電子產品包括電腦、手提電話、手提攝錄機等不斷微型化，體積越來越小，重量越來越輕，功能卻越來越多。

線路板是所有電子產品的基本組件之一，產品趨於微型化，線路板的電路密度亦相應提高。香港的印刷線路板是講求技術的工業; 生產高密度幼線的線路板，更是一門高增值的行業。面對二十一世紀高科技發展的挑戰，香港印刷線路板工業須在短時間內提升生產技術水平，解決傳統的線路板質量及可靠性問題，而生產力亦需作出突破。

印刷線路板技術轉移計劃

理大製造工程學系助理教授**容錦泉博士**積極推動發展線路板技術，經過周詳的策劃和準備，獲政府工業署資助，於系內成立了線路板技術轉移中心，目的是為本港工業界引入外國的先進技術，透過講座、工作坊及博覽會，介紹新知識及技術，於本地工業界應用，為各廠商提供增值技術支援，從而提高本港的競爭力。

激光打孔

目前，線路板技術以美國、歐洲及日本最先進，技術轉移中心曾派員前往美國及歐洲視察當地的技術，首先引入和推廣兩種生產技術──微孔加工技術和直接成像技術，因為這些技術能直接提高高密度幼線線路板的生產水平，並提高質量及生產力。

由於提高線路板密度使到微孔的尺寸縮小(小至50微米)，傳統的機械打孔技術就難以繼續採用，必須引入先進的激光打孔技術。

該中心採用三倍頻Nd:YAG激光打孔技術，打孔直徑可小至 25 微米，最快打孔速度可達每秒二百多個。由於底層銅的光熱特性，此種技術特別適合盲孔和通孔加工。

直接成像

在高密度線路板內，線路線寬十分幼細，可低至50-100微米，傳統的「接

觸晒印成像」技術難以達至這種要求，其生產成本較高，生長週期長和缺乏彈性，亦導致新技術「直接成像」得以發展。

「直接成像技術」同樣採用激光，根據CAM系統定義的線路圖樣直接在塗敷抗光蝕劑的基體上成像，因而無需使用中間介質，避免了相關的質量問題，而且線路線寬可低至50微米。直接成像技術為徹底革新線路板的製造提供了重要機遇，無論在提高線路板的質量或生產率方面都取得突破性的進展。

激光打孔系統

電氣測試及可靠性測試

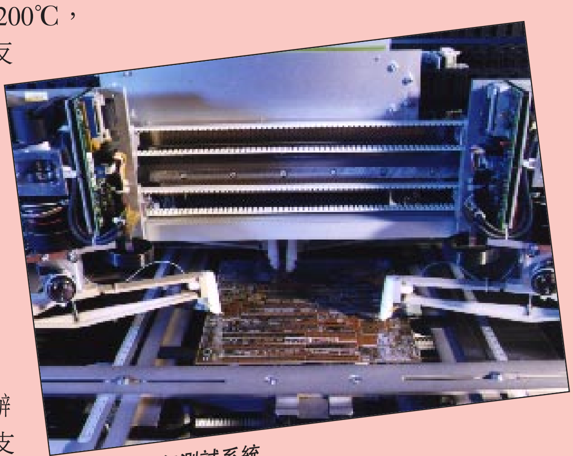
線路板的組件密度及組件相互連接越來越精益求精，因而需要進行更多測試。針床的密度開始成為限制。設於中心內的飛行探針電氣測試系統，以原型和小批量產品為測試對象，在生產中提供低成本和高質量服務。

另外，可靠性在線路板製造過程十分重要。通過熱衝擊試驗，可以確定線路板對溫度突然變化的承受能力。線路板暴露於高、低溫(高至200℃，低至-60℃)的反覆變化中，可得知是否存在電路通斷及顯微斷面的問題。技術轉移中心根據最新工業要求(IPC，MIL-STD)，設有熱衝擊室進行可靠性測試。

中心提供全方位服務

線路板技術轉移中心所舉辦的活動和提供的服務深受業界支持，反應非常理想。由於掌握專業知識，並且是中立團體的角色，現在已有五、六家大型線路板公司採用該中心引薦的技術，加強線路板工業的競爭力。

中心定期舉行講座及工作坊，講座多邀請歐美兩地的專家演講，與本港廠商分享經驗。除了向業界人士介紹線路板技術知識，並為他們提供專業顧問意見，以及各項配套設施的建議。◈



飛行探針電氣測試系統

Helping *An An* and *Jia Jia* settle in at Ocean Park

Dr. Fiona Brook, Associate Professor of Department of Optometry and Radiography, writes about the lives of two new immigrants who have caught the attention of the public.

Although the giant panda (*Ailuropoda melanoleuca*, meaning black and white bear) was unknown in the West until the latter half of the 19th century, it has been revered in China for hundreds of years and Chinese emperors often kept them as pets. The Chinese name for the giant panda is 'Da xiongmao', meaning 'great bear cat' and many people believe these animals have mystical powers capable of diverting natural disasters and evil spirits.

This amazing animal is under serious threat of extinction and it is estimated that only 700 to 1,000 are still alive in the wild, existing in a few, small, forest areas in China. They are under constant threat from poaching and human encroachment on their habitat. Individuals have now become isolated as they are unable to cross developed areas to find new food sources or potential mates.

As a special symbol of reunification, the Chinese mainland has gifted Hong Kong with two giant pandas, a male, An An, and a female, Jia Jia, who have settled comfortably and happily in to their new, custom-built $80,000,000 enclosure at Ocean Park.

The public can now visit and see these great bears, in their simulated natural habitat of around 2,000 sq.m., at close range. What the public will not see are the incredible facilities provided for the care and welfare of these animals behind the scenes, nor all the work and effort that go into their daily care. These facilities include quarantine, den and 'quiet' areas, plus a state-of-the-art hospital facility dedicated solely to the pandas. It was here that An An and Jia Jia were kept for the first weeks after their arrival from the Wolong Nature Reserve, under the watchful eye of Curator Timothy Ng and vets Dr. Natalie Rourke and Dr. Natalie Mauroo. Mainland scientists Dr. Hu Da-ming and Mr. Han Hong-ying have accompanied the pandas from Wolong and will remain for some time to share their knowledge and experience, and also to learn how the animals will be cared for in Hong Kong.

As new arrivals at the Park, it was necessary to keep An An and Jia Jia in quarantine and to conduct detailed medical and health checks to ensure that they were both fit and healthy. These check-ups included full body measurements, blood tests, dental examinations, X-rays and ultrasound examinations. All check-ups were carried out with the pandas under general anaesthetic as, despite their docile manner and appearance, these are wild animals! Ocean Park gathered together an impressive group of experts to assist, including Dr. Sam Silverman, a veterinary radiologist from San Francisco, and a local team of thoracic specialists from Queen Mary Hospital, led by Dr. Ken Leung. Because of long association with Ocean Park and experience in examining other large animals, I was also privileged enough to be asked to participate in this, undertaking the initial X-ray and ultrasound examinations. Very few living pandas have been examined in this way, as the reserves in China do not generally have access to the equipment required. To my knowledge, only the pandas kept in zoos in Berlin, Mexico and San Diego, have been scanned before and thus the information obtained from An An and Jia Jia is extremely valuable and has added much to our knowledge of the normal anatomy and biophysical profile of the species. This information will be published in conjunction with the findings from the pandas in Mexico and San Diego and should contribute towards the care of other pandas in the world.

• photos by K.T. Luk

Jia Jia undergoes ultrasound scanning.

Dr. Brook (left) prepares An An for a chest X-ray.

An An sleeps comfortably through examination.

Both An An and Jia Jia have been declared fit and healthy, the only finding being some arthritis in Jia Jia's left forepaw. Jia Jia is now 21 years of age and this is not unusual in an animal of her age. She has successfully raised at least four cubs, but is not expected to breed again now. An An is 16 years old. Both pandas are wild-born but were brought in to the rescue centre at Wolong as very young animals, having been found close to starvation. An An was abandoned by his mother and Jia Jia was a victim of a periodic die-off of bamboo, the staple diet of the species, which left her struggling to survive. The life span of giant pandas in the wild is thought to be about 25 years and some have lived much longer in captivity, providing millions of people the opportunity to see and learn about these unique animals and the efforts being made to save them. Now the public in Hong Kong has the same opportunity to learn about and contribute to the future well-being of this special symbol of China.