

III-V Compound Semiconductor Industry and Technology Development in Taiwan

Yung S. Liu

Optoelectronics & Systems Laboratories, Industrial Technology Research Institute,
Bldg 78, 195 Chung Hsing Road, Sec. 4, Chutung 310, Hsinchu, Taiwan
Tel: 886-3-591 3525; Fax: 886-3-582 0214; email: liuys@itri.org.tw

Keywords:

Taiwan, optoelectronics, wireless, compound semiconductor industry, LED, nano-photonics

Abstract:

This paper reviews the current status of the compound semiconductor industry and technology development in Taiwan.

Introduction:

The Si-based semiconductor industry in Taiwan including IC design, fabrication, packaging and testing has become the fourth largest in the world with a total industrial production revenue exceeding USD\$22B in 2000. The industry, starting in early 70's focusing almost exclusively on the CMOS technology, has housed the world's largest IC foundry and packaging companies. The Si-based IC industry is the engine that has propelled the economic growth of Taiwan.

In comparison, the R&D on the compound semiconductors did not start until late 80's with the first commercial MOCVD reactor (Cambridge MR 102) installed in 1987 at ITRI and the first company, UEC, dedicated to the compound semiconductor products formed in 1993. The compound semiconductor industry, however, has grown rapidly since 1998 with over 20 companies actively engaged in manufacturing optoelectronics and RF components like LD, LED & HBT devices. (Fig. 1) It is estimated there are close to 200 MOCVD reactors installed in Taiwan for growing III-V compound materials such as GaAs, GaP, GaInN and InGaAsP for optoelectronics and RF devices. Taiwan has been the one of the major producer in the world for LEDs. Production of LD and RF devices, however, are in the early stage with only a minor world market share. Currently, machines with capacity for 11-wafer (2") are being used in operation, 24-wafer machines are being installed.

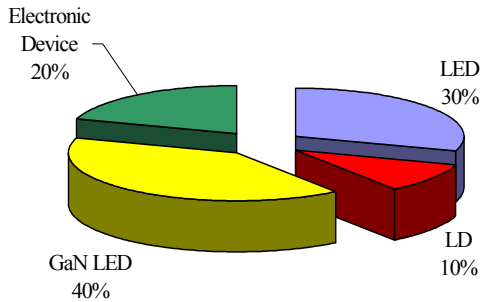


Fig. 1 Breakdown of the compound semiconductor business in Taiwan.

R&D activities at ITRI:

A major part of the R&D work has been carried out at the government sponsored research institute, Industrial Technology Research Institute since early 1980's. (Fig. 2) The program with a strong emphasis on the industrial application focused first on AlGaAs technology in the early 80's, then on AlGaInP to develop high brightness LED, and LD devices. The GaN work started in mid-90's for developing blue, green LED and later GaN-based white LED. Currently, the ITRI program

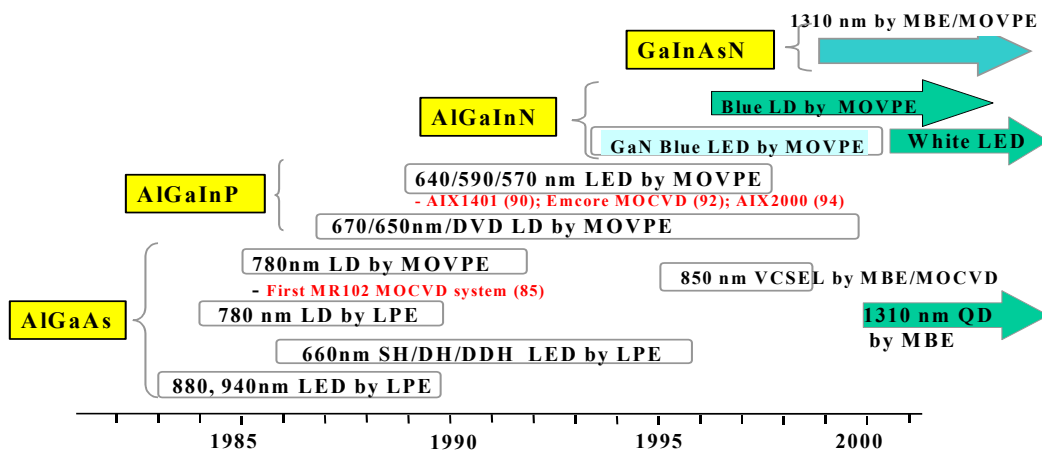
has focused on (a) development of high power and high efficiency GaN-based LED devices for illumination applications, and (b) InGaAsN-based and InAs nano-structure devices for optical data communication used in metro- and access-applications. Recently, a joint research program between ITRI/OES and IOFFE Institute, directed under Dr. Ah I. Alferov, has developed CW InGaAsN lasers operated at 1.3 um.

National program on nano- technology:

As part of the USD\$700M, 6-year, (2003-2008) national initiative on the Nano-technology, ITRI/OES has launched a nano-photonic project focusing on photonics crystals and quantum dots devices based on III-V materials. As part of this research initiative, ITRI/OES, working jointly with IOFFE Institute in St. Petersburg, directed under Dr. Zh. I. Alferov, has recently successfully demonstrated quantum dots InAs lasers



III-V Development Milestones at ITRI/OES



operated at 1.3 μm with a single mode output at 400mW.

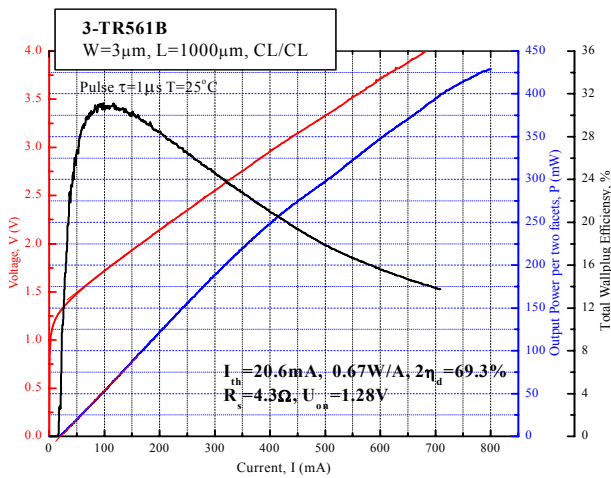


Fig 3, Single mode operation of quantum dots InAs lasers.

In addition, another USD\$260M, 3-year national industrial research initiative starting 2002 was the National Si-Soft Project to SOC technology for wireless, processor and optoelectronics applications. In addition to the emphasis on development of IP mall and SOC technology, the research effort has targeted on the development of chipset for wireless and optical communication applications..

Industrial status:

The largest industrial production of the compound semiconductor in Taiwan is light-emitting diodes (LEDs) with an industry output close to US\$550M, which was about one third of the world production of visible-light LED. The industry is expected to grow at a compound annual growth rate over 12%

for the next several years. In 2002, demands for blue GaN blue LED were particularly strong and the LED industry has registered strong sales in 2002.

To develop advanced technology and to speed up the industrial applications of GaN for illumination applications, an Industrial pre-competitive research consortium was formed in 2002 by 11 local companies. The goal of this R&D consortium, partially sponsored by the Ministry of Economic Affairs (MOEA), ROC, is to develop the LED-based white light with an efficacy targeted at 50 lm/W by 2005.

Conclusion:

The emphasis on the technology development, and a strong government-supported research, and coupled with relatively available venture capital funding, created a favorable environment for the development of the III-V compound semiconductor industry in Taiwan. The industry has grown rapidly in the past five years and is now ranked perhaps among the world top three producers in the world. In the recent Gorham’s Conference on Compound Semiconductor Outlook’2002 held in Taipei, this trend was illustrated by the sub-title of the conference by asking, “Has the Asian Manufacturing Era Arrived?”