Industrial Laser Markets in Taiwan

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This report analyzes the industrial laser markets in Taiwan. The total market is analyzed by the following end-use applications: mobile phone proximity sensor (PS), gesture controller & moving sensor, communications, consumer electronics, industrial processing machine, night vision surveillance and medical. The focus will be on Vertical Cavity Surface Emitting Laser (VCSEL). VCSEL provides the high performance, ultra high resolution, low cost and high throughput. The applications including scientific, military, firearms, medical, industrial, commercial and images. The global laser technology market will reach US$10.40 billion by 2016. One of the key factors contributing to this market growth is the increasing demand for laser technology from developing countries. The global laser technology market has also been witnessing the development of next-generation laser technology. In Taiwan, the scale of laser industry is small relative to the world. Almost companies focus on materials processing and lithography material process.

Due to the rapidly growth of smart phone/TV and gaming, many laser applications such as 3C products, high-speed fiber transmission, HDMI, USB photoelectric conversion joints, automatic car, moving sensor (gesture) and 3D printer are attracted. The small output power laser diode of < 100 mW is employed for these applications.¹⁻⁵ Laser diode can be divided into short wavelength and long wavelength lasers. Short wavelength laser of 390 nm to 950 nm, mainly using in optical drives, laser printers, bar-code machines, scanners, optical information and display applications such as indicator. Long wavelength lasers of 980 nm to 1550 nm, mainly used in fiber communications. Global communications lasers about US$3.013 billion in 2014. Optical communications future trends on high speed, broadband transmission of 10 Gbps, 40 Gbps, and 100 Gbps transceiver module.¹⁻³ The market grew 3 times in the last few years. Communication laser diode and optical communication system’s market share is relatively small to the all laser markets.

Due to the increasing of network bandwidth, DVDs and other audio-visual download had become popular, optical laser applications on optical drive CD, MD, DVD, BD will grow up continue. By the popularity of high density hard disk, the laser storage industry will grow slowly.

Key Words: Proximity sensor, Gesture, VCSEL

1. Introduction

Recently, laser had been focused all over the world due to its high performance, ultra high resolution, low cost and high throughput. The applications including scientific, military, firearms, medical, industrial, commercial and images. The global laser technology market will reach US$10.40 billion by 2016. One of the key factors contributing to this market growth is the increasing demand for laser technology from developing countries. The global laser technology market has also been witnessing the development of next-generation laser technology. In Taiwan, the scale of laser industry is small relative to the world. Almost companies focus on materials processing and lithography material process.

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2. Taiwan laser industry analysis

Past Taiwan laser industrial were focused on material process applications and services, including: metal processing (cutting and welding), metal, plastic sculpture, PCB board drilling, semiconductor, LED, hard and brittle materials such as glass, ceramic processing, LCD Panel, mask repair, 3C, and Thin-film solar cells. The high power industrial laser equipment is mainly dependent on imports in the past from Europe, America and Japan in Taiwan. The rise of China’s laser industry in recent years, a direct replacement will be on these importers. Taiwan mainly laser processing machinery and equipment output will vary with the market rise NT$350 billion output value. ITRI IEK analysis 2013 global laser is worth about US$8.8 billion, 2014 is expected to be up to US$9.33 billion in 2015 and breaking tens of billions. Laser
3. Laser market in 3C products

Along with the human science and technology progress, the moving sensor or the gesture controller is becoming the main component of next generation 3C product, including smart phone/TV, gaming and tablet. Worldwide smart phone unit shipments increased 50% in 2013 to 1064 million, and continuing the strong growth. However, due to the ongoing rapid decline in feature phone sales, the overall mobile market only grew by 11% to 1775 million as shown in Fig. 1. Future-source anticipates slowing growth from 2014 as consumers have largely transitioned to smart phone, which made up 61% of worldwide sales in 2013, and some major markets are approaching saturation. However, in many developing markets there are still considerable growth opportunities, with feature phones still making up a significant share of sales, and much of the population not owning a mobile phone at all. While overall average prices increased from $149 to $166 due to the move towards smart phones. Smart phone prices are falling rapidly, with a decline of 8% in 2013 to $243. The total market value was 28% growth in 2013 with the growth of smart phones, though ongoing price erosion and slowing growth will lead to a value decline by 2018 in the overall market.

The main requirement is thinner and low power consumption for 3C products applications. Now, all the light sources for PS and gesture applications are IR LED of 850 nm or 940 nm wavelength. Due to large divergent angle and large operation current in LED, the smart phone IC designer is current searching new component to overcome. VCSEL had developed from 1979 by Soda, Iga, Kitahara and Yasuharu Susmatsu.6 Today, VCSEL have replaced edge-emitting lasers in applications for short-range fiber communication such as Gigabit Ethernet and Fibre Channel. The low threshold current of < 1 mA and low divergent angle of < 30 degree performances had attracted these IC designer to use it. The muRata Japan had announced the smallest sensor in May 2014. The IR VCSEL was designed in. More for gesture application in smart TV/gaming/tablet will grow up rapidly by using VCSEL middle output power of about 100–300 mW. The wearable electronics products will be popular in the future. The super low power consumption is the main domain. VCSEL will be the key component.

4. VCSEL development and future trends

VCSEL with high conversion efficiency, low power consumption, low-divergence beam, temperature stability, two-dimensional array and high fiber coupling effect had been rapid developed in the past ten years.7,8 The VCSEL resonator consists of two distributed Bragg reflector (DBR) mirrors parallel to the wafer surface with an active region consisting of one or more quantum wells for the laser light generation in between. The planar DBR-mirrors consist of layers with alternating high and low refractive indices. Each layer has a thickness of a quarter of the laser wavelength in the material, yielding intensity reflectivity above 99%. High reflectivity mirrors are required in VCSELs to balance the short axial length of the gain region.

VCSEL has been used in lighting monitor night light cars with distance lighting at night and the car monitor optical sensing cell phones close sensing (PS) gesture control (remote control) laser mouse optical fiber communication touch panel.

Due to the super low threshold current, VCSEL was employed for mobile phone PS and gesture sensor and tablet/smart TV/gaming moving sensor recently. In the past ten years, all the PS or gesture light sources were IR LED (850 nm or 940 nm). The large operation current of 100mA and wide beam angle were the main disadvantages. By the requirement of small size and thinner design, IR LED cannot
meet the specifications. VCSEL was fabricated by metal organic chemical vapor deposition (MOCVD) or molecular beam epitaxy (MBE) systems. In Taiwan, there are more than 500 sets MOCVD for LED, microwave, solar cell and laser industries. The technology and equipment are mature to develop VCSEL. Most of them are focused on LED, especial in blue LED. In 2000, due to the rapid development in fiber communication, many companies invest to VCSEL. But with the bubbled market of fiber communication, almost of them were closed or changed to LED or microwave industries. Just a few of two or three companies continue to develop VCSEL. By the development and investigation over the fifteen years, the high performances of 10Gbps, watt level output power and single mode were achieved in Taiwan. The rapidly developed MOCVD, high throughput and good uniformity was achieved.

Because VCSELs emit from the top surface of the chip, they can be tested on-wafer, before they are cleaved into individual devices. This reduces the fabrication cost of the devices. It also allows VCSELs to be built not only in one-dimensional, but also in two-dimensional arrays. The larger output aperture of VCSELs, compared to most edge-emitting lasers, produces a lower divergence angle of the output beam, and makes possible high coupling efficiency with optical fibers. The high reflectivity mirrors, compared to most edge-emitting lasers, reduce the threshold current of VCSELs, resulting in low power consumption. However, as yet, VCSELs have lower emission power compared to edge-emitting lasers. The low threshold current also permits high intrinsic modulation bandwidths in VCSELs. The wavelength of VCSELs may be tuned, within the gain band of the active region, by adjusting the thickness of the reflector layers. While early VCSELs emitted in multiple longitudinal modes or in filament modes, single-mode VCSELs are now common.

Due to the surface emitting in VCSEL, multi emitting apertures are easy to achieve by mask design. The super high output power VCSEL was fabricated easily. The range of output power from 1mW to 10 W is easy to achieve, depend on the different emitting apertures.

For high speed data communication (10 Gbps to 100 Gbps), the p n common anode VCSEL structure was fabricated. In the past five years, due to the requirement of high capacity server, fiber communication was growing up rapidly. More for USB 3.1 C or HDMI light transmission applications, 10 Gbps VCSEL will be the key component.

The future trend of VCSEL is high speed, high power, and visible light.

5. Conclusions

Taiwan laser industry had been dominated by OEM design, but with increasing use of the laser industry, Taiwan Government and civil society associations (Taiwan Laser Technology Application Association, TLTAA) is set to establish and promote Taiwan laser industry tribe. Including Taiwan laser application industry international exhibition and the Taiwan laser Valley, was founded.

Based on the semiconductor industry, Taiwan has the good opportunity to develop the laser diode, especially in VCSEL. In the past years, wavelengths of 650 nm, 808 nm, 850 nm, 980 nm, 1310 nm and 1550 nm were mass production for laser pointer, pump laser source, double crystal green light, and fiber communication. Recently by the increasing of requirement on 3C consumer electronic products, VCSEL will be the important device. Especially in low out-power (< 2 W) IR region (740-1000 nm), VCSEL will lead a new industry.

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