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Views

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State of photonics-related industry in Japan: Digital economy is creating a deep integration in East Asia

Abstract: Future challenges and problems of Japanese photonics-related industries are discussed by analyzing the statistics of domestic photonics production trend in Japan from the aspects of offshoring and deep integration taking place in East Asia due to the growing of the global digital economy. Mobile phone, digital camera, semiconductor stepper, and fiber to the X. X is home, buildings, factories, shops, government (FTTX) are case studied, and the utilization of the information and communication technology (ICT), together with a free trade policy, is expected for the future challenges.

Keywords: deep integration; digital camera; digital economy; ICT utilization; mobile phone; photonics; offshoring; standardization.

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1 Introduction

Even after the collapse of information and communication technology (ICT) bubble economy in 2001, the Internet traffic is increasing about 40% every year, and recently, it was reported that a zettabyte traffic flood is coming soon due to the explosion of the additional smart phone access. The economy that is driven by the ICT is called digital economy that brings about a higher productivity with lower cost [1]. The photonics technology is a part of ICT so that the photonics-related industry will grow with the digital economy hand in hand as far as they are connected to the digital economic network value chain.

In this article, domestic photonics market trend in Japan provided by Optoelectronics Industry and Technology Development Association (OITDA) (http://www.oitda.or.jp/) is shown and analyzed from the aspects of offshoring of the Japanese manufacturer to East Asia. It is creating a deep integration not only due to the economic gravity law but also because of the digital economy, which is characterized by digitization, ICT utilization, globalization, standardization, modular, horizontal, and vertical manufacturing. On the other hand, the universal digital economy is inducing a Galapagos problem in Japan, which came up on the sight in the mobile phone market as a result of an innovation dilemma [2]. On the contrary, in the field of digital camera and semiconductor stepper, Japanese photonics-related manufacturers have quite a strong worldwide competitiveness, but it is revealed that the universalized global digital economy is giving a serious influence and market change to the Japanese photonics industry as well. Finally, the future challenges for the photonics-related Japanese industry are discussed, and the importance of the internationalization for Japanese industry by means of the free trade agreement in the East Asia and the utilization of the advanced ICT not only for the manufacturing industry but also for the agriculture and service industries are emphasized.

2 Photonics production trend in Japan

To discuss the state of photonics-related industry in Japan, let me start with a photonics market trend statistics provided by OITDA, which is depicted in Figure 1. OITDA is an organization that was established in 1980 by the government associated with Japanese electronics and photonics manufactures such as Hitachi, Toshiba, Mitsubishi, NEC, Fujitsu, Panasonic, Canon, Nikon, etc. and now supported

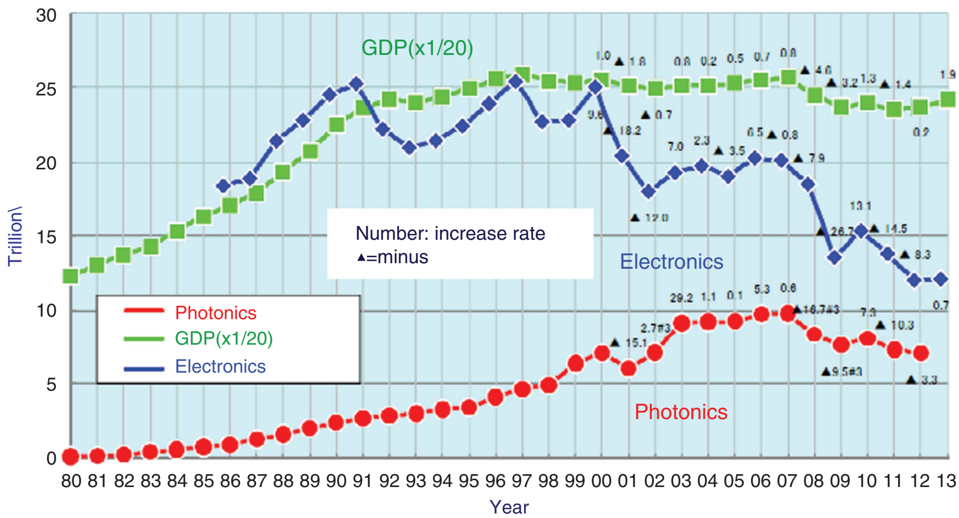

Figure 1 Photonics domestic product trend (red) compared with Japan's GDP (green) and electronics products (blue) (Source: OITDA).

by about 150 companies. OITDA is organizing seven committees specified by display lighting, input-output equipment, optical storage, fiber communication, laser processing, photovoltaic cell, and measuring-sensing equipment. Each committee is organized by about 10 photonics experts. Since 1980, OITDA committees continue to research Japanese statistical photonics production trend by means of an operation of questionnaires to about 300 Japanese photonics-related manufacturers inquiring about the products of the previous year, this year's estimation, and predictions for the next year, and the data are analyzed and summarized by the authorized analytical committee of the OITDA.

The green curve in Figure 1 is the Japanese GDP trend. After World War II, Japanese people worked hard, and the GDP increased with rates of 8–10% year by year. But in the beginning of the 1990s, the GDP has been saturated after the collapse of the financial bubble that originated from the Plaza Accord in 1985. In the same period, a paradigm shift took place from the mainframe computer to PC in the field of electronics product. The Japanese semiconductor manufacturers lost market share in the low-cost and high-volume DRAM market because of this change. But for the domestic photonics product, it continued to increase with a rate of more than 10% by year in the early 1990s. Even after the collapse of the ICT bubble in 2001, it still continued to increase. But in 2008, it started to decrease due to the economic downturn precipitated by the subprime lending issue. Just after the recession, it slightly recovered, but notwithstanding the increase of worldwide market growth of photonics production as reported by PIDA of Taiwan, it started to decrease again in Japan. What is the reason of this decrease? It is the offshoring.

3 Deep integration in East Asia

Figure 2 shows the rates of the offshoring products from field to field in this decade. For the case of optical storage, it is up to 80%. Display is 70%. Input-output equipment is 60%. Totally, more than 50% of the Japanese photonics products are produced outside the Japan Islands

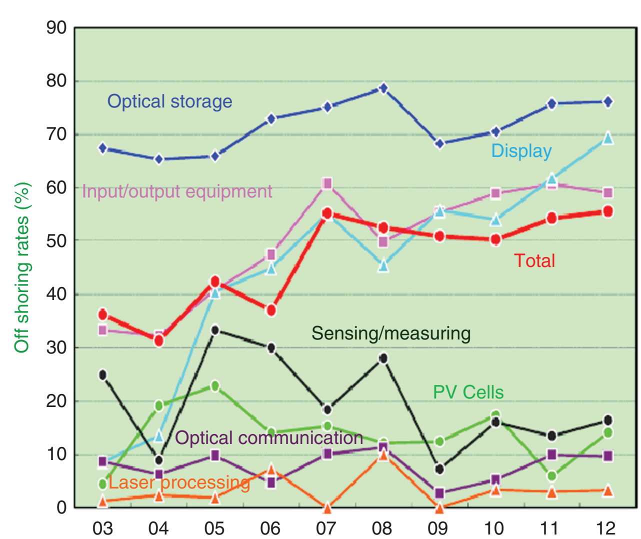

Figure 2 Rates of the offshoring photonics products by field (Source: OITDA).

such as Taiwan, Philippines, China, Vietnam, Malaysia, Thailand, and Indonesia. Moreover, in order to reduce the total cost of the products, the digital economy, characterized by the horizontal division of labor due to the digitalization, standardization of the products, and the components in the total manufacturing process, is changing the manufacturing structure in East Asia. In the case of the printer, for example, the LSI and the paper handling mechanic parts are produced in Japan, optics in Taiwan, and assembled in Thailand. It came to be known during the serious water flood that took place in Thailand in 2011. For the case of the automobile, the engine is produced in Japan, the transmission in the Philippines, the steering in Malaysia, the chassis in Indonesia, and assembled in mainland China, for example.

Not only the change in the manufacturing partner network but also the trade partners are changing. The first Nobel Prize winner in economics in 1969 was Jan Tinbergen (1903–1994). He founded an economical law wherein the amount of trade S between two countries can be formulated as

$$S = M1 \times M2 / R$$

where M1, M2 are the economical sizes of each country, and R is the distance between the two, similar to Newton's law of gravity. Figure 3 is a proof of this law showing the trend of the trade amount between Japan vs. East Asia, China, Middle East, and the USA. The biggest trade partner has been the USA but was changed to China in this decade, just after the Lehman Brothers bankruptcy in 2008 and the trade between the Asian countries is increasing remarkably. This economic phenomenon that each Asian country cannot survive without each other is called 'Deep Integration'.

4 Galapagos problem

Digital economy is forcing to change the market share of the photonics products. Figure 4 shows the change in the market share for the mobile phone from 1985 to 2012.

In 1985, more than 46% was shared by the Japanese manufacturers such as NEC, Oki, Matsushita, and

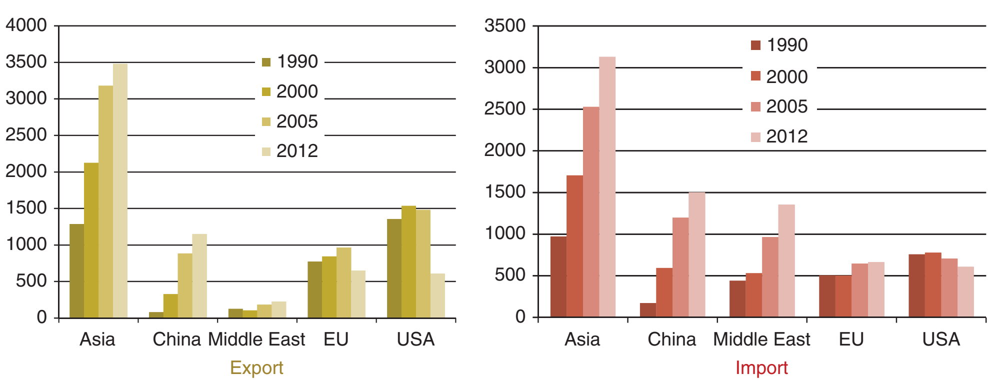

Figure 3 Trend of trade partner of Japan (Source: Ministry of Finance).

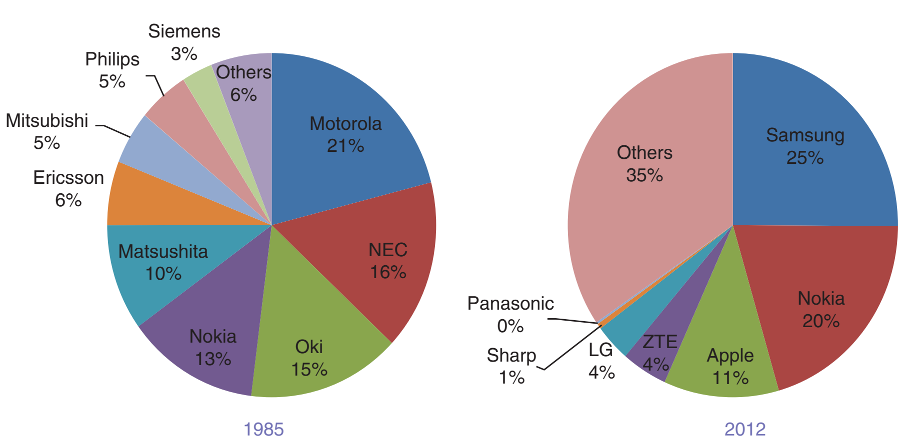

Figure 4 Change of the mobile phone market share (Source: Nikkei).

Mitsubishi. But in 2012, more than 64% was shared by Samsung, Nokia, Apple, ZTE, and LG. What is the cause of this drastic change? To find out what the cause is, Figure 5 is introduced, which indicates a mobile phone spec share in 2007. More than 86% of the specs are from the middle range, entry, and ultralow-end models.

Most of the mobile phones produced by Japanese manufacturers have high-end specs with higher costs due to the domestic market demand, which turned to be a minority for the global market [2]. In an ironical way of expression, the Japanese mobile phone shows an analogy to the special animals that evolved in the Galapagos Islands [3]. They have evolved under a special environment isolated from the rest of the world so that they can live only in the Galapagos Islands and cannot survive outside due to weakness against the competitive global volume zone. The Japanese market that is based on the domestic population (0.128 billion) is sizable but not large enough to generate universal global digital standards and limited to a few of them. On the other hand, the rest of the world have a strategy with a strong universal standardization aiming and selling their mobile phones in the global market whose demands are mainly practical entry specs.

There is a horizontal division of labor of production strategy not only in the market strategy but also in manufacturing. The mobile phone consists of modular type of components, and each part can be standardized by the digitalized specifications that are similar to the PC, flat panel display, and many of the electronic products. Especially for the semiconductor manufacturing process relationships constructed by the western fabless and Taiwan foundries, they are very successful in gaining the high-performance per cost of product. Extending this argument, one could see an analogy in a drastic change of the market share of the stepper for the semiconductor lithography. The market share of the Japanese manufacturers reduced from 70% to <20% in this decade. The change might be analyzed from the same aspect that the market of the Japan-made stepper is limited to a specialized customer from the USA in this case.

5 Digital camera

Let us take a look at the digital camera wherein Japanese manufacturers have a strong worldwide market share. Figure 6 indicates that the Japanese companies have more than 75% of the world share, and it is well known that almost 99% of the single-lens reflex camera is Japan made. The origin of this strength to generate such a high-performance per cost comes from the specialized Japanese integrating technology called 'Suriawase' in Japanese [4] that creates a value added in the optimization of interfaces between optics, mechanics, and electronics components constructing the digital camera. The 'Suriawase' technology has been developed inside the closed vertical integration type of manufacturing such as in automobiles rather than in the open horizontal division of labor type of manufacturing such as in PCs and mobile phones. On the other hand, the technology transfers including the 'Suruawase' are taking place from Japan to the East Asian countries, which might raise the market share change. Moreover, the digital camera is going to be a component embedded in the smart phone. Thus, the 'Suriawase' technology would remain mainly in the high-end product such as the single-lens reflex and inside the modular components for the smart phone.

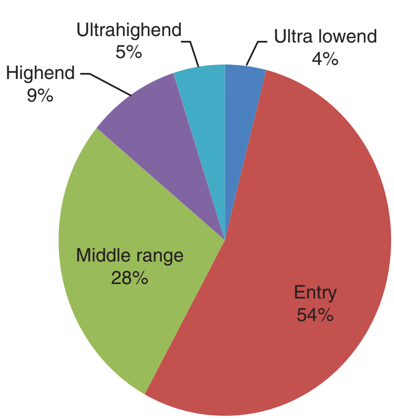

Figure 5 Mobile phone specs share in 2007 (Source: Nomura Securities Co., Ltd.).

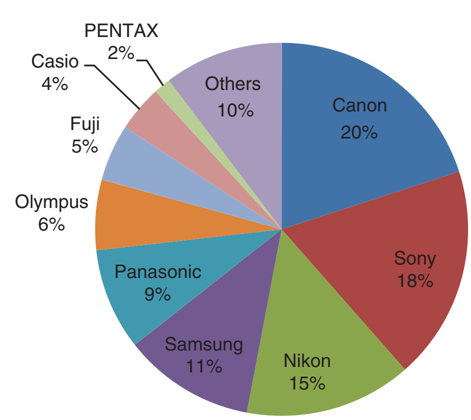

Figure 6 Worldwide share of the digital camera in 2010 (Source: Nikkei).

6 Future challenges

6.1 Free-trade strategy in East Asia

To take advantage of the deep integration in East Asia, a market research into the regional demand in East Asia and feeding back to the manufacturing side is one of the key issues to solve the Galapagos problem. Therefore, the Japanese government is leading a policy to contract the free-trade agreement (FTA), economical partnership agreement (EPA), and Regional Comprehensive Economical Partnership (RCEP) with the East Asian countries (http://www.meti.go.jp/). Figure 7 depicts the structure of the FTA with Japan-China-Korea, RCEP with 16 countries, EPA with EU-Japan, and Trans Pacific Partnership (TPP) with 14 countries. Associated with these customs' tax-free trade, the comparative advantage issue with the trade partner would take place, which forces the generation of a labor migration problem. Thus, the safety net policy for risk sharing is inevitable to avoid the unemployment problem.

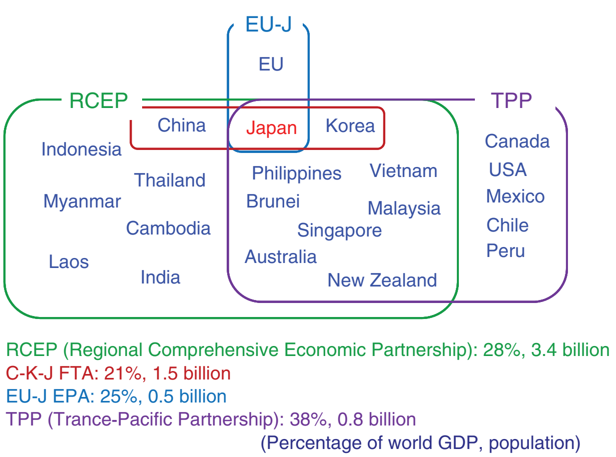

Figure 7 Structure of the trade partner in East Asia (Source: METI).

6.2 Utilization of ICT

ICT that is the origin of the digital economy is going to be utilized much more than before not only for the manufacturing industry such as machine to machine (M2M) but also for the civil engineering, agriculture, and service industries. According to the Metcalfe's law, the value of a network is proportional to the square of the number of connected users of the system. One of the advantages of the Japanese industry is an advanced broadband network infrastructure represented by the fiber to the X. X is home, buildings, factories, shops, governments (FTTX). Figure 8 shows the statistics of the number of broadband subscribers in Japan. The number is more than 35 million, and the FTTH is about 24 million. They are 67% and 46% of the total household (=52 million), respectively. The speed is extended up to 1 Gbps.

Recently, in the big cities like Tokyo, a big data of traffic information of passengers is collected by means of a tremendous number of customer's pass cards passing the city train and bus gates. The big data are transferred to the cloud computing system operated by the service-managing industries. They analyze the big data and create a new business model for the other industries connected to the network value chain. A tire company embeds a sensor inside the tire, and the sensor sends traffic information to a civil engineering company to show the state of the surface smoothness of the roads for paving maintenance. A Japanese construction equipment manufacturer

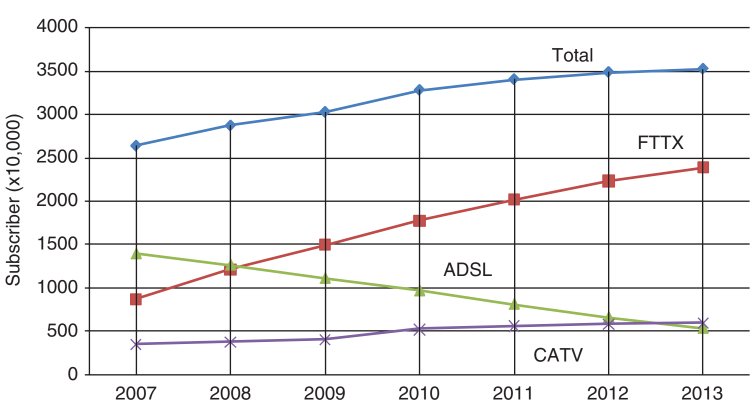

Figure 8 Broadband subscriber trend in Japan (Source: MIC).

installs wireless transceivers on the equipment, and the transceivers send information that the equipment is in operation or not. More than 300 000 constructing equipment is delivered all over mainland China, and one can monitor the real-time Chinese economic situation through the big data.

In the agricultural industry, a combination of ICT and nutrient solution soil cultivation method is promising to increase the productivity of the agricultural products [5]. The sensors installed in the agricultural fields send data of the photo of the field, temperature, amount of solar radiation, water concentration, humidity, and soil fertilizer concentration everyday to the cloud computer. The big data is analyzed by the agricultural engineer and the ICT engineer to find the optimized timing and quantity of the fertilizer to be sprinkled. These kinds of ICT utilizations will increase the productivity with a lower cost.

The global warming issue will give more chances for the Japanese photonics industry to lead the green digital economy. Because in the green photonics field, Japan is a top runner not only in the energy-saving technology of the ICT, itself, but also in energy saving by the utilization of the ICT [6, 7]. METI is taking initiative for this very important policy and five photonics R&D projects, such as Organic EL, Organic PV, Si-Photonics, POF, and Quantum information technology, are selected in the top 30 green technology challenges in Japan.

7 Conclusion

The state of photonics-related Industry in Japan is discussed, and it is shown that digital economy is creating a deep integration in East Asia. It is changing the economic structure there both in the supply and demand side. On the contrary, it generated the Galapagos problem, unfortunately as an example of the innovator's dilemma. The government is leading the policy of free-trade partnerships to solve this problem, and the Japanese manufacturers are challenged to take the advantages given by this deep integration. It has been found out in this decade that the ICT is leading the digital economy to grow so that the utilization of the ICT becomes much more important than before. Many of the photonics technologies are installed in, and contributing to, the ICT systems. Therefore, the photonics-related industry in Japan will grow with the increase in digital economy. Especially, green photonics will play an important role to lead the green digital economy.

References

[1] T. Friedman, 'The World Is Flat' (Farrar, Straus and Giroux, New York, 2005).

[2] C. M. Christensen, 'The Innovator's Dilemma' (Harvard Business School Press, Boston, 1997).

[3] T. Miyasaki, 'Galapagos Problem in Japan's Manufactures' (Toyokeizai, Tokyo (in Japanese), 2008).

[4] T. Fujimoto, 'Philosophy of Japanese Manufacturing' (Nikkei, Tokyo (in Japanese), 2004).

[5] Fujitsu, NEC and Hitachi. 'Cloud Computing in Agriculture' (Nikkei Business, Tokyo (in Japanese), 2013.3.4).

[6] K. Tatsuno, 'Future Challenges in the Photonics Market' (Photonics 21, Annual Meeting, Brussels, 2008.12).

[7] K. Tatsuno, 'State of R&D in Photonics-Related Fields in Japan's Industry and Academia' (ODS'2010, Boulder Colorado, USA, 2010).

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