



Photonics in China

Opportunities for Dutch companies, institutes, and universities

December 13th, 2011

The copyright of this report is with NL Agency - Dutch Ministry of Economic Affairs, Agriculture, and Innovation.

Contents

Executive summary 3

1. Introduction..... 4

2. Organization of photonics in China 5

2.1 Research institutes and universities in photonics..... 5

2.2 Focus areas for photonics in China..... 9

2.3 Government funding and funding agencies (5 year plan)..... 12

3. Report on fact finding mission in Shanghai, Wuhan, and Beijing 13

3.1 Shanghai area – visited parties..... 13

3.2 Shanghai area – additional institutes – not visited 16

3.3 Wuhan Area – visited parties 16

3.4 Wuhan area – additional institutes – not visited 19

3.5 Beijing Area – visited parties 20

3.6 Beijing area – additional institutes – not visited 24

3.7 Shenzhen Area..... 24

3.8 Changchun Area 25

4. Relevant events in 2012 (exhibitions, conferences, matchmaking)..... 26

5. References 27

6. Fact-finding mission team 30

Executive summary

Photonics is recognized to be an important technology field that is growing rapidly on a global scale. Also in China, photonic activities are growing fast. The number of people working in photonics in China and the financial support by the government are huge. On the other hand, people are working less efficiently according to western standards and collaboration between parties within China is still limited.

Up till now the presence of Dutch photonic companies in the Chinese market has been limited to a few players including Philips Lighting. Only a handful of Dutch SME's have entered the Chinese market. It turns out that knowledge of the Chinese market is limited for most SME's.

In November 2011, a fact-finding mission on photonics in China was organized by NL Agency - the executive agency of the Dutch Ministry of Economic Affairs, Agriculture, and Innovation in order to get a proper feeling for opportunities for Dutch photonic companies and institutes entering the Chinese market. Universities, institutes and companies were visited in the cities of Shanghai, Wuhan, and Beijing, all having extended photonic activities. Results of these discussions are reported in this publication showing that there is ample opportunity for Dutch universities, institutes and companies to start collaborating with Chinese counterparts.

Obviously only a small number of parties was visited during the fact-finding mission. Nevertheless, a proper feeling for the Chinese photonics market has been created and useful contacts have been established. These can be used for the matchmaking mission. There are definitely opportunities for Dutch photonic companies in China.

Of course, cultural differences between the Dutch and Chinese can cause confusion or different expectations. On the other hand, Chinese businesses are adapting to the demands of the global market. This implies improved quality control and taking IPR more seriously. The language barrier still is an issue: most Chinese don't speak English, so an interpreter is often required.

It is foreseen that a larger mission, taking place in 2012, will focus on matchmaking.

1. Introduction

Photonics and photonic devices are becoming increasingly important both from a scientific and an economic perspective. In fact it's an enabling technology having impact in many sectors in terms of photonic components, devices and technologies. The turnover of photonic technologies based components was approximately Euro 43.5 billion in Europe in 2007. On a global scale, growth levels between 10% and 40% are expected for this industry.

Extended photonics activities in the Netherlands, support by the government

In the Netherlands, we have a strong scientific position in photonics, and many companies are involved in development, engineering, production, and M&S of photonic components and products. Well-known players in this respect are e.g. ASML, Philips Lighting, and Thales, but many SME's play significant roles in niche markets as well.

The Dutch government (Ministry of Economic Affairs, Agriculture, and Innovation) acknowledges the importance of photonics and supports activities in that field financially. A prominent example of this is the research program IOP Photonic Devices. In this joint effort between universities and industry, several innovative projects in the photonics area are being executed. Dr. Bart Verbeek is chairman of this program and member of the fact-finding mission.

Chinese photonic companies becoming increasingly important

It's obvious that the Asian market is growing rapidly, also for photonic-based products. Countries like Japan and South Korea already have a strong position in photonics. China is catching-up quickly. Having huge resources, both in finance and a well-trained dedicated workforce, it can be expected that China will play a leading role in this field in the near future.

It should be noted that precise data on the size of the photonics market in China are hard to get as most easy accessible literature is in Chinese. Numbers on the LED and Chinese laser market however, could be retrieved and are shown in this report.

It is of vital importance for Dutch companies to be part of this emerging market as soon as possible: on the one hand for sales opportunities for products developed and manufactured in the Netherlands, but also for collaborating with Chinese companies, universities, and institutes. In joint projects and joint ventures, new products can be developed together and the fast growing photonics market in China offer opportunities for economic production. At the same time, China is a very important market for new products.

Fact finding mission to prepare for a large mission in 2012

For entering the Chinese' photonics market, the Dutch photonics sector is in need of information on opportunities and challenges for collaboration. In that respect market figures, focus areas of Chinese companies and institutes, do's and don'ts are important too. Several Dutch companies have indicated specific questions and needs.

It was concluded that a small fact finding mission could make the larger mission with companies in 2012 more effective. This fact finding mission took place in November 2011. Several universities, institutes and companies were visited in Shanghai, Wuhan, and Beijing. In this report, conclusions

from these visits are presented together with results from literature search. Other regions of interest will be discussed shortly.

Unfortunately, only a few systematic studies about China’s photonics industry are available. An example of this is ref [1]. Most articles are in the Chinese language.

In this report, information and data on the photonics knowledge infrastructure and industry in China will be presented with an emphasis on the cities of Shanghai, Beijing, and Wuhan.

2. Organization of photonics in China

It goes without saying that China is a large country with huge resources in terms of man power and money. At all places we visited, there was no lack of these resources. Nevertheless, advanced equipment and components from western countries were in need, indicating that the Chinese technology standard isn’t at the same level as ours in several fields. This, however, seems to be just a matter of time. Photonics research and development has received a high priority from the government resulting a massive financial support. It is thus foreseeable that the photonics field will obtain the same level as in the western countries in a couple of years from now. At the same time, China is a huge market for photonic products and Chinese companies and institutes are eager to collaborate with counterparts from foreign countries in order to do joint R&D, production, and marketing.

It should be noted that in China, the term ‘opto-electronics’ is often used instead of ‘photonics’.

2.1 Research institutes and universities in photonics

The laser and optoelectronic industry relies heavily on technological advancement as well as the human resources that are available locally and nationwide. The academic and technology advantage in a local area largely decides the future orientation or path of the industry there. By now, the academically powerful cities with large achievements or potential in the laser and optoelectronic technology and industry are Wuhan, Shanghai, Changchun, Beijing and Xi’an. An overview of major academic institutes in this field is presented in Table 1.

Table 1 : Regional Major Academic and R& D establishments of laser and optoelectronics in China

	Optoelectronic Communication	Optoelectronic Information (Storage, Imaging)	Laser
Wuhan	WRI		HUST, WJI, Gongyan, 717
Shanghai	CETC 23, SJTU, SEU (Nanjing)	SITP	SIOM,SILT
Changchun	Jilin University	CIOM, Jilin University	CIOM
Beijing	Beijing U. Tsinghua U.	ISC, Nankai U.(Solar Battery)	CETC11, BIOET, KLOP, NCRIO,BUT(NCLT), Tsinghua U., Beijing U.
Xi’an	XOAI	XIOM	
Shijiazhuang	CETC13		

Guangzhou/Shenzhen	OEMT of SYU	GISM	IOE of SCNU, GILA, SZU
---------------------------	-------------	------	------------------------

Source: ref [1]; Official website of related institutions

Research institutes play an important role with respect to development of photonics in China. Many of those research institutes are institutes of the Chinese Academy of Sciences (CAS). Historically CAS institutes were the only organizations that were designated by the Chinese government to do (applied) research as universities were focused on academic research and companies on production. This clear division in tasks has become less strict, but the CAS headquarters still is a ministry-level organization, including the financial privileges that come with that position.

Currently, quick profits can still be made in China by manufacturers just producing at a lower cost, buying existing technologies instead of developing themselves. This situation is however changing, especially in high-tech markets such as photonics, where quality and production speed rely on using advanced manufacturing equipment. Because of the technological expertise and skills at the different CAS institutes, they are often closely connected to the local Chinese industry.

Next to using CAS institutes to perform research, the Chinese government is also assigning State Key Labs (SKL). When an existing Chinese laboratory or a professor has made good quality publications or produced useful research results (and has good connections with the government), the laboratory can obtain the status of a SKL. This means that they will have more/easier access to funding for research. Table 2 gives an overview of State Key Labs having relevant activities in photonics.

Table 2: Distribution of SKLs for laser and optoelectronic technologies in China

	Optoelectronic devices and materials	Optoelectronic Information	Optoelectronic Communication	Laser
Beijing	1) Superlattices and Microstructures 2) Surface Physics 3) Superconductivity 4) Magnetism 5) Artificial Microstructures and Mesoscopic Physics	Software Development Environment	1) Networking and Switching 2) Microwave and Digital Communication	
Shanghai	Infrared Physics		1) Sensor Technology 2) Optical Communication	1) Optical and Magnetic Resonance Spectroscopy 2) High Intensity Optics
Wuhan		Software Engineering		1) Spectroscopy, Atomic and Molecular Physics 2) Laser Technology

Changchun	Integrated Optoelectronics	Applied Optics		
------------------	-------------------------------	----------------	--	--

	Optoelectronic devices and materials	Optoelectronic Information	Optoelectronic Communication	Laser
Chengdu	Electronic Thin Films and Integrated Devices			Microfabrication
Xi'an		Transient Optics and Photonics		
Guangzhou	Optoelectronic Materials and Technology			
Hangzhou	Silicon Materials	Modern Photonics Apparatus		
Jinan	Crystal Materials			
Nanjing	Solid State Microstructures			
Taiyuan	Quantum Optics Device			
Tianjin		Precision Test		

Source: www.chinalab.gov.cn; ref. [1]

In China, 220 State Key Labs are present in various fields. The term State Key Lab qualifies for additional financial support from the government. The SKL system is a measure of major China's basic research capacity. Altogether, there are 27 SKLs that are laser and optoelectronic, or photonic related, accounting for 12.2%. And most of the 27 SKLs are located in the eastern part of China. Most of the labs center on the basic science and a few of them act as technological providers, i.e. CIOM, HUST and SIOM, to their affiliated spin-off companies and enterprises.

To get access as a student for a MSc or PhD position, a national exam has to be passed successfully. Typically, a PhD-student earns 3000-5000 RMB (350-600 Euro) per month. Projects are partially funded by companies. In that case, the company acquires the IPR. In order to get projects funded, one has to submit proposals. Approximately 17% of the projects submitted to the National Science Foundations are being granted. Obviously, not all key labs are on photonics: other State Key Labs are working on topics like ship building, mechanical vibration, and thin film manufacturing for solar and nanotechnology.

Such institutes and universities have powerful technological influence over the laser and optoelectronic industries in China. For instance, almost all laser optoelectronic companies in Changchun are spin-off enterprises of CIOM or technologically supported by CIOM.

The arrangement of such research institutes and universities is partly because of the central government's planning, like Changchun, and partly because of a city's strategic position in China, like Shanghai or Beijing. Due to their openness, all laboratories have various kinds of technological

coordination and academic communication with academicians from technologically advanced universities and institutes. Although Beijing has the largest number of SKLs, it still lags far behind Wuhan in the development of laser and optoelectronic industry. However, in some sectors that have a technological disadvantage but large market potential industry, like LCDs and LEDs, the research powers act as technological challengers to those multinational companies.

Apart from research establishments financed by the central government, there are also some research institutes in technological agglomerated cities like Wuhan and Shanghai financed by local government.

2.2 Focus areas for photonics in China

Four major regions witnessed the growth of the optoelectronic technology and industry. Next to the three economically developed regions, i.e. the Yangtze River Delta, the Pearl River Delta and the Bohai-bay Area, Wuhan and its surrounding cities have become the center of the laser and optoelectronic industry.

Beijing, Shanghai, Wuhan, Nanjing, and Changchun are academic centers in laser and optoelectronic technology in China. Wuhan tops the other cities in academic-engineering transfer, with a strong research capacity agglomerated in it.

Due to the resource shortage in the eastern coastal areas and the guidance of the national policies, China's optoelectronics industry is seeing an accelerating relocation westward, forming the Central Belt ranging from Chengdu in the west to Hefei in the east and the Eastern Belt ranging from Dalian in the north to Zhuhai in the south.

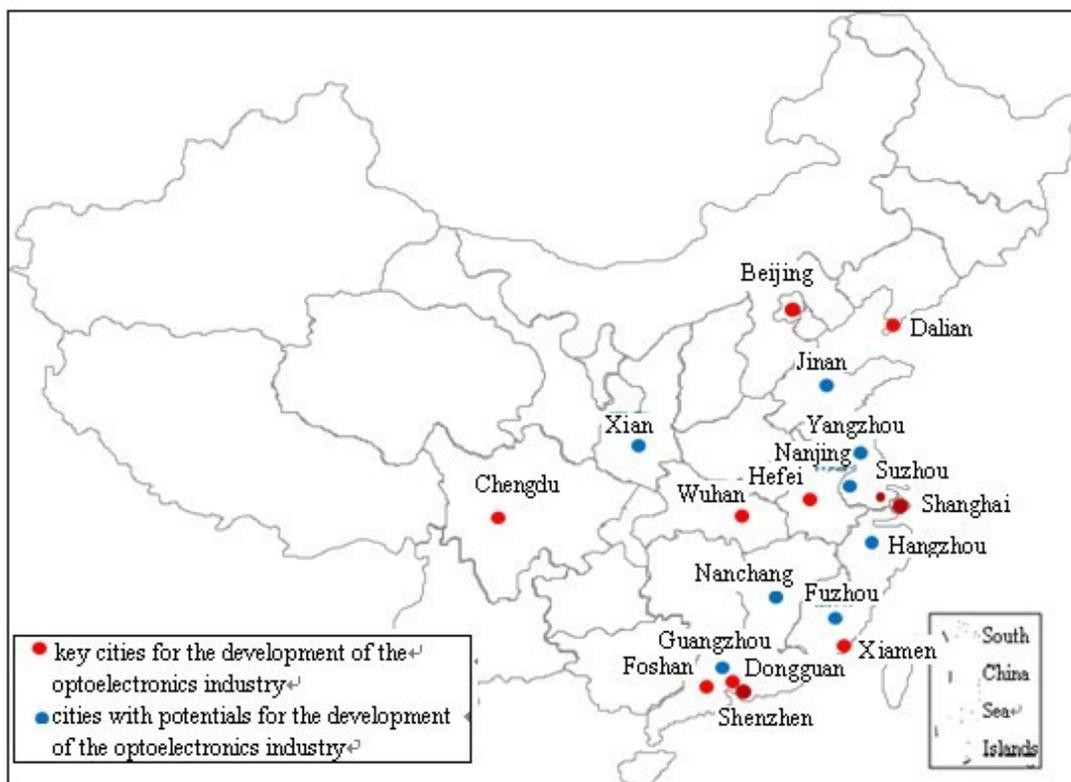


Figure 1 Key Cities of China's Optoelectronics Industry in 2010

<http://event.ccidconsulting.com/en/images/en-map2.JPG>. Source: CCID Consulting, May 2011

The European photonics²¹ report (ref. [3]) indicates that photonics production is dominated by Asia, notably Japan, Korea, and Taiwan. But China is catching up, hosting production facilities of overseas producers and Electronic Manufacturing Services (EMS). Also locally owned companies in China play an increasing role.

According to the Chinese Photonics Industry Association, the photonics industry in China has gained rapid growth in the past ten years with an average growth rate at about 20% each year. China has achieved Outstanding photonics production in three out of ten sectors of photonics (ref. [3]):

Lighting (the LED segment): In the segment of LEDs, China is one of the fastest growing areas in the world. It has built complete R&D capacity and industry chain, ranging from production of LED wafers, chips, packaging to various LED applications for illumination, general lighting, display, signaling and application products combining LED lighting with solar energy.

According to the Chinese Solid-State Lighting Alliance (CSA), more than 3000 Chinese companies are engaged in LED industry in 2008, including about 25 'upper stream' LED wafer and chips producers, 1000 doing packaging in the middle and 2000 'down stream' companies involved in LED application. Every aspect of China LED industry, wafer, chips and packaging as well as application, has entered the phase of economy of scale. China's total LED production volume in 2008 is estimated at RMB 70 billion. This includes RMB 1.9 billion for chips production, which makes China the third biggest GaN chips manufacturer. China has become an important manufacturing hub for world LED packaging, its 2008 production volume accounts for RMB 18.5 billion. The production of China's LED applications grew by 50% to RMB 45 billion in the same year.

China is not only a major manufacturer for LED products but also engine for growth and innovation in R&D. China claims to have made major technological breakthroughs in deep UV LEDs and OLEDs. For example: the Changchun Institute of Applied Chemistry at Chinese Academy of Sciences had developed efficient tandem LED that can produce white light at a CRI rating of nearly 70, almost good enough to read by.

In 2009, 6 ministries have presented proposals to develop the LED-lighting industry further. Until 2015, a yearly growth of 30% is expected. According to some branch experts, a production value of 500 billion RMB could be possible in 2015. Based on this figure, export of related products could raise to \$ 30 billion.

The driver for this, is the huge opportunity for reducing energy consumption. Already in 2009, 21 cities carried out pilots for using LED's for lighting in public areas. Between 2010 and 2012 and other 50 demonstration projects are envisioned using approx.. 2 million LED-based lamps.

Optical communications: The Chinese industry holds a strong position in the sector of Optical Communications, optical fiber and cable products as well as photoelectron devices. China Optical fiber production is the second largest in the world, and accounts for more than a share of 12% of total world production volume. In terms of R&D in photonic systems, China made major technological breakthroughs in a 40Gb/s SDH (STM-256) Optic Communication Equipment and System fiber-to-the-home (FTTH) project. This project aims at the highest line rate till date, viz. 40Gb/s, STM-256 SDH fiber-optic communication equipment and system. With the technologies

coming from Indigenous Innovation, the project team successfully developed the first STM-256 (40Gb/s) SDH equipment according to ITU-T standard in the world. This system transmits STM- 256 signal up to 560 KM on link or ring topology via widely used G.652 or G.655 fiber systems, and provides the highest rated business system present till date by using expanding single-channel bandwidth four times to 40Gb/s, compared to the predominant 10Gb/s single channel rate in business systems.

Solar Energy: China is one of the major producers of solar panels and solar cells in the world. However, this segment has not been subject of the fact finding mission. For more information on Chinese activities in the solar energy market, see ref [1] and ref. [2].

Major activities in laser development and production

Chinese laser companies are mainly located in the provinces Hubei, Juilin, Jiangsu, and Guandong, and near Beijing and Shanghai. According to the China Optics and Optoelectronics Manufacturers Association (COEMA), approximately 200 companies cover 90% of the total laser market in China. Companies like Wuhan Huagong Laser Engineering and Shenzhen have a position at the Shenzhen stock market.

COEMA expects strong demand for high-power lasers for e.g. the steel industry. For the high segment, German suppliers have a solid position in the Chinese laser market. Examples of such German suppliers are Trumpf and Rofin-Sinar. Trumpf has a production facility in Taiceng for some standard lasers.

China aims to reduce the dependency on import and several programs have been positioned to increase technology build-up on high-power lasers. There are five national centers for laser research; four of them are located in Wuhan. Nevertheless, it seems that up-till now, China isn't able to achieve the same quality as German competition.

The laser business is growing rapidly in China. Thanks to growing demand in many segments China remains one of the most interesting markets for laser applications (ref [2]). China has been renowned long for growing laser crystals and building Nd:YAG lasers. The segment for material processing however is growing very fast (double digit numbers yearly) . Focus is on marking and engraving, but also laser cutting in the lower and medium-power segments are growing significantly.

Table 3: Chinese Laser market for laser cutting devices (low- and medium power segment)

	Turnover [mln RMB]	Change [%]
2006	286	-
2007	355	24
2008	402	13
2009	449	12
2010	587	31
2011	777	33
2012	1038	34

Source: COEMA

In this segment, market leaders are Guandong Han's Yueming Laser Technology, Wuhan Golden Laser, and Boye Laser Applied Technology. In 2008, they possessed approx. 45% of the market. The market share of laser manufacturers form abroad in this segment was 16% in 2008.

2.3 Government funding and funding agencies (5 year plan)

The National 12th Five-Year Plan on Science & Technology Development was released by the Ministry of Science and Technology in July 2011. According to the Five-Year Plan, the overall objectives of China's science and technology development during the period of 2011-2015 will focus on 'building China into a knowledge based innovative nation by significantly boosting its strength for indigenous innovation and its international competitiveness in high-tech sectors and achieving breakthroughs in priority S&T areas and key technical fields.'

In its 'Action Plan: Fostering strategic new industries', one of the key areas is 'Energy efficiency' including LED lighting projects. This LED lighting part focuses on the development of key technologies on white light emitting diode (LED), light source system integration and devices. The following goals have been defined:

- Enhancing LED lighting applications
- Setting-up LED standards and testing system
- Speeding-up the "10 City, 10.000 LED lights" project
- By 2015:
 - white LED luminous efficiency reaching international level
 - LED accounts for 30% of the lighting in the Chinese market with expected turnover of 500 billion yuan
 - China has to become top 3 in the world in LED lighting industry.

The 12th Development Plan for Information Technology also emphasizes other development areas of photonics in China. These include:

- Optical communication network and system equipment
- Flat panel displays
- New optoelectronic devices, sensors and applications, terahertz sources

The objectives are to realize key technology breakthroughs through innovation, to build a complete value chain, and to strengthen China's overall competitiveness in the selected areas of photonics.

3. Report on fact finding mission in Shanghai, Wuhan, and Beijing

As mentioned above, Shanghai, Wuhan, and Beijing are major cities for photonic activities that were visited during the fact finding mission in November 2011. For each of these cities, results of the visits will be presented below, together with additional information on related institutes and universities.

Next to this, information on institutes in the Shenzhen area are presented. This city has not been visited during the fact finding mission.

3.1 Shanghai area – visited parties

In Shanghai, having a population of approx. 19 million, many universities, institutes, and companies are engaged in photonic activities. It is interesting to note that in Shanghai, a free trade zone (manufacturing for export) is present having financial benefits for both the Chinese government and foreign companies.

The following parties were visited during the fact finding mission:

Shanghai Jiao Tong University

Jiao Tong University is present on five locations in China, including Taiwan. At the Shanghai site, 33.000 students are present together with 3000 faculty members.

This university houses six State Key Labs including the State Key Lab for Optical Communications Research. It focuses on test beds, optical switching architectures and photonic devices. Every year 150 students graduate (MSc and PhD) and the faculty size is 40 persons. Several faculty members have post-doc experience in Europe (including the Netherlands) or the US. For obtaining a degree, publications in international journals are mandatory.

The SKL collaborates with 53 participants, including carriers, (China Telecom), vendors Huawei, universities, and institutes. International collaboration has been realized with companies and institutes from USA, UK, Germany, France, Singapore, and Korea. The collaborations have a bi-directional character.

Research topics include:

1. Optical Networking - intelligent optical network design. In contrast to the choice made in Europe, China has selected passive optical networks (PON) as the approach for ‘fiber to the home’. This choice has been made by the carrier.
2. Transmission & Switching
3. Opto-electronics & Photonics: working on theory of micro ring resonators and optical delay lines for optical communication purposes.

The SKL are executing design activities for circuitry and in the process of setting-up their own cleanroom. For this purpose, a budget of Euro 5 million is available. Up till now, they are using foundry facilities in Singapore and Taiwan. Even then, not all facilities will be available. For example,

III-V facilities are not available and could be sourced from Cobra, Eindhoven, with whom they already have contact.

Possible leads: collaboration on integration of electronics and photonics

Philips Lighting – Shanghai (www.lighting.philips.com.cn)

The Philips LED-activities are concentrated in Shanghai. It is a competitive field with many active competitors. During discussion with Philips employees, a couple of issues arose that could be of interest for companies considering to start activities in China:

- There is a tendency for companies filing patents in China too, and trespassing is being sanctioned . Nevertheless, IP has to be considered thoroughly in negotiations on collaboration. The largest threat however are key employees transferring to the competitors site. It is possible that a local company at the opposite side of the street, supported by the government, starts competing with you, recruiting your best employees.
- For SME's working with an agent is not always a solid way to go: if the loyalty of this person ends, you're facing transfer of your technology to a competitor. The best way to avoid this is to take care that your product can't be copied easily and to continue innovating.

NTS-Group- Shanghai (www.nts-group.nl)

The NTS-group owns companies in the Netherlands, China, Czech, and Israel employing 800 people in total of which 60 people at the Shanghai site. The central account management team is located in Eindhoven. The company focuses on designing and manufacturing opto-mechatronic- and mechanical modules for OEM companies. Application areas include healthcare, semiconductor, analytical instrument, printing, and solar. This is a competitive field.

Starting as an after-sales center, NTS started series production in 2005, now also active in designing for local customers. As the company's activity is on assembling, most components are being sourced locally from approx. 200 suppliers. Quality control is an issue taken care of. Also it is quite difficult to find good designers.

Also the Frencken group is active in China having acquired a local company in the Shanghai area.

Shanghai Institute of Microsystem and Information Technology (SIMIT) <http://english.sim.cas.cn/>

This major institute is active in various fields of photonics and they are in the process of founding a company on optics. They seem to have direct funding lines with central government as some of their equipment/facilities are funded via the Mega Projects Zhongda zhuanxiang 国家科技重大专项 scheme. Current topics include:

- Silicon based photonics; Examples include a Ge-detector and a fiber-chip coupler. In the near future the fiber-to-home market will be addressed. Next to this there is an interest in biomedical applications. The institute has 30 years of experience in III-V materials and they are searching for a foundry for research and volume production.
- A group is working on lasers and photo detectors, a.o. quantum cascade lasers in the wavelength range of 4 – 10 micron. For wavelength tuning, an external cavity is used. A single-photon emitter is being developed for quantum cryptography.

- 4 people are working on theory of photonic crystals. There is a close connection with MIT. For the experimental part, another postdoc (from MIT) will start soon. The aim is to integrate photonic crystals with III-V materials. Also thin-film techniques are being considered.
- Theory of plasmonics, no experiments yet
- THz-applications

Several employees have experience from institutes abroad (a.o. MIT, TU/e). Collaboration exists with the French foundry LETI , IMEC / Holst Centre, and TUD (space applications for THz).

With respect to photonic crystals, the groups are oriented on MIT. There is no contact yet with Dutch groups working on related topics.

With respect to experimental equipment, facilities are present for epitaxial growth. MOCVD is not available yet.

Possible leads: the institute is interested in collaboration on microlenses for coupling light into chip and on technologies for integrating electronics and photonics.

Shanghai Institute of Technical Physics (SITP) (www.sitp.ac.cn)

This institute is large, having a staff of approx. 500 people and 400 temporary positions (graduate students, post docs, and visiting professors). In 1998 it has been selected for knowledge innovation, initiated by the Chinese Academy of Sciences (CAS).

Research includes fundamental issues (optical, electrical, and structural characterizations), materials and devices (infrared detectors, coolers etc.), and systems and applications (a.o. remote sensors, optical system design and electronics, and thin-film research).

Applications are mainly in the field of satellite technology for e.g. meteorology, and ocean temperature monitoring. A high-spectral interferometer has been developed for methane detection. SITP is working on studies only, on behalf of the Chinese Academy of Space Technology in Beijing. No commercial activities. SITP helps companies in using the sensors.

Possible leads:

- Opportunities for collaboration on remote sensing applications
- The institute is searching for:
 - gratings in the wavelength region 0.4 – 2.5 micron with 100 – 200 lines / mm
 - detectors in the wavelength regions 3 – 5 micron and 8 – 12 micron

SCOP – Shanghai (www.scop.com.cn)

SCOP is an example of a SME in the photonics area. Having six employees, the company has developed burst trans-impedance- and post amplifier and laser driver for 2.5 Gb/s optical communication. Application area is fiber-to-home.

They are in the process of pre-producing the chip using the IBM foundry. No sales have been realized yet. SCOP is dedicated to the design on which they have filed patents.

3.2 Shanghai area – additional institutes – not visited

Shanghai Institute of Optics and Fine Mechanics (SIOM), CAS

- Website: <http://english.siom.cas.cn/> (English)
- Keywords / focus area: High Power Laser Technique, Strong-Field Physics and High Intensity Optics, Information Optics, Quantum Optics, Laser & Optoelectronic devices, and Optical Materials, etc.
- Director: Zhu Jianqiang

Shanghai Jiao Tong University, Laboratory for Laser Plasmas

- Website: <http://llp.sjtu.edu.cn/>
- Keywords / focus area: lasers

3.3 Wuhan Area – visited parties

China's biggest photoelectron information industry base, known as Optical Valley, is located in the city of Wuhan, central China's Hubei Province.

There are 18 universities and institutes, 56 state level research organizations and over 150,000 high-technology experts in the area. About one third of the experts work in the photoelectron information industry.

In May 2001, the Optical Valley Technology Stock Exchange was established in Wuhan. It was the first optical technology exchange center in China. After less than one month's operation, more than 200 projects were released and around 30 members had joined. The government has defined a 5-year plan for activities on laser technology.

Also venture capital is available for this purpose: yearly, an exhibition is organized for Chinese and foreign venture capital companies, and high-tech enterprises.

In Wuhan more than 200 photonic companies are active. Approximately 100 companies are connected to the Center for Laser Processing. International collaboration exists with Russia, India (major market for export), and Germany (Munich exhibition and contacts with major companies as Siemens and Mercedes).

Other Optical Valleys are planned in south China's Guangdong Province with the cooperation of the US company Lucent Technology and Changchun, the capital of northeast China's Jilin Province, and Shanghai Pudong New Area have plans for the construction of an Optical Valley and photoelectron industry park of their own.

The following parties were visited during the fact finding mission:

Wuhan National Engineering Center for Laser Processing (<http://laser.hust.edu.cn>)

The Wuhan National Engineering Center for Laser Processing aims for collaboration with SME's. In their opinion, large companies like Rofin-Sinar and Trumpf don't need support.

The Engineering Center has 2 areas of interest:

1. High-power photonics
2. Information photonics

Ad 1: CO₂-slab lasers have been acquired from Rofin-Sinar ; the high-power lasers are not allowed to be built outside Germany. Also high-power fiber lasers are bought abroad. Application areas include welding, cutting, and marking.

The Center is planning to build a high-power UV-laser. The route for this is to start with a 750 W Q-switched disk laser (Trumpf) and use non-linear optics for frequency doubling and mixing.

Chutian Laser Group (www.chutianlaser.com)

Chutian Laser is a large company, having 1000 employees, in the field of laser applications. Also welding, cutting, and marking activities are executed for customers.

Using commercially available lasers, Chutian develops laser systems for medical applications (e.g. dermatology). In this respect Philips is a competitor.

Chutian is also marketing laser systems from other companies.

Possible leads: Chutian is interested in marketing Dutch products for the Chinese market, e.g. laser systems or medical diagnostic tools. Next to this, they would like to collaborate on femtosecond laser processing.

HG Laser (www.hglaser.com)

The company is a spin-off activity from the university in Wuhan. The turnover in 2010 was 2.1 billion RMB of which 50% is laser business. Other activities include counter fare, EO optical components, and sensing parts using ceramics (PTC and NTC).

HG laser manufactures approximately 70-80 laser products: CO₂-lasers, Nd:YAG (1064 nm, 532 nm, 355 nm) , fiber lasers, and diode-laser pumped lasers. Diodes are obtained from e.g. Coherent.

In the factory, they also had high-power Rofin-Sinar and IPG-lasers. They expect being able to build such lasers themselves within two years from now.

The lasers manufactured are applied in e.g. welding, marking, and laser dicer machines.

A collaboration exists with Australian manufacturer Farley in the field of high-power CO₂-laser systems . A manager from this company will obtain a position in HG soon, a.o. to tackle quality issues.

Chutian is not considered a competitor as it is not building lasers itself, but using them for medical applications. Chutian is privately owned whereas HG laser is state owned.

3.4 Wuhan area – additional institutes – not visited

For Wuhan, the focus of the visit was on laser industry. Wuhan is also a strong base regarding optical fiber/cable, main players are

- Nat'l Engineering Lab for Fiber Optic Sensing Technology (linked to the Wuhan University of Technology, visited by Teijing in March 2011) <http://public.whut.edu.cn/fostrc>
- Fiberhome Group: before a state-owned institute (WII), now being privatized. More information can be found on www.fiberhomegroup.com. Production as well as R&D
- YOFC, joint venture with Draka. www.yofc.com.cn. Production as well as R&D. YOFC is said to be one of the top-3 players in the world

Other major institutes in Wuhan:

Wuhan National Laboratory for Optoelectronics (WNLO)

- Website:
 - <http://222.20.94.9:8083/> (English)
 - <http://wnlo.cn/> (Chinese)
- Keywords / focus area: Fundamental Photonics, Integrated Optoelectronics and Micro-nano Fabrication, Laser Science and Technology, Optical Network and Communication, Opto-electro Measurement and Instrument, Optoelectrical Information Storage, Biomedical Photonics and Optoelectronic Medical Devices, Organic Optoelectronics, Advanced Optoelectronic Materials and Energy Optoelectronics

State Key Laboratory of Digital Manufacturing Equipment and Technology (DMET)

- Website: <http://dmet.hust.edu.cn>
- Keywords / focus area: Fundamental theory of digital manufacturing, Advanced process & methods, Key technology of digital manufacturing equipment, Digital manufacturing systems

Huazhong University of Science & Technology (HUST), College of Optoelectronic Science and Engineering

- Website: <http://oe.hust.edu.cn:8082/Overview/Profile/index.html>
- Keywords / focus area: optical fiber communication technology and sensing, high-power laser, laser processing device and technique, MOSEMS technology, laser medical equipment, optical storage technology, optical information detection and image processing technology and military optical technology.

Huazhong University of Science and Technology (HUST), School of Life Science and Technology

- Website: http://english.hust.edu.cn/170_overview.html
- Keywords / focus area: Key Laboratory of Biomedical Photonics, Key Laboratory of Image Processing and Intelligence Control.

3.5 Beijing Area – visited parties

Like Shanghai, Beijing is one of the major cities in China with over 19 million inhabitants. Numerous universities, institutes and companies are working on photonics. Below, an overview is shown of the visits paid during the fact finding mission.

CAS Institute of Semiconductors – Beijing (www.semi.ac.cn)

In this institute, both photonic components (LED and blue diode lasers) and applications are developed.

With respect to components development, the total chain is explored and the focus is on increasing efficiency of the devices. For research also a nano-optoelectronics lab is available.

LED-development is concentrated in the Beijing area, industrial applications in Xian Xu, and manufacturing in the Guandong area.

The following applications are under development:

- a. Plant growth (adapting the wavelengths to optimize growth)
- b. Smart lighting (i.e. combining lighting and communication – internet access). This could result in using internet in an airplane
- c. Intelligent lighting – opening curtains, controlling air-conditioning using light
- d. The blue LED is being considered / used for military communication, killing of bacteria, and printing.

The UV-LED (< 200 nm) still has a low output power (order of 1 mW). It is the aim to increase the output power to say 10 mW as it will be interesting for water treatment then. To realize this increase of current and increasing the number of devices per unit are possible solutions. The institute is also considering using Al-nitride for the blue-LED, but the lifetime is disappointingly low.

The institute have developed a platform for LED-production (including MOCVD-equipment). Companies can get access to this platform.

Next to this, a group is working on III-V materials for military applications. Another group is working on high-power all-solid-state lasers. With respect to the latter, there is no collaboration with companies or institutes in the Wuhan-area.

TU Delft has realized a collaboration with this institute.

Possible leads: the institute would like to collaborate on

- Technologies for increasing LED efficiency (e.g. plasmonics)
- Technologies for generating light out of silicon
- Application areas such as water treatment and plant growth

ISA – Beijing (www.isa-world.org)

ISA stands for International Solid-State Laser Alliance and is an association between the government and companies working on roadmaps, standardization, and promotional issues of solid-state lighting.

LED development is a high priority for the Chinese government: it is part of out of seven strategic emerging technology directions:

1. Energy savings; LED is part of this
2. New IT
3. Biotech
4. Automotive
5. New energy
6. New materials (including photonic materials)
7. Medical and well-being

There is a strong SME presence on LED in China with 4000 (!) enterprises active, divided over luminaires, packaging, and chip manufacturing. With respect to the latter, 65 (!) GaAs foundries are active in China.

Approximately 10 – 20 companies can be considered as leading in their field. While R&D is focused in Beijing, most companies are located in het Shanghai and Guandong area.

In the Board of Advisors, Prof. Guoqi Zhang is co-chairman. He is also director at DIMES Centre for SSL Technologies and professor at Delft University.

Philips Lighting and TNO are ISA members too. TNO has been contributing to the Strategic Research Agenda (SRA) for this field. In the near future, the SRA will be converted into a roadmap.

Two times per year, an international forum and exhibition on LED is being organized. This event can be used for matchmaking. In April 2012 the event will take place in Shanghai, in autumn 2012 in Guandong.

China Academy of Space Technology – Beijing (<http://www.cast.cn/CastEN/index.asp>)

CASC (China Aerospace Science and technology Corporation, 20.000 employees, 22 billion RMB turnover in 2011) is prime contractor for China national space crafts. The China Academy of Space Technology is part of this institute.

Core businesses are space technology R&D and spacecraft design and manufacturing.

Technological development are:

1. Sensors for sun and stars research
2. Camera's
3. Laser communication between satellites and from satellites to earth

With respect to the Netherlands, the China Academy of Space Technology has contacts with TU Delft, SRON, and TNO. China Academy of Space Technology and TNO are collaborating on calibration of instruments.

The institute is in need for CMOS-camera's and a space-qualified laser instrument (optical amplifier).

Part of the program is military oriented. At the moment it is not clear if export limitations are an issue.

Chinese Optical Society (<http://english.cast.org.cn/> currently only in Chinese)

The Chinese Optical Society which is close to its US-counterpart OSA has a good overview of photonic activities in China. It's also working closely together with SPIE.

It is a non-profit organization, connected to CAST.

The China Academy of Sciences (CAS) has seven institutes that are specialized in photonics. An institute in Chan Chun (north of China) has over 4000 staff members. The smallest institute has over 1000 staff members. In 25 out of 32 provinces of China, COS has sub-offices.

In China, there are approx. 17 institutes for PhD students, 100 institutes for MSc students, over 200 institutes for bachelor students. Yearly, 10.000 bachelor students graduate, together with 6.000 MSc students and 1.000 PhD students.

As an example, at the Beijing institute for Optical Engineering, 150 bachelor students graduate each year, together with 30 PhD's. PhD positions are obtained by passing national exams.

The COS has several sub-societies and special committees in different fields, e.g. laser infrared technology, optical engineering, holography, etc. This is a similar set-up as SPIE and OSA.

Focus areas for photonics in China are: semiconductors (lasers and components for telecom and LED), lasers, and solar (photonics for energy)

COS has approx. 4.000 individual members.

COS organizes bi-annual conferences, the next taking place in October 2012 (ASIA Photonics). Sub-committees also organize conferences.

The COS income has the following distribution:

- 10% membership fee
- 20-30% government support
- 50-60% technical support & services (exhibitions, training)

COEMA (www.coema.org.cn)

China Optics and Optoelectronics Manufactures Association (COEMA) fills the gap between government and companies. Activities include gathering and fact finding. They are also involved in roadmaps for the five-year plan of the government and giving input to the strategic research agenda. Formally, they are part of the MIIT ministry.

In China approximately 10.000 companies are active in the field of opto-electronics of which 800 have a membership of COEMA. This percentage is relatively small due to the large number of associations that companies can subscribe to. Most of these companies produce components and parts.

COEMA has several contacts abroad, e.g. with Canada, Japan, and Korea. In 2009 COEMA organized an event in Beijing together with Germany. There is a collaboration with the German Association for Medical Devices. In the past (2009) also matchmaking was organized with French companies.

COEMA and COS mostly cover similar fields, but COS is more scientific oriented and COEMA is more enterprise oriented.

With respect to quality control, MIIT sent a survey last year to companies. The response was however quite low; companies are reluctant sharing information on this topic.

Phoebus Vision (www.phoev.com)

Phoebus Vision focuses on display technologies. It is a company co-funded by CAS and has 4 international patents.

Phoebus have developed a 71 inch HD TV using 3 lasers: a 638 nm diode laser, a frequency-doubled diode laser pumped Nd:YAG laser and a blue laser by sum-frequency mixing the former two lasers.

Phoebus is claiming a lifetime of the lasers of 20.000 hours.

With respect to technology demands, Phoebus is searching for green and blue diode lasers and integration of the display system (optical engine).

Looking at activities in the Netherlands, there may be a possibility for collaboration with parties working on integrating electronics and photonics.

Beijing GK Laser Technology (www.gklaser.com)

The main business of this company is manufacturing laser-diode pumped solid-state lasers. They are part of the CAS Institute of Optics and Electronics. The company employs a staff of over 100 people and have a ISO 9001 quality management system.

Part of the product development is what they call “self-directed innovation”, i.e. having free choice for developing new products.

Several laser systems were presented:

- Several solid-state lasers (diode-laser pumped) in the range from 40 – 4000 W
- 100 W laser @ 532 nm
- Pico-second laser
- Fiber laser: 2 kW @ 1064 nm
- Amplifier @ 1053 nm (Nd: Glass ?, amplification 109 x?, pulse length 1-10 ns ?) for a secret application (‘nuclear’)

Application areas for the lasers include laser shows, ceramics manufacturing, diamond cutting, silicon scribe, marking.

GK Laser has international collaboration with Russia, Lithuania, Germany (Edgewave), US (Laser Spectrum Corp., Yuco). No collaboration with similar companies and institutes in the Wuhan-area. The turnover in 2010 was approximately 50 million RMB.

Laser diodes for their products are obtained from e.g. France and the US. They don’t make them themselves.

3.6 Beijing area – additional institutes – not visited

Peking University – SPM Group

The Silicon, Photonics & Microsystems (SPM) Group is a platform for research and education on new frontiers of nanophotonics and nanoelectronics. The objective is to develop the next generation of compactly integrated low cost optoelectronic systems that may be used for real time sensing/detection, high-density data communications, and high-speed control/actuation.

Website: <http://spm.pku.edu.cn/>

3.7 Shenzhen Area

During the fact-finding mission, the Shenzhen area has not been visited. Nevertheless, extended photonic activities take place there. Below, an overview is given of relevant universities institutes in that area.

Shenzhen Institutes of Advanced Technology (SIAT), Chinese Academy of Sciences

Comprehensive research institute(s) under SIAT characterized by an extremely wide coverage of research areas and focus on industrial research in cooperation with (local) industry. Two photonics-related departments (lab & research center; see website)

- Website:
 - <http://english.siat.cas.cn/> (English)
 - <http://english.siat.cas.cn/rh/rd/ioait/rcl/lfpit/in/> (Laboratory for Photonics Integrated Technologies)
 - http://english.siat.cas.cn/rh/rd/iobe/rcl_1/rcfb1/in/ (Research Center for Bio-Photonics)
- Keywords / focus area: Bio-photonics, mixed-signal integrated circuits, high-density system-on-package, miniaturization and multi-function integrated systems.
- Remarks: collaboration with Huawei on optical interconnected sender and receiver IC

Research Institute of Tsinghua University in Shenzhen (RITS)

Relevant research centers are the Center for Optomechatronics & Advanced Manufacturing, Center for Advanced Materials & Biotechnology.

- Website:
 - <http://en.tsinghua-sz.org/> (English)
 - <http://en.tsinghua-sz.org/Research.aspx?CateID=356> (Center for Optomechatronics & Advanced Manufacturing)
 - <http://en.tsinghua-sz.org/Research.aspx?CateID=264> (Center for Advanced Materials & Biotechnology)
- Keywords / focus area: optomechatronics integration, micro-nano engineering, micro electro mechanical systems, sensor technology.

Shenzhen University Institute of Optoelectronics

Besides the Institute of Optoelectronics Engineering (see website), Shenzhen University houses two Shenzhen key labs: Key Lab of Laser Engineering, Key Lab of Micro-Nano Photonic Information Technology.

- Website:
 - http://opto.szu.edu.cn/en/General_info.htm (English; outdated)
 - <http://opto.szu.edu.cn/cn/> (Chinese; College of Optoelectronics Engineering; updated)
- Keywords / focus area: ultra-fast diagnostic technology, flat display technology, semiconductor material & devices, electro-optics systems, vacuum ultra-fast photoelectric devices, laser technology.
- Remarks: Shenzhen University's reputation is not particularly strong

As an example of the importance of the Shenzhen area: the company Huawei (www.huawei.com), a leading company on global information and communications technology are executing their photonics R&D in Shenzhen.

3.8 Changchun Area

The Changchun area hasn't been visited during the fact-finding mission. Also here, several photonic activities take place that are worth mentioning:

Changchun Institute of Optics, Fine Mechanics and Physics (CIOMP), CAS

CIOMP belongs to the Chinese Academy of Sciences (CAS). It is a multi-disciplinary and comprehensive research institute. It is engaged in fundamental research, applied fundamental research, engineering technology research and high-tech industrialization.

Main topics of research: luminescence, applied optics, optical engineering, precision mechanics and Instruments.

CIOMP has 13 research departments, laboratories and centers, including the State Key Laboratory of Applied Optics, National Engineering Research Center for Diffraction Gratings Manufacturing and Application, the National Supervision and Test Center for Optics Mechanics Quality and the Key Laboratory of Excited State Processes, CAS.

Website: <http://english.ciomp.cas.cn/>

Jilin Photonics Industry Incubator

Jilin Provincial Photonics Industry Incubator is financially supported by the Jinlin provincial government. More than 60 companies are based in this incubator.

Products include: optical measurement and control products, light-emitting materials, information display, optical element base parts, semiconductor packaging equipment, laser imaging devices, laser processing equipment, medical devices for clinical testing etc.

4. Relevant events in 2012 (exhibitions, conferences, matchmaking)

In case the company mission to China will be combined with a conference or trade show, the following events could be considered in 2012:

Date (2012)	City	Conference / tradeshow	Info
February 22-24	Shanghai	China (Shanghai) International Optics Fair	http://www.siof.cn
March 20-22	Shanghai	Laser World of Photonics China	http://www.world-of-photonics.net/en/laser-china/start
April 26-29	Xiamen	International Symposium on Advanced Optical manufacturing and Testing Technologies (AOMATT)	http://www.ioe.ac.cn/gjil/jldt/201111/P020111103360981754881.pdf
May 21 – 23	Shanghai	SOPO 2012 — International Symposium on Photonics and Optoelectronics	www.sopoconf.org/2012
June 12-14	Beijing	China International Photoelectronic Exhibition	www.cipeasia.com
July 18-20	Shanghai	The 11th China (Shanghai) International Optoelectronics Expo	http://www.chinaexhibition.com/trade_events/1080-Optoelectronics_Shanghai_2012_-_The_11th_China_%28Shanghai%29_International_Optoelectronics_Expo.html
September 6-9	Shenzhen	The 14 th China International Optoelectronic Expo	http://www.cioe.cn/files/CIOE%2012%20Invitation%20Brochure.pdf
September 10-12	Beijing	CIOF 2012 - The 25th China (Beijing) International Optics Fair	www.coif.cn/eng/fairinfo.php?p=4
November 2-9	Wuhan	9 th Optics Valley of China Int'l Optoelectronic Exposition and Forum (OVC Expo 2012)	

5. References

1. 'A Study on the Development of China's Laser & Optoelectronic Technology and Industry', with city cases of Wuhan, Shanghai and Changchun, Hao Wang, University of Giessen, 2008, http://fss.plone.uni-giessen.de/fss/fbz/fb07/fachgebiete/geographie/forschung/pdf/wirtschaft3/file/2008-03_Studi_z_WiGeo_Development%20of%20China.pdf
2. Der Photonikmarkt in der VR China, Germany Trade & Invest, www.gtai.de, 2010
3. Photonics in Europe, Photonics21, 2007
4. Zakendoen en kansen in China voor de fotonica sector, NL Agency, January 2010

Additional information from internet:



[< Acta Photonica Sinica >](#)

ACTA PHOTONICA SINICA is a monthly journal which is sponsored and edited by The Chinese Optical Society, co-sponsored by Xi'an Institute of Optics and Precision Mechanics, CAS, and published by Science Press. It mainly publishes academic theses, research notes and research letters on Photonics. The contents deal with Optics, particularly, Transient Optics, Optoelectronics, Integrated Optics, Optics, Nonlinear Optics, Photo-Biology, Optical Information Optics, Guided Wave Communication, Optical Sensing, Optical Computing, Optical Neural Network, High Speed Photography, Intellectualized Optical Instrument, Photon Function Materials, Interaction between Photons, Classical and Nonclassical effects of Photons, etc. '

Website: www.photon.ac.cn

Email: czej@opt.ac.cn

Add: P.O. Box 47, 17 Xinxi Road, New Industrial Park, Chang'an District, Xi'an, Shaanxi, P.R. China

Post code: 710119



[< China Laser Press >](#)

'A new magazine of Chinese Laser Press, is featured by OE news, products and market reports, and

the circulation covers OE-related companies, universities and institutes. It aims to accelerate China OE research and industrial development. The main columns include news, viewpoint, interview, focus, technology exchange, product information, etc.

OEPN provides readers a channel to know the OE market and buy devices, and it is also a favorable platform of promoting products for companies.'



[< Lightwave China >](#)

'Launched in September, 2002, Lightwave China Bimonthly is the Chinese version of the well-known Lightwave magazine. Lightwave China is authorized to publish by Pennwell and is published in Simplified Chinese by ACT International in Hong Kong, circulating controlled-free to average of 10,000 professionals in the China optical communications industry.

Focusing on optical communication, Lightwave China provides engineers and senior executives in China with in-depth information about optical communication technologies, up-to-date news, applications, market, products and standards, etc.

Lightwave China magazine organizes "FTTH China Conference" annually, and manages www.lwc.com.cn, a professional website for optical communication.'



[< Laser Focus World China >](#)

'The Premier Publication for Laser and Opto-Electronics Industry in China Published since 2005, Laser Focus World China, the Chinese edition of the well-known Laser Focus World magazine, is the professional magazine for engineers, researchers, scientists, and technical professionals in China. It provides comprehensive global coverage of optoelectronic technologies, industrial and R&D applications, and market information. The editorial content licensed exclusively from LFW is supplement by content generated by our own editors in China. Laser Focus World China is published every other month in simplified Chinese and distributed to over 8,000 qualified optoelectronics professionals in China. Through our digital magazine and website we provide coverage to an even larger audience base.'



[< International Optoelectronics and Displays >](#)

'Founded in 1999 by Yawei Information Co., Ltd., "International Optoelectronics and Displays" is the most popular FPD Industry magazine in China, and it is the only industry magazine recognized by China Optics & Optoelectronics Industry Manufactures Association LCD Branch and Shenzhen Flat

Panel Display Industry Association. It introduces the latest industry development trends or companies' demand information to readers.'

6. Fact-finding mission team

This fact-finding mission was conducted by:

Jan Willem Gerritsen – PhotonTec BV

Bart Verbeek – Barnel BV, IOP Photonic Devices

Nasrat Popal – NL Agency

We gratefully acknowledge the support and input of the staff of the Royal Embassy of The Netherlands in China (including the Science and Technology Office in Beijing and Shanghai) and Netherlands Business Support Office (NBSO) in Wuhan.

Dutch Embassy, Beijing:

Jan Reint Smit

Harro Wintermans

Jingmin Kan

Maurits van Dijk

Ma Qing

Dutch Consulate, Shanghai:

Jaap van Etten

Netherlands Business Support Office Wuhan:

Bertrille Snoeijer

Yuan Fei