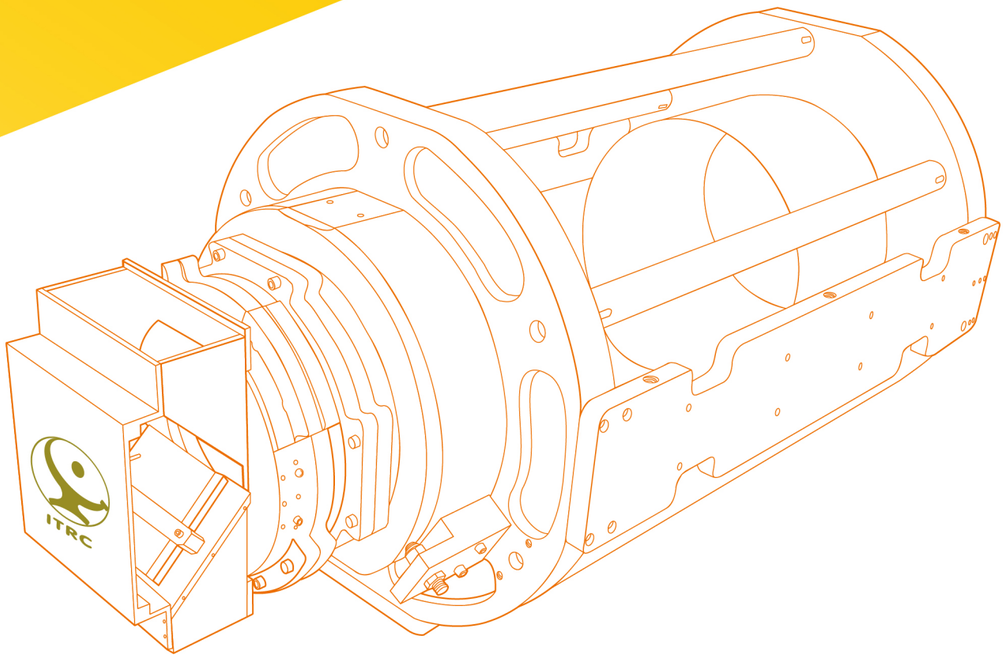
NARLabs 國家實驗研究院

儀器科技研究中心

Instrument Technology Research Center



2014 Annual Report

儀科中心一〇三年報

Instrument Technology
Research Center
Annual Report 2014

國家實驗研究院 儀器科技研究中心 一〇三年報 Instrument Technology Research Center **Annual Report 2014**

NARLabs 國家實驗研究院
儀器科技研究中心
Instrument Technology Research Center

300 新竹市科學園區研發六路20號
Instrument Technology Research Center,
National Applied Research Laboratories
20 R&D Road VI, Hsinchu Science Park,
Hsinchu 300, Taiwan, R.O.C.
TEL:886-3-577-9911 FAX:866-3-577-3947
http://www.itrc.org.tw

國家實驗研究院

儀器科技研究中心

Instrument Technology Research Center

Foreword

A Word from the Director General

2014 年，儀科中心歡慶四十歲生日，一百多位在「精儀中心」時代服務的同仁回娘家一同歡慶。不惑之年，儀科中心清楚地定位自己責無旁貸的使命 -「嫁接產學、共同提升國內儀器設備產業之國際競爭力」，特別是在半導體設備與醫學光電等領域。

在創立初期，中心成功為國內莘莘學子研發與製造實驗用「六百倍顯微鏡」，並研發國內第一代真空計，帶動我國光學與真空產業的興起。時至今日，儀科中心影響力已經擴及產學研各界，四十年的勤奮耕耘，綻放出繽紛的成果。

這一年來，中心與產、學、研各方合作交流，積極拓展中心對外服務業務，與半導體製造商以及光電產業標竿企業合作開發，加速業界研發進程，將技術轉化為具有市場需求的商品。完成晶背瑕疵檢測系統，搭載上國內機台成功外銷韓國 S 集團；6 寸石英透鏡與晶圓移動機構頂針已分別售予國內半導體代工領導廠以及國外半導體設備大廠 A 公司；並自主開發 3D IC 步進式曝光機投影鏡頭模組，期望兩三年內為我國半導體產業設備開創新契機。

年初成立的「光學系統整合研發聯盟」促成多件「產、學、研」協同研發案，參與的業界夥伴包括 LED 廠晶元光電、台灣先進手術醫療器材、高醫大附設中和紀念醫院等，強化產學連結、共創產學研三贏的成果。另，儀科中心加速台灣醫材產業發展，串聯產官學研各界組成「國研醫材創價聯盟」，輔導齒顎整形客製化手術醫材研發團隊以及新穎神經導管研發團隊，分別成立巧醫生技公司及善醫生技公司。

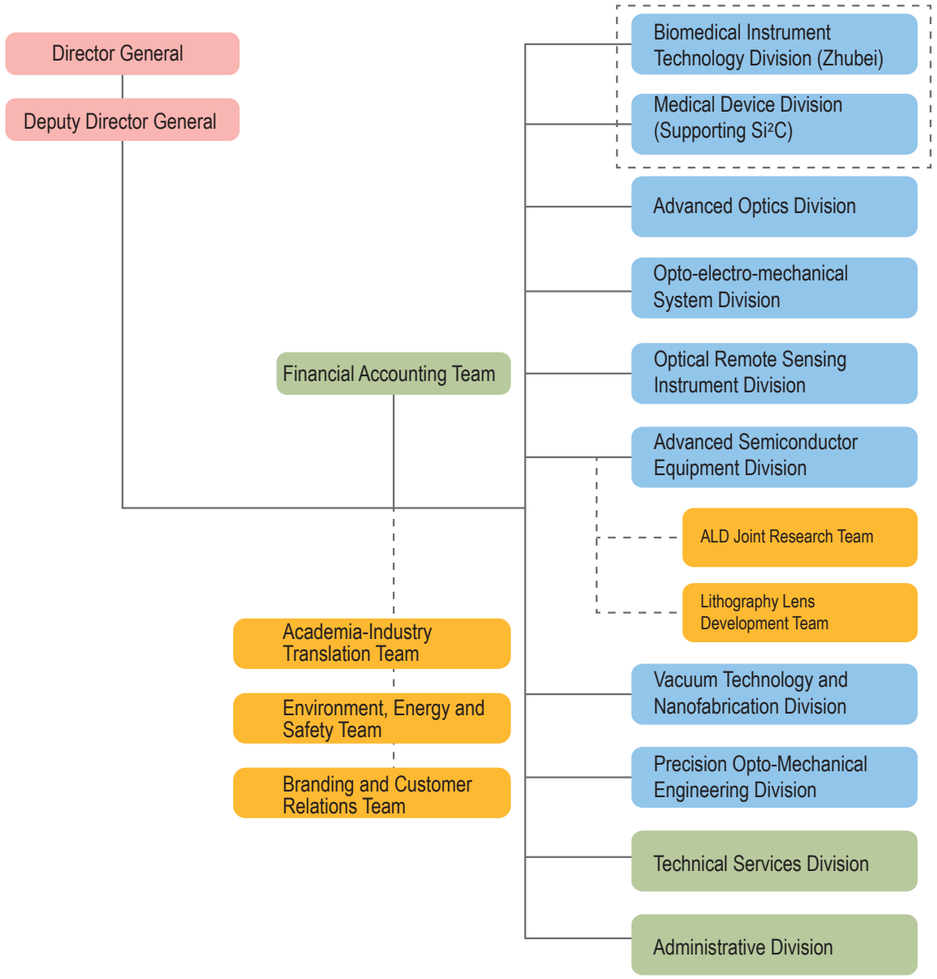
在國際合作方面，儀科中心長年發展高光譜儀技術，2014 年獲得南澳總理基金會支持，受邀於南澳聖文森海灣進行海洋水草沙漠化的研究，此舉為國內科技外交開拓新頁。除此之外，中心也致力於節能減碳，本年度通過「ISO 50001 國際能源管理系統標準」驗證，2013 年、2014 年分別較前一年度節電達 25%、16%，降低營運成本。在樽節成本與同仁群策群力下，中心過去兩年對外服務收入成長兩倍多。

展望 2015 年，期許在「外部質感」上能營造新局；更希望與更多具高度國際影響力之台灣企業成為合作夥伴。儀科中心「承諾」積極落實「創新」於產業應用。期許透過良性互動，贏得客戶「信賴」，藉由服務創新來獲得「倚重」，並將客戶「需求」置於中心核心價值。期許帶動台灣產業科技競爭力，為我國產學研的研究發展貢獻一己之力。

主任 葉哲良 J. Andrew Yeh

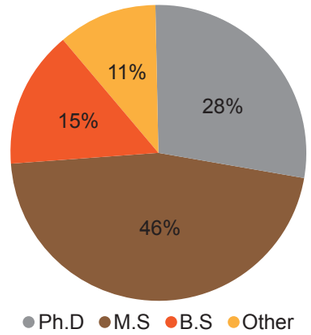
Overview of the Instrument Technology Research Center

Organizational structure

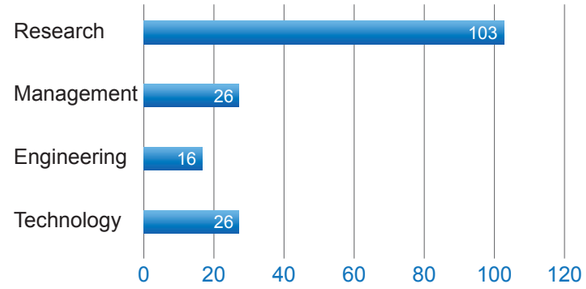


Manpower deployment

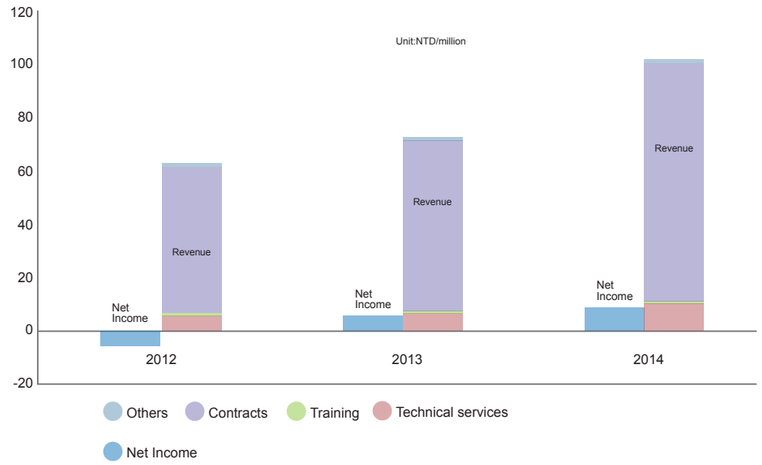
Educational attainment



Manpower deployment



Financial information

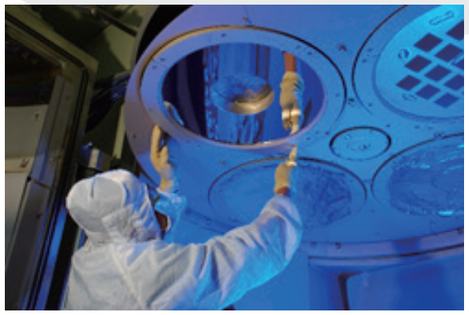


Core facilities

Vacuum technology & nanometer processes

ITRC provides advanced vacuum system development, nanometer process development, and inspection/calibration service platforms; its chief core facilities include:

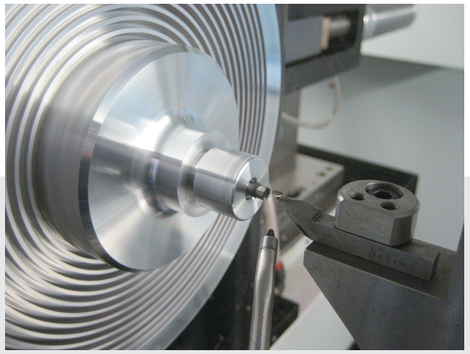
- Large-aperture lens coating system
- Transmission electron microscope
- Single-wafer plasma-enhanced atomic layer deposition (PEALD)

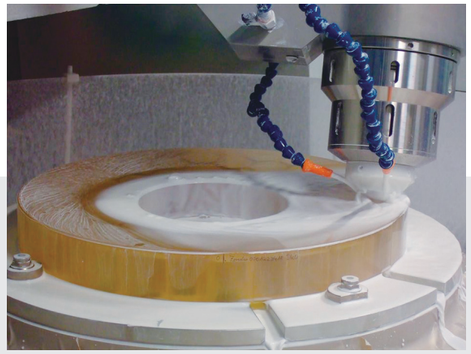


Precision opto-mechanical engineering

Having accumulated 40 years of experience in optical polishing technology, ITRC provides precision opto-mechanical element and system design and produce services; its core facilities include:

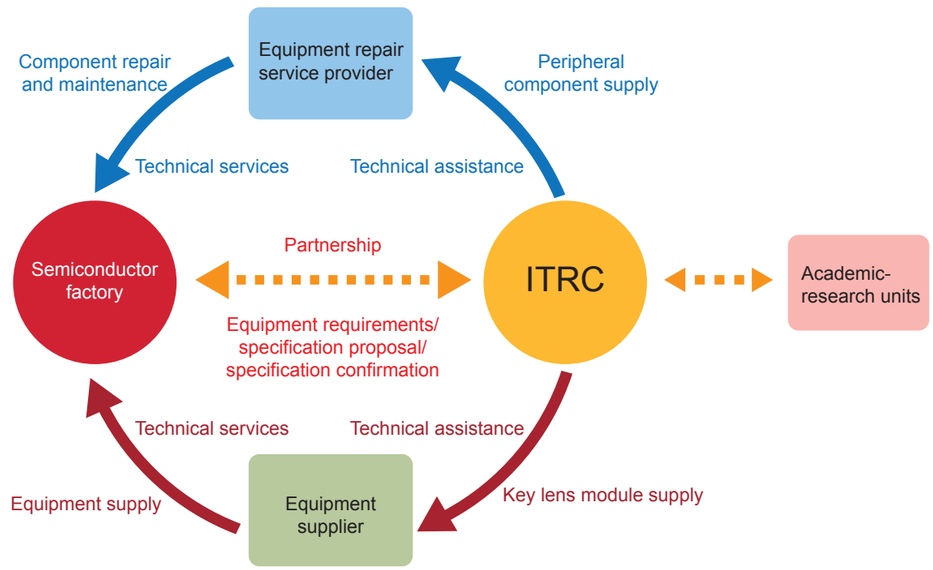
- Lens polishing and testing equipment
- Ultra-precise diamond turning and milling machine
- Segmented interferometer





Business cooperation model

ITRC actively introduces a new operating model of "serving customers of customers." The goal is to bridge the gap in the product supply and demands of the three - upstream companies, downstream firms, and R&D institutions. ITRC tries hard to research, develop, and translate the demands at the consumer end into capacities at the supplier end. Tapping on the novel service concept of integrating innovation into engineering and incorporating engineering into services, ITRC accelerates transforming R&D and innovative outcomes into industry applications, thereby adding value to the services of its industry chain. The diagram below illustrates the operating model of manufacturing lithography lens modules, which comprises of three stages: Lens customization service, lens batch production, and technology transfer after trial mass production.



Operating model of manufacturing lithography lens modules

GABC Service

Executing crucial policy tasks (G)

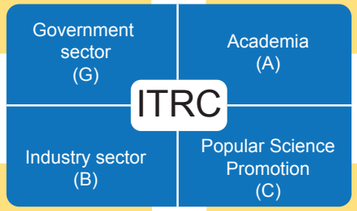
Supporting major academic projects (A)

Commercializing novel technologies (industry) (B)

Promoting popular science education (C)

- Serving as the eyes of the FORMOSAT-5 satellite
- Developing a monitoring device for disaster prevention at the Zhuoshui River Bridge.
- Assisting with refining agricultural development.
- Executing the "Taiwan Biotechnology Take-off Action Plan".

- Supporting national projects and industrial fundamental technology projects.
- Supporting innovation, entrepreneurial projects, and prototype production.
- Cultivating biomedical teams and verifying medical equipment.
- Cooperating with academic institutions in the R&D of instrument technologies and systems specific for prospective studies.



- Improving industry-specific instrument systems and key components.
- Selling lithography lens to Taiwan's semiconductor leading company
- Selling lithography E-pin to A company,a semiconductor manufacturing company in the Netherlands.
- Cooperating with Epistar in developing LED chip inspection systems.
- Selling the developed chip inspection system and Taiwan-made machines to Korean S Group.

- *i*-ONE International Instrument Innovation Competition
- Fostering talents in instrument technology and providing popular science education.
- Updating knowledge and information regarding technological instruments and ITRC.
- Hosting optoelectronics exposition, semiconductor expositions, and SPIE exhibitions.

Notable achievements in 2014

ITRC relies on its R&D expertise to strive for technological breakthroughs. In 2014, ITRC successfully developed many customized instruments, promoting domestic industry upgrades and reinforcing the foundation of localization. The Optical Systems Integration R&D Consortium applies ITRC's technology capabilities in commercializing the products of academia-industry R&Ds to create economic benefits for Taiwan's biomedical industry, thereby generating mutually beneficial outcomes for both industry and academic researchers. ITRC's underwater hyperspectral imager jointly developed with the Australian Water Quality Centre (AWQC) has successfully attracted international attention. This endeavor is considered highly successful and has received considerable media coverage.

The commercialization of R&D technology and localization of semiconductor process equipment

Using the core techniques of instrument technologies in developing instrument systems, ITRC overcame industry bottlenecks and accelerated the progress of industry R&D. Concurrently, ITRC cooperates with various industries and converts technology outcomes into products that fulfill market demands. Its chip back defect testing system developed in 2014 has been successfully sold to Korean S Group. ITRC cooperated with business firms and jointly established a laboratory where innovative technologies are developed for enhancing Taiwan's international competitiveness. By collaborating with major semiconductor firms in Taiwan, ITRC dedicates its efforts in producing precision opto-mechanical elements for semiconductor processes and in promoting the localization of semiconductor equipment. To date, ITRC has accomplished the development of lithography beam shaping lens, quartz rod, wafer clamping modules, and top pin for wafer transport mechanism, all of which have been verified by semiconductor firms. Specifically, the beam shaping lens and top pin for wafer transport mechanism have been sold to other semiconductor firms. In addition, ITRC has autonomously developed the 3D IC lithography projection lens module, which serves as the source of business opportunities for localizing the equipment production process of the semiconductor industry in Taiwan.

Optical Systems Integration R&D Consortium: A win-win situation between academia and industry

In 2013, ITRC launched the Optical Systems Integration R&D Consortium, followed by cooperating with the National Yunlin University of Science and Technology as well as M&R Nano Technology Co., Ltd. in the project "MEMS Microlithography Process Equipment UV Light Narrow Bandpass Filter R&D and Coating" in 2014. Subsequently, ITRC joined forces with the Kaohsiung Medical University Chung-Ho Memorial Hospital, Taiwan Surgical Corporation, and Lumos Tech. Co., Ltd. in the development of the guided endoscopic image sensor and 5.9-mm smart micro transnasal endoscopy. Later on, the collaboration with Epistar and National Central University Thin Film Technology Center (TFTC) in the development of high-temperature plasma enhanced atomic layer deposition system applied to UV LED was built. ITRC utilizes its own resources and leverages the capabilities of industry and academic organizations to drive the future development of industrial technologies, in order to create a beneficial outcome for both industry and academic researchers.

ITRC, Kaohsiung Medical University Chung-Ho Memorial Hospital, Taiwan Surgical Corporation, and Lumos Tech. Co., Ltd. announced their cooperation in the development of the guided endoscopic image sensor and the 5.6-mm smart micro transnasal endoscopy.

ITRC cooperates with Epistar and National Central University Thin Film Technology Center (TFTC) in the development of high-temperature plasma enhanced atomic layer deposition system applied to UV LED.

Taiwan-Australia International Collaboration: Underwater hyperspectral imager

As the leading technology of ITRC, the underwater hyperspectral imager contributed to ITRC's cooperation with the National Cheng Kung University (NCKU) and AWQC in 2014. The cooperation involved using ITRC's underwater hyperspectral imager to monitor and manage the marine ecology in South Australia. In May of this year, ITRC researcher was invited to participate in the launch of its underwater imager at the Gulf of Saint Vincent in South Australia for the first time. This project was reported on the local news media in Australia, opening a new page for Taiwan's international technological exchange. The outcome of this project was also announced in a press conference. ITRC's research team subsequently acquired funding for international collaboration with Australia. The team will be actively engaging in the underwater seagrass observation project, with the goal of expanding its technological applications used in prediction, evaluation, and restoration topics related to environmental migration.

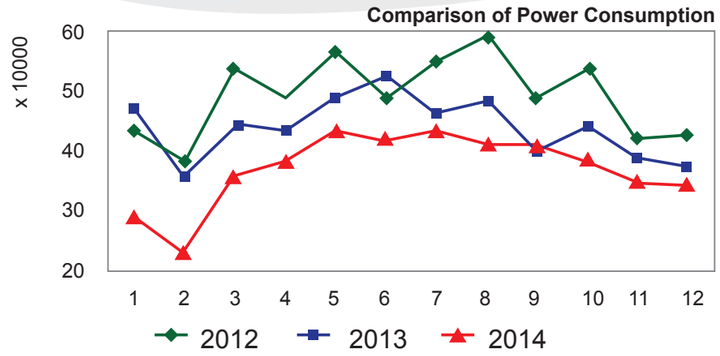
ITRC holds the underwater hyperspectral imager announcement meeting
The underwater hyperspectral imager

R&D Creativity Award for Measurement Science and Technology: Portable wafer edge defect testing system

ITRC successfully developed its portable wafer edge defect testing system, which has a resolution of 30 μm in defect testing and a testing accuracy of 99%. The system serves as a remedy for resolving the problem of unclear defects observed in wafer inspection projection methods. It won the R&D Creativity Award for Measurement Science and Technology awarded by Chinese Metrology Society.

Energy management system: ISO 50001 certification

ITRC is certified with the International Energy Management System Standards ISO 50001. By using the operating procedure of the energy management system, ITRC continually optimizes and improves its energy efficiency within the organization, thereby achieving the policy goals of energy conservation and carbon reduction as well as reducing its operating costs. To incorporate the energy management system into its business operation and promote measures for energy conservation and carbon reduction, ITRC has set up green solar devices since 2013, supplying power to information facilities such as the fire prevention system and telecommunication computers. Moreover, it has established a central control air-conditioning system and a laboratory air-conditioning control system. Because of its devotion to building these systems, promoting energy conservation, and transforming the entire center to a green building, ITRC conserved approximately 10% of energy consumption in 2013, and further reduced its energy consumption by 16% in 2014, which helped them lower its electricity expenses by approximately NT$2.42 million.



Launching of the Medical Equipment Value Creation Alliance

To accelerate Taiwan's production of biotech medical equipment, ITRC gathered industry, academia, and research experts to form the Medical Equipment Value Creation Alliance. The Alliance offers assistance in various stages of entrepreneurial endeavors, including rendering a single-package service integrated with upstream, midstream, and downstream processes such as prototype trial testing, professional consultation with clinical physicians, administrative legal consultation and verification applications, animal testing and clinical trials, investment and financial planning, listing and over-the-counter consultation, and funding assistance. All in all, the establishment of the Medical Equipment Value Creation Alliance has opened a new chapter for Taiwan's medical equipment industry.

Before startup companies aspiring to enter the medical equipment industry in Taiwan can manufacture their products, they must undergo a series of tedious and time-consuming processes such as testing their product prototype, analyzing legal regulations, and undertaking animal testing and human clinical trials. In response, the Medical Equipment Value Creation Alliance primarily offers verification services required during the innovation and production stage of medical equipment products, helping inventors find the most efficient way to launch their products into the market, thereby accelerating the revelation of a product's value. In the future, ITRC endeavors to guide the medical equipment industry in Taiwan to generate trillion dollar outputs and to attain yet another record-breaking achievement.

Launching ceremony of the Medical Equipment Value Creation Alliance

International recognition of R&D outcomes achieved in 2014

With its abundance of R&D results, ITRC has continually received awards for its achievements. Specifically, the article, Uniaxial-isotropic Metamaterials by Three-Dimensional Split-Ring Resonators, has been selected by Nature as the "Research Highlight" of a device that "bends light from all angles."

Awards received in 2014

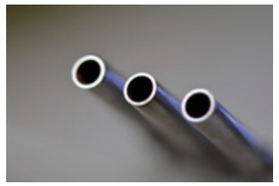
Event	Participating work	Award
Chinese Metrology Society	Portable wafer edge defect testing system	R&D Creativity Award for Measurement Science and Technology
NARLabs Award for Outstanding Contributions in Science and Technology	Development of a portable clinical skin pathology testing platform	Awarded the Outstanding Achievement Award under the technology development category in the 8th "NARLabs Award for Outstanding Contributions in Science and Technology"
Industry-academic research outcome announcement meeting by the Department of Engineering and Technologies, Ministry of Science and Technology	Mini hyperspectral imager production	Award of Excellence for Poster Exhibition
Industry-academic research outcome announcement meeting by the Department of Engineering and Technologies, Ministry of Science and Technology	Applying Novel Precursor Synthesis to Diffusion Barrier Layer of Copper Internal Wiring in Plasma-Enhanced Atomic Layer Deposition	Award of Excellence in R&D Achievement
Industry-academic research outcome announcement meeting by the Department of Engineering and Technologies, Ministry of Science and Technology	Production of Fluorine-Containing Transparent Conductive Thin Film	Outstanding Award for Poster Exhibition
2014 International Conference on Advanced Materials for Science and Engineering (ICAMSE 2014)	Optical Characteristics and Microstructures of Large-Field-Angle P-Polarizer Deposited by E-beam System	ICAMSE Best Paper Award 2014
The 3rd International Symposium on Next-Generation Electronics (ISNE 2014)	Effects of In/Al ratio on Structural Properties of InAlN films Grown on Si(100) by RF-MOMBE,	ISNE Best Paper Award 2014
2014 NI Paper Contest	Development of a Multi-Confocal Interferometer Probe	Champion in Automated Testing Group
2014 NI Paper Contest	Applying NI LabVIEW in Chemical Beam Epitaxy to Produce Nitride Epitaxy Thin Film	Runner up in Advanced Research Group

Areas of focus

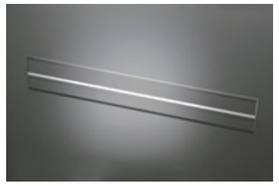
ITRC has long pursued instrument technology research and the development of basic instrument engineering technology, possessing extensive R&D capabilities and instrument technical service platforms. Not only does ITRC assist academic organizations in developing special experimental instruments and equipment needed for prospective studies, but also realizes its R&D innovations as industrial applications. Looking ahead to the future, ITRC strives to become the pilot in semiconductor equipment and medical optical technologies. Within the next few years, ITRC will introduce its semiconductor lithography lens model, lithography replacement lens, and atomic layer deposition (ALD) nanometer process equipment into the industry supply chain, with the goal of elevating Taiwan's competitiveness in industrial technologies and contributing to the R&D achievements of domestic industries and academic institutions.

Optical systems and elements for semiconductor process equipment

ITRC has developed optical elements required for the wafer positioning platform of semiconductor lithography equipment, thus overcoming the challenge where high-precision optical elements must be precisely positioned and are prone to heat deformation. In addition, ITRC has completed the Zerodur® reference mirror that can be used in precision stage of semiconductor manufacturing equipment, as well as the i-line glass lens, which can be applied in lithography illumniation and projection lens systems. Concurrently, ITRC has developed the elevating pin in wafer transport mechanism with a surface roughness (Ra) under 30 nm. This element has passed verification by semiconductor equipment manufacturers and ITRC is currently producing it in small batches. Furthermore, ITRC has researched and produced the quartz rod, elongating the rod from 250 mm to 450 mm. The quartz rod is expected to be applied in ITRC's lithography illumination system. The aforementioned R&D achievements are all key optical precision elements for semiconductor equipment, the design and production process of which both conform to international equipment standards. This presents Taiwan's semiconductor manufacturers with opportunities for production localization.

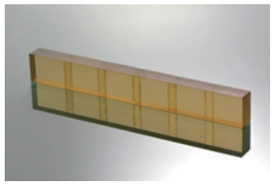


Wafer elevating pin (L, 120 mm; end diameter, 4.5 mm), a key element of lithography for wafer transport and leveling.



Quartz rod (Dimension, 447x34x14 mm; end flatness, < λ/4 @ 632.8 nm; side flatness < 40λ @ 632.8 nm), a crucial optical element required for lithography illumination system.

i-line glass lens for semiconductor (Size, ϕ152 mm), an optical element required for lithography illumination and projection lens systems.



Zerodur reference mirror (Dimension 30x250 mm, shape precision/flatness ≤λ /10 @ 632.8 nm), used in precision stage of semiconductor manufacturing equipment

Atomic layer deposition

Since 2003, ITRC has engaged in design and process development of ALD and plasma enhanced ALD (PEALD) systems for the academia and industry. Currently, developments of cluster-type and batch-type ALD systems are underway for next-generation nanoscaled devices. The 12 inch PEALD module is connected to a SEMI certified vacuum platform, allowing the wafer transfer without breaking vacuum. Thus, off-site demonstration of novel thin film processes can be realized by using ALD capability in ITRC, which is crucial for local semiconductor manufacturers to maintain the technological competence.

Development of 12-inch PEALD system in ITRC for the purpose of depositing ultra-thin film (< 20 nm) with a high step-coverage over high aspect-ratio trench.

AOI – automated optical inspection

In response to the development of miniature semiconductor products, ITRC uses automated testing equipment to enhance its quality management and production performance, and hopes to expand market demands for cost-effective products. ITRC has developed a high-resolution automated optical testing device for LED chip defects. This optical defect testing platform and technology have a high spatial resolution of 1.83 μm and a broad field of 4.2 x 2.8 mm, rendering the capabilities of high-resolution testing and measurements to the semiconductor industry. Compared with similar testing systems (3~5μm spatial resolution) available in the market, ITRC's testing device is advantageous both in terms of precision and cost. This testing system can be applied to wafer form and chip form in testing LED chip surface electrode defects and edge defects on these types of wafers. The device is capable of testing 4" LED wafer chip defects within 20 minutes and projected to replace the current manual inspection as far as possible. This would further enhance the competitiveness of Taiwan's LED industry.

High-resolution automated optical testing device for LED chip defects The device is projected to replace the current manual testing methods and capable of testing 4" LED wafer chip defects within 20 minutes. This would further enhance the competitiveness of Taiwan's LED industry.

Medical optical instruments

ITRC has developed a transnasal endoscopy integrated a guided software and an ultra-thin endoscopic lens with an image sensor. The software is primarily applied to the smart micro transnasal endoscopy system featuring positioning sensing. With an external diameter of 3.8 mm and a resolution of 400 × 400 pixels, the ultra-thin endoscopic image sensor lens can be used to acquire segmented close-up images of the esophagus. Subsequently, these segmented images can be pieced together, forming a complete image of the esophagus using image stitching technologies. The smart micro transnasal endoscopy, composed of an ultra-thin endoscopic image sensor and multidirectional rotating lens, is adopted to acquire images of the human esophagus and the interior of the stomach. Integrated with ITRC's self-developed image algorithm and Gyro and G sensors on top of the endoscope, the smart transnasal endoscope provides feedback on the distance and position where the endoscope is located. Through the image algorithm, this 3D coordinate information is then converted into 2D coordinates based on the geometric relationship of the coordinates. The image coordinates are subsequently converted into image maps, which are provided to physicians for them to examine the condition of a patient's esophagus and stomach interior. In future, after it is verified, registered, and tested in clinical trials, the use of this smart endoscopy system will be promoted to enhance the R&D standards of Taiwan's medical equipment.

Transnasal endoscopy integrated guided software
Enables physicians to examine the condition of a patient's esophagus and stomach interior. It is primarily used to acquire segmented close-up images of the esophagus, which are then pieced together, forming a complete image of the esophagus.

Development of instrument technology

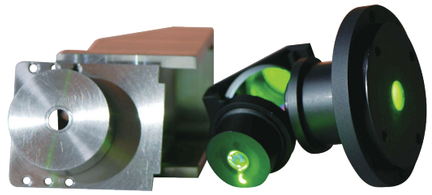
Production and testing of large-aperture lens and customized optical elements

Catadioptric endoscopy

In current medical practices, examining oral pathology requires sampling from the skin inside the mouth for specimen sectioning. This procedure leaves a wound inside the patient's mouth. It also causes the subsequent tissue section analysis to be extremely time-consuming. To accelerate the diagnostic process of physicians so that patients can quickly obtain appropriate treatments, ITRC has reconstructed a typical endoscope, reducing its size to form a miniature device. In addition to being used in smaller oral cavities, this miniature endoscope can intensify the focal spot of infrared (IR) light and increase the light collection efficiency of blue and red lights produced upon skin stimulation. This upgraded endoscope lens can help frontline health professionals to diagnose patients' conditions more quickly and accurately.

365/632.8 nm dual wavelength 6-in transmission sphere

The transmission sphere is attached to the interferometer system for inspecting precision optical surfaces or optical systems. It is a key element of an interferometer. Typical commercially available transmission sphere are designed using only 632.8 nm He-Ne laser band. Therefore, to fulfill the requirements of testing applications in the semiconductor industry, ITRC developed a dual-band transmission sphere, which can be used in red laser interferometers for lens testing as well as in i-line 365 nm UV light wave segments to facilitate the testing of lithography projection lenses.



Catadioptric Endoscopy

365/632.8 nm dual wavelength 6-in transmission sphere

Spectroscopic and image application technology

Underwater hyperspectral imager

As the leading technology under ITRC, the underwater hyperspectral imager contributed to ITRC's cooperation with the National Cheng Kung University (NCKU) and the AWQC in 2014. The cooperation involved using ITRC's underwater hyperspectral imager to monitor and manage the marine ecology in South Australia. In May of this year, the ITRC was invited to participate in the launch of its underwater imager at the Gulf of Saint Vincent in South Australia for the first time. This project was reported on the local news media in Australia, opening a new page for Taiwan's international technological exchange. The outcome of this project was also announced in a press conference. ITRC's research team subsequently acquired funding for international collaboration with Australia. The team will be actively engaging in the underwater seagrass observation project, with the goal of expanding its technological applications used in prediction, evaluation, and restoration topics related to environmental migration.

Portable multiband LED light-separating spectral imager

This instrument is a lightweight, inexpensive, small, and portable spectral imager. By measuring the relative absorption intensity of substances illuminated with lights of varying wavelength, the compositions of liquid substances can be preliminarily detected to facilitate the rapid screening and use of water samples and biological samples. The system is equipped with 8 independent LEDs featuring wavelength of 375 nm-635 nm. By controlling the direction of LED lighting and altering the relative position of the projected light and sensor, the absorption intensity or fluorescence reaction of test samples exposed to lights of differing wavelengths can be measured. This instrument is currently provided to College of Life Science, National Tsing Hua University as a teaching material for high school and university basic laboratory courses.

Underwater hyperspectral Imager

Portable multiband LED light-separating spectral imager

Vacuum film-coating technology

Organic light-emitting diode depositor

Organic light-emitting diode (OLED) depositor satisfies the needs of prospective studies. It is a thermal deposition system featuring real-time monitoring functions and can be applied to investigate the changes in the electrical property of organic thin films during the initial period of film formation. It can also be used to explore the effects of process temperature on the quality of thin films. The system features the following distinctive characteristics: Real-time epitaxy electrical property measuring module; diverse process temperatures (-196–200 °C), liquid nitrogen condensing plate, two-segment chamber module, separated independent pressure environment, diversified flow meter control module and process control interface, high-stability power output module (0.5‰ @ 200 A), multifunctional deposition control module featuring external parameter import function, remote system diagnostic function, and function layer management model.

Metal organic chemical vapor deposition control subsystem

The metal organic chemical vapor deposition (MOCVD) control subsystem is the R&D outcome of the "Enhancing of Basic Industrial Technology Project" implemented in collaboration with National Central University. MOCVD is a crucial method for fabricating epitaxial materials. It is widely applied in semiconductor production and in the key process equipment of the optoelectronics industry. The epitaxy process involved in MOCVD is time-consuming; therefore, any mistakes made during the process may reduce the process yield. Consequently, manual control and a testing platform are needed to integrate various signals and equipment. ITRC has autonomously developed power control systems and automated control human-machine interface, which can be employed during epitaxy processes to select diverse processing methods for coating process elements with multi-alloy thin films. This approach is highly conducive for improving the epitaxy interface quality and effectiveness of process elements. It also effectively enhances the reproducibility of thin-film quality.

Organic light-emitting diode depositor

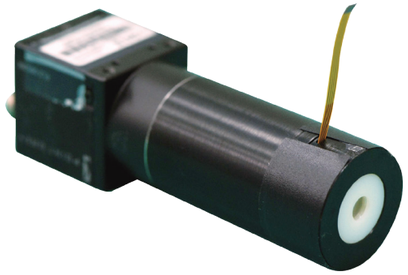
MOCVD control subsystem

Opto-electromechanical systems integration technology

Liquid-state microscope module comprises the liquid lens and solid lens, and which is a portable microscope. The length of microscope is 6 cm, operating voltage ranges from 0 to 20 V, and the actual magnification of microscope is 100X with a focal length of 1.1 mm. In contrast to the previous solid-state microscope, the focus of microscope was adjusted only by shifting the position of entire module. Thus, the focus of ITRC's liquid-state microscope module can be adjusted by different operating voltage and adjusting the curvature of the liquid lens. This lightweight and portable microscope can be applied to observe biological cells and specimen textures at a microscopic level.

Mobile-controlled close-up image module

This module is composed of a wireless camera equipped with a dual-light close-up image device. The images can be observed and captured by using the typical mobile devices. Thus, the macro images can be captured easily and conveniently without using a heavy lens module. Field of view of the ITRC's image module was 42 mm in diameter with working distance of 90 mm, and the magnification was 60X. In addition, the lens cylinder is designed for isolating the external light effectively, thereby enhancing the intensity and improving the quality of fluorescent images. This lens module can be applied during criminal investigation, evidence collection (finger prints and accident sites), and microscopic observations.



Liquid-state micro lens module

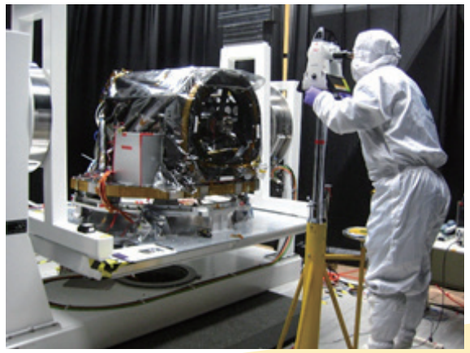
Mobile-controlled digital close-up imager module

Mission-oriented R&D

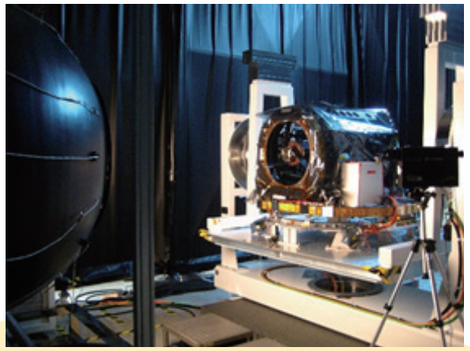
Development of remote sensing optoelectronic instruments

Relying on its long-term experience of optoelectronic instrument development and opto-mechanical systems integration, ITRC is now in its seventh year of participating in the FORMOSAT-5 remote sensing payload development project. ITRC's primary duty is to develop and produce a remote-sensing imager for the satellite's remote-sensing payload, and assist integrating tests of the payload. As the launch of the FORMOSAT-5 draws near, and considering the increasing needs of Taiwanese people for satellite images featuring enhanced resolution, ITRC proposes to conduct a preliminary research on second-generation payload system (Three Mirror Anastigmat, TMA).

In 2014, ITRC has completed measurements of crucial parameters of the satellite's remote-sensing payload, as well as TMA system optical design, tolerance analysis, lens weight reduction, and preliminary design and analysis of mechanical structures. In contrast to FORMOSAT-5, this TMA system involves a non-axial symmetrical design and is capable of collecting images with a ground resolution of 0.7 m. Thus, the TMA system is superior to the FORMOSAT-5 with regards to system specifications, lens polishing requirements, and testing precisions. Producing products applicable to this technology signifies that ITRC is equipped with the core competency of manufacturing semiconductor lithography optical elements, thus contributing to future domestic development of large-aperture long-focal length observation systems. The technology created in this project is primarily applied to satellite systems; however, the future of ITRC's technology is promising because NASA and ESA technologies have already been integrated into typical industrial applications.



Parameter measurement of FORMOSAT-5 remote-sensing payload



Measurement of FORMOSAT-5 remote-sensing payload photoresponse

Research and development of biomedical technology and verification services

ITRC is employing its core capabilities and R&D expertise to integrate academic research resources and implement biomedical technology R&D and verification projects. ITRC expects that the establishment of clinical, academic, and industrial integration platforms will accelerate the translation and value-adding of research results, and support the vigorous growth of Taiwan's biomedical industry.

Key achievements of the year

ITRC launched the Medical Equipment Value Creation Alliance this year, and comprehensively integrated the most broad-based cross-ministerial supporting system, which included the Ministry of Science and Technology, Ministry of Economic Affairs, Ministry of Health and Welfare, and the Council of Agriculture. In addition, the research capacities of Science Parks in Hsinchu, Taichung, and Southern Taiwan with regards to medical equipment were integrated with those of 20 industry, governmental, academic, and research institutions. Through this comprehensive integration, a one-stop service will be provided, which will accelerate the process of medical equipment development, verification, and product production. It will also provide future R&D teams with a fully integrated single-package service and medium.

In 2014, ITRC assisted 15 R&D teams, by offering them advices on strategies of technological commercialization and legal affairs. ITRC successfully helped 2 R&D teams in establishing their companies in February. They are Choice Biotech (founded by the R&D team specializing in medical equipment customized for tooth and jaw plastic surgeries) and Shan-yi Biotech (founded by the R&D team specializing in novel nerve conduits). The services provided by the Alliance reduced the teams' exploration period by 2 years, helping them save the expenditure up to 15% .

ITRC actively promoted the capability of the Hsinchu Science Park in medical equipment testing and verification, effectively utilized resources of certified agencies, and signed a MOU for the strategic alliance with UL Taiwan, Medgaea Life Sciences Ltd., and Taiwan Electronic Testing Center.

ITRC nurtured the teams' pitching ability when seeking funds for entrepreneurial ventures. Collaborating with the National Cheng Kung University, ITRC hosted the 1st Global Biomedical Engineering Meeting and 9th Asia-Pacific Biomedical Engineering Meeting. In the Meeting, the Si²C Three-in-Five Competition was held: Speech for Seeking Entrepreneurship Funds. A total of 8 teams participated in the competition. Twelve judges were invited, among them 4 judges were biomedical experts from Israel and the United States. The R&D team from National Yang-Ming University won the gold medal of the Si² C competition.

Development of instruments used in disaster prevention

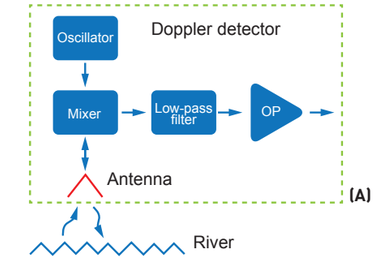
The flow meter with the use of image module

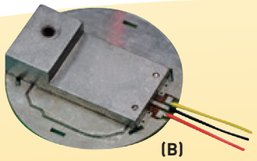
Compared with conventional river measurement technologies, the measurement observation based on image technologies are advantageous in that they are both inexpensive and quickly measurement efficiency. In addition, such technology is not labor intensive and not prone to influences from objects drifting in the water. Therefore, ITRC has developed a lightweight, convenient, inexpensive the flow meter of the use of image module. This module features has a hardware acceleration function that permits a 30 fps preview. In addition, it is equipped with firmware design, which first records a segment of real-time images before saving these images. Then, it can be calculated and shown the surface flow speed using a flow speed formula. Subsequently, these results can be stored in the system. The system can therefore serve as a flow meter with real-time image . The flow meter not only output a set of water speed data but also output a single image per minute.

Design of radar Doppler sensor for surface water flow meter

When river flooding occurs, the rapid water flow increases the momentum of rocks flowing in the river, causing the rocks to collide into and damage the river bridges. Therefore, monitoring of the river flow speed is crucial. Consequently, developing a low-cost localized radar flow meter is applicable to the river areas in Taiwan. ITRC' developed radar Doppler sensor can be used to detect water flow speed. When the flow speed of a river increases rapidly within a short period of time, local residents can be warned immediately to stay away from the river area. Therefore, the sensor provides early warning before a disaster occurs and achieves the objective of disaster prevention. Figure A presents a schematic diagram illustrating the principle of the radar Doppler sensor, and Figure B shows the physical model of the radar Doppler module. The radar Doppler sensor module is tested to yield an output power of -3.2 dBm and the operating oscillation frequency of 10.5 GHz, and responds to changes in water flow speed as placed about 5 m above the water level.

Flow meter with the use of image module





(A) Schematic diagram illustrating the principle of the radar Doppler sensor

(B) Physical model of the radar Doppler probe

National research programs

In conjunction with national policy, ITRC actively participates in many national research programs. It seeks to promote the country's academic and industrial development via technological innovation, integration, and value added development models. ITRC participated in the following national research programs during 2014:

Enhancing of basic industrial technology projects

Project name	Cooperating unit	Time	Technological outputs
MOCVD key components technologydevelopment and manpower training	National Central University	2014/01/01 2015/03/31	MOCVD gas transport and power control subsystem
Basic technology R&D for a multi-axis grinding and forming system and mounting of hydrostatic bearing foundation	National Tsing-Hua University	2014/01/01 2016/12/31	Multi-axis grinding and forming system and lens centering system architecture
Production and analysis of a multi-layer nanometer structure, and establishment of a promotion center	National Cheng-Kung University	2013/11/01 2015/04/15	Multilayer epitaxy interfacial atomic structure and the corresponding composition analysis technology

National technological programs

Project name	Cooperating unit	Time	Project outputs
Extreme UV microlithography technology II (EUVL II)- From illumination and testing of analytical techniques to nanometer elements reliability research	National Chiao-Tung University	2013/08/01 2015/01/31	Extreme UV (13.5 nm) mirror

Technical services

TAF accredited laboratories

ITRC offers standard testing and calibration services, including 9 calibration services and 2 testing services, all of which conform to ISO/IEC 1702 international standards as certified by the Taiwan Accreditation Foundation (TAF). ITRC can provide ILAC-MRA-labeled calibration reports recognized internationally (60 economies and 73 accredited institutions) and issues more than 200 test and calibration reports each year. The certification items and a brief introduction to the laboratories are described below.

TAF accredited laboratories	Certification items
ITRC vacuum standard laboratory (laboratory number: 0081)	KD2002 (calibration) ion vacuum gauges
	KD2003 (calibration) capacitative vacuum gauges
	KD2006 (calibration) other vacuum gauges
	O001 (calibration) film reflectance
	O001 (calibration) film transmittance
	KA2014 (calibration) SPM line-distance standards
	KA2014 (calibration) SEM line-distance standards
ITRC optoelectronic calibration laboratory (laboratory number: 1529)	KG3012 (calibration) luminance meter/brightness colorimeter
	KG3027 (calibration) gloss boards
ITRC optoelectronic calibration laboratory (laboratory number: 2340)	O999 (testing) radius of curvature
	O999 (testing) index of refraction

Vacuum standard laboratory (TAF laboratory number: 0081) of ITRC is the first facility of its kind to receive CNLA calibration certification. The laboratory's calibration items include the ionic vacuum gauge KD2002 (calibration), capacitative vacuum gauge (KD2003), and other vacuum gauges (KD2006); this laboratory serves industry, government and academic institutions. It issues over 100 calibration reports every year. Furthermore, this is the sole laboratory in Taiwan to perform the optical testing items of film reflectance and film transmittance (O001, testing). It provides comprehensive spectrum measurement services to academic and industrial users. These laboratories employ scanning probe microscopes and scanning electron microscopes to provide line distance calibration service for the ranges of 100 nm-10,000 nm and 100 nm-2,000 nm (KA2014). The calibration results are based on the weights and measures of international institutions such as Physikalisch-Technische Bundesanstalt (PTB) and National Physical Laboratory (NPL). Thus, substantial calibration costs and waiting time (3-6 months) of sending samples overseas for calibration are reduced. In response to customers' needs, ITRC provides customized high-precision line-distance standard components (sigma < 0.3%), which contributes to ITRC receiving the 8th R&D Creativity Award for Measurement Science and Technology from Chinese Metrology Society.

Optoelectronic calibration laboratory (TAF laboratory number: 1529 and 2340) is the first laboratory to apply for TAF certification after ITRC became part of NARLabs. This facility has two laboratory numbers because it offers certification items including calibration and testing. Certification items consist of the four items of luminance meter/brightness colorimeter (KG3012, calibration), gloss boards (KG3027, calibration), radius of curvature (O999, testing), and index of refraction (O99, testing). It is the first laboratory in Taiwan to offer radius of curvature and index of refraction certification.

ITRC advocates the policy of ensuring precision quality, being innovative, and showing respect for others and positive teamwork. It also embraces the goal of providing the best quality and credible services. In addition to ITRC's internationally recognized measurement services offered to domestic and foreign industry, academic, and research institutions, its calibration ability has also established a solid foundation for instrument technology development, which is expected to promote domestic exchanges regarding relevant instrument technologies and further perfect the technological standards and product quality in Taiwan.

Commissioned production and repair services

In line with its goal of supporting academic research and serving industry players, ITRC provides commissioned production, repair, and calibration/testing services for vacuum, optical, and electronic instruments and components. In 2014, ITRC provided testing and process equipment services a total of 1,942 times to 112 companies, academic institutions, and research organizations during the year.

The following are some of the more notable technical service cases performed by ITRC on behalf of academic and industrial users in 2014

Entrusted by	Case name
Semiconductor manufacturer	SiO^2 Etching
Biochemical technology R&D industry	Vacuum gauge calibration
Taiwan Electronic Testing Center	Transmittance and reflectance measurements
Optoelectronics manufacturer	Standard lens precision testing
Metal Industries Research & Development Centre	Free-curve 3D drawing
Testing technological service industry	Gloss boards calibration
Precision machining manufacturing industry	Level measurement
Computer and peripheral equipment manufacturer	3D measurement
Optical equipment manufacturer	Gloss boards calibration
Aircraft repair industry	Surface shape precision testing
Medical equipment manufacturing industry	3D object rapid prototype production
Medical service industry	Design and production of customized medical conductive element and circuit
Medical service industry	Portable living tissue fluorescence imaging system
Optoelectronics industry	Ellipsometry measurements
National Kaohsiung First University of Science and Technology	Silicon etching
Center for Condensed Matter Sciences, National Taiwan University	Production of chamber cover for vacuum testing system
National Yang-Ming University	3D composite spray printer
National Tsing-Hua University	Research and production of array lens clamping structures
Academia Sinica	SEM observation
National Chiao-Tung University	Yellow light process
National Taiwan University	Optical fiber strain measurement clamping design and processing
National Tsing-Hua University	Yellow light processing and etching
National Tsing-Hua University	Silicon etching

Instrument technology training programs

ITRC hosts multiple workshops and seminars to cultivate outstanding talented professionals and incubate research manpower needed by Taiwan's high-tech industries and academic institutions. It aims to enhance the quality and quantity of the country's research manpower.

ITRC held the following workshops and seminars in 2014

Name of workshop/seminar	Date
Laboratory workshop on nanometer processes and testing	02/12-02/13
Basic optical design (jointly hosted with Tze Chiang Foundation of Science and Technology)	02/13-02/14
Workshop on film optics and deposition technology (theory)	03/19-03/20
Workshop on film optics and deposition technology (laboratory)	03/21-03/21
Graphical system design and virtual instrument control class	03/27-03/28
Basic iPhone / iPad apps	04/23-04/24
Optical engineering technology class (jointly hosted with Tze Chiang Foundation of Science and Technology)	04/23、04/30、05/07、05/14、05/21、05/28、06/04、06/11
Seminar on the application of human factors and ergonomics in the development of medical devices	04/29-04/29
Workshop on vacuum practice	05/28-05/29
ISO 13485 training class	06/04-06/04
Reverse engineering scanning system training course	06/18-06/18
Seminar on micro-electromechanical sensing technology	06/27-06/27
Instrument technology training, Hsinchu session	06/24-06/26
Micro-projector optical system design class (jointly hosted with Taiwan Optics/ Optronics Manufacturers' Association)	07/05-07/26
Skills in R&D price quotation and negotiation	07/15-07/15
Instrument technology training, Tainan session	08/04-08/06
Practical class on imaging and non-imaging optical engineering (jointly held with Taiwan Optics/Optronics Manufacturers' Association)	08/02-09/20
Instrument technology training, Taipei session	09/01-09/03
Seminar on powder flow characteristics	09/23-09/23
Production management training course (1)	10/31-10/31
Class on the future application and skills requirement of LED optical system (jointly hosted with Tze Chiang Foundation of Science and Technology)	11/01、11/08 11/15、11/22
Production management training course (2)	11/14-11/14
Production management training course (3)	11/21-11/21
Production management training course (4)	11/28-11/28
Opto-electro-mechanical system training course (1)	11/14-11/14
Opto-electro-mechanical system training course (2)	11/21-11/21
Basic Android cell phone apps	11/26-11/27
Opto-electro-mechanical system training course (3)	11/28-11/28
Opto-electro-mechanical system training course (4)	12/05-12/05
Class on breaking the optical code hidden behind the lens of a camera (jointly held with Taiwan Optics/Optronics Manufacturers' Association)	12/13-12/21
Graphical system design and virtual instrument control class	12/22-12/23

Academia-research-industry collaboration

Industry contract cases

In order to diffuse its R&D capabilities, ITRC encourages its R&D teams to meet the needs of industry via academia-industry collaboration. This enhances the R&D capacity of domestic industry, increases product added value and promotes the technological upgrading of industry.

The following are a few of the notable industry contract cases in 2014:

Contract name	Industry categories
Development of PEALD applied to UV LED	Optoelectronics industry
Design and production of objective lens stage drive module for microscopic testing systems	Optical product production
Development of biomedical micro current signal processing module	Measurement instrument production
Commissioned a research project on nitride titanium coating process development and measurement	Electronic material production
Commissioned development of a high-speed linear scanning chip back defect testing system	Semiconductor packaging equipment manufacturer
Polishing of top pin in wafer transport mechanism	Production of electronic equipment
Light blocking system for in vivo cell observation	Precision instrument production
Design and production of ball-shaped multi-camera aerial system	Machine production
Energy optimization and environmental testing	Electromechanical engineering
Research and production of high-frequency conductive probe for semiconductor defect testing machines	Semiconductor manufacturing
Project on the development of implant electrical stimuli medical equipment	Medical equipment manufacturing
Electric cutter circuit design	Gift and stationery industry
High-density plasma sputtering system	Electronic material production
Intraoral camera (including oral tissue fluorescence identification)	Medical service industry
Smart lithium battery management module design	Industrial machine production
Project on the development of high-intensity ceramic corrector	Health care service industry
Assembly of electrically excited spectral sensor and spectral characteristics analysis of microscope images	Semiconductor manufacturing
Development of measurement system for image quality of finger print reading module	Optoelectronics industry
Five-sided chip defect optical testing system	Semiconductor packaging equipment manufacturing

Academia partner contract cases

ITRC is an ideal ally and promoter for academic researchers thanks to its support for academic research, promoting the development of science and technology, and its engagement in long-term cooperation with universities in Taiwan,. The following are a few of the most notable academic partner contract cases during 2014:

Contract name	Cooperating partner
Commissioned production of chemical gas-phase deposition system	National Chiao Tung University
Wavefront measurement system	National Tsing Hua University
In vivo cell culturing system	National Taiwan University
Micro hardness tester	National Taiwan Ocean University
MOCVD key components technology development and manpower training (1/3)	National Central University
Commissioned production of paper fluid chip colorimeter	National Chung Hsing University
Basic technology R&D for a multi-axis grinding and forming system and mounting of hydrostatic bearing foundation (1/3)	National Tsing Hua University
Integrative research on the development of 3D Connex Bio-factory composite bioprinter system for craniofacial and maxillofacial reconstruction surgery on oral cancer patients (1/3)	Taipei Medical University
High brightness 13.5-nm extreme UV illumination R&D (3/3)	National Taiwan University
Portable biofeedback and electrical stimulation therapy device for swallowing training	Taipei Medical University
Research on the innovation of large-sized ultra-thin silicon solar cell with ≦ 50um thickness	National Tsing Hua University
Development of a large-scale forced flow ALD nanometer reactor for production of hydrogen via continuous visible light hydrolysis and hydrogen separation (3/3)	National Tsing Hua University
Optical element module production	National Taiwan University
Development of UVB-optimized healthy lighting instrument for daily use	Kaohsiung Medical University
Project on the development of customized smart bone fracture fixation technology (1/3)	National Yang-Ming University
Deposition equipment (including arsenic and hydroxide particles suction waste discharge system)	National Central University
IR proximity fluorescence real-time projection system	National Taiwan University
Medical imaging for ultrasound muscle identification	National Yang-Ming University
Electrical real-time testing PCR teaching tool	I-Shou University

Academia-industry-research contract cases

Not only for promoting industrial development, mitigating the gap between learning and practical application, but also for creating concrete beneficial outcomes for industry, academia, and research organizations, ITRC launched the Optical Systems Integration R&D Consortium, and completed the following collaborative projects: Development of the I-line narrow band pass filter applied to lithography equipment for MEMS process, guided endoscopic image sensor and 5.9-mm smart micro transnasal endoscopy, and Development of high-temperature plasma enhanced atomic layer deposition system applied to UV LED. The following are the academia-industry contract cases during 2014:

Contract name	Academic cooperating partner	Industry cooperating partner
Development of the I-line narrow band pass filter applied to lithography equipment for MEMS process	National Yunlin University of Science and Technology	Optoelectronics equipment manufacturer
Guided endoscopic image sensor and 5.9-mm smart micro transnasal endoscopy	Kaohsiung Medical University Chung-Ho Memorial Hospital	Medical equipment industry Optoelectronics industry
Development of high-temperature plasma enhanced atomic layer deposition system applied to UV LED	National Central University	Optoelectronics industry
Project on the development of temperature-controlled ultrasound contrast agent generation system	National Tsing Hua University	Biotech industry
Measurement technology for quality of optical fiber cut edges	Southern Taiwan University of Science and Technology	Information and communication industry
Using mobile device to identify home-based risk factors for cardiovascular disease	I-Shou University	Biotech industry
Development of high-quality otoscope optical module featuring optical fiber guided light	National Tsing Hua University	Medical equipment industry
R&D of polarization system for UV light of new-generation lithography equipment and deposition technology	National Taiwan University &National Yunlin University of Science and Technology	Optoelectronics industry
Development of real-time multiband high-resolution spectral analyzer	National Central University	Optoelectronic laser industry
Development of concave grating galvanometer scanning broadband polarization micro spectroscopy	National Chiao Tung University	Optoelectronics industry
R&D of reflective LED energy-saving module and smart portable testing device	National Taiwan University of Science and Technology	Lighting instrument industry
Development of zinc oxide gallium transparent electrode nanometer process technology for optoelectronic elements	Chang Gung University	Mechanical equipment manufacturer
Development of high-rigid XY θ tri-axial laser direct-writing image feeding system featuring mask aligner	National Taiwan Normal University	Mechanical equipment manufacturer
Remote control ultra-resolution microscopic module development	National Taiwan University of Science and Technology	Precision machining manufacturing industry

International cooperation

Memorandum of Understanding

ITRC has currently signed cooperation MOUs with the following units: (1) RIKEN, Japan, (2) Center for Information Storage Device, Yonsei University, Korea, (3) Advanced Photonics Research Center, Osaka University, Japan, and (4) University of Technology of Troyes, France

Participation in the operations of international instrument technology organizations

ITRC actively participates in international instrument technology organizations, targetingto enhance its own international visibility and status. ITRC currently participates in the following international organizations:

ASME (American Society of Mechanical Engineers)

NAMIS (an international research network on Nano and Micro Systems)

IEEE IMS (Instrumentation and Measurement Society)Taipei Chapter

SPIE (The International Society for Optical Engineering)

TC member of TC-18 (Environmental Measurement), IEEE IMS

International cooperative research projects

ITRC is conducting preliminary-stage commissioned projects and joint research with international academic and research units, attempting to establish a foundation for formal cooperation in the future. The following is a summary of cooperation cases and their progress:

Cooperating unit	Topic of cooperation	Year	Progress
RIKEN, Japan	3D optical metamaterials	2009-2019	The two parties have commenced a research project, conducted several short-term visits and have published a number of joint papers.
Center for Information Storage Device, Yonsei University, Korea	Instruments for green living, energy, and the environment	2010-2015	In 2011, ITRC participated in an alliance conference on Korea's Jeju Island.
Advanced Photonics Research Center, Osaka University, Japan	Production of ultra-smooth, ultra-thin silver films	2011-2016	The two parties have commenced a research project, conducted several short-term visits and are performing bilateral research. The two parties have published a joint paper. ITRC has performed deposition of ultra-smooth, ultra-thin silver films for Osaka University, meeting the needs of the university's Advanced Photonics Research Center.
University of Technology of Troyes, France	Instrumentation and measurement for integrated photonics and spectroscopy	2011-2016	The two parties have conducted short-term visits for the purpose of project discussion and experiments.
Academy of Physical Sciences, Czech Republic (bilateral international joint research project)	Atomic layer deposited TiO_2 and Al_2O_3 coatings on NiTi alloy	2012-2014	ITRC has dispatched personnel on a short-term visit for the purpose of project discussion and experiments, and cooperated in publishing joint papers.
Nelson Mandela City University, Republic of South Africa (bilateral international joint research project)	Ultra-High Precision Diamond Machining of Optical Mould Inserts from Modified Optical Aluminium	2013-2015	The two parties have published their R&D outcomes and presented them at the 2014 SPIE international seminar.South African representatives plan to conduct a second visit and perform experimental research on the research topic.
Teams from the AWQC and University of South Australia, and Department of Environmental Engineering, National Cheng Kung University (bilateral international joint research project)	Enhanced Water Management through Advanced Monitoring and Modeling	2014-2015	ITRC dispatched personnel to Australia to conduct on site measurement research. In future, ITRC will use its underwater hyperspectral imager to conduct underwater seagrass observation research.

Milestones in 2014

2014/02

02/04 ITRC participated in the SPIE Photonics West 2014 Conference and Exhibition in the US to promote its R&D outcomes, deepening its international influence.

On-site display at the SPIE Photonics West 2014 Conference and Exhibition

2014/03

03/01 ITRC participated in the contract-signing ceremony with NARLabs and the Entrepreneur Club, in an effort to promote industrial upgrading in Taiwan.

Contract-signing ceremony with NARLabs and the Entrepreneur Club

03/09 ITRC assisted the American Society of Mechanical Engineers (ASME) in hosting the Student Professional Development Conference (SPDC) competition to foster Taiwan's outstanding talents in technological research.

ASME SPDC competition

2014/04

04/07 Portable wafer edge defect testing system was awarded with the 10th R&D Creativity Award for Measurement Science and Technology by Chinese Metrology Society.

Portable wafer edge defect testing system was awarded with the 10th R&D Creativity Award for Measurement Science and Technology by Chinese Metrology Society.

2014/05

05/16 The spring seminar of Optical Systems Integration R&D Consortium was held in Taichung, bridging academia-industry collaboration, and enhancing the feasibility of future cooperation.

Optical Systems Integration R&D Consortium spring seminar

05/30 ITRC and National Cheng Kung University co-hosted a press conference on Taiwan-Australia international cooperation in the first launch of the underwater hyperspectral imager for observing coastal seabed ecology

Press conference on Taiwan-Australia international cooperation in the first launch of the underwater hyperspectral imager for observing coastal seabed ecology

2014/06

06/16 ITRC participated in the 2014 International Optoelectronics Exposition Taiwan to promote its R&D outcomes.

ITRC participates in the 2014 International Optoelectronics Exposition Taiwan

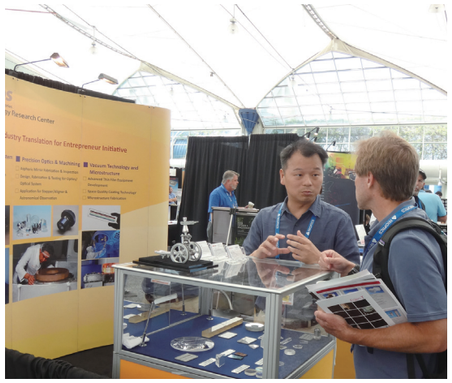
2014/07

07/24 ITRC participated in the BioTaiwan Exhibition to demonstrate Taiwan's biomedical capabilities and achievements.

BioTaiwan Exhibition

2014/08

08/19 ITRC participates in the SPIE Optics +Photonics 2014 Conference and Exhibition in the US to promote the R&D results.

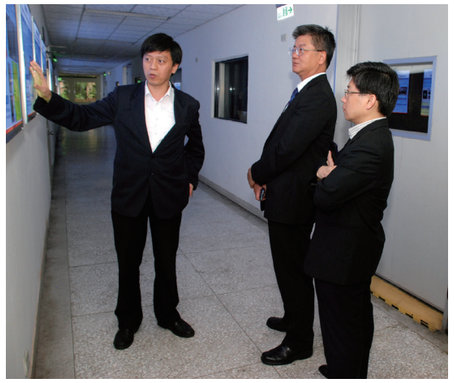


2014 SPIE Optics+Photonics Conference and Exhibition

09/02 ITRC participated in the SEMICON Taiwan 2014 International Semiconductor Exhibition held in Taipei to demonstrate how ITRC has influenced the semiconductor industry through its opto-electro-mechanical systems and achieved localization in the production of semiconductor equipment and elements.

2014/09

09/02 Minister of Science and Technology, San-Cheng Chang, visited ITRC.



Minister of Science and Technology, San-Cheng Chang, visits ITRC.

09/19 ITRC celebrated its 40th birthday and reviewed the splendid moments in the history. Looking ahead towards the future, ITRC intends to further enhance Taiwan's competitiveness in industrial technology and embark on the next 40 years of prosperity.

Diagram on the left: ITRC plants a tree in celebration of its 40th birthday
Diagram on the right: ITRC celebrates its 40th birthday; (from left to right) Chien-Jen Chen, Ching-Shen Su, and Wen-Hsiung Huang (former director generals), Ching-Hua Lo (President of NARLabs), Ta-Keng Wang (former director general), and J. Andrew Yeh (current Director General)

2014/10

10/08 Two projects, "Development of a Multi-Confocal Interferometer Probe" and "Applying NI LabVIEW in Chemical Beam Epitaxy to Produce Nitride Epitaxy Thin Film", received first prize in the Automated Testing Group and runner up in the Advanced Research Group awarded by the National Instruments in the US, respectively.

10/25 The autumn seminar of Optical Systems Integration R&D Consortium was held in Miaoli, attracting partners from academia, industry as well as research organizations to have communication on collaboration.

Optical Systems Integration R&D Consortium autumn seminar

ITRC participates in the NIDays 2014 Taiwan Exhibition

2014/11

11/19 ITRC participated in the NIDays 2014 Taiwan Exhibition, during which ITRC representatives interacted with expert engineers from various fields to share their knowledge. The exhibition aimed to enhance creativity and promote collaboration opportunities.

The 6th "*i*-ONE International Instrument Innovation Competition" Award Ceremony

11/27 ITRC hosted the 6th i-ONE International Instrument Innovation Competition Award Ceremony, which was organized to cultivate outstanding talents in science and technology for Taiwan.

2014/12

12/09 ITRC hosted the ceremony of the Medical Equipment Value Creation Alliance, aiming to accelerate the production of biotech medical equipment products in Taiwan.

12/11 ITRC's energy management system passed the ISO 50001 certification, generating substantial reductions in ITRC's water and electricity expenses.

ISO 50001 certification