STRATEGIC BUSINESS PLAN

ISO/TC 172
Optics and photonics

EXECUTIVE SUMMARY

ISO/TC 172 sets standards for terminology, requirements, interfaces and test methods in the field of optics and photonics. This includes complete systems, devices, instruments, ophthalmic goods including implants, optical and photonic components, auxiliary devices and accessories, as well as materials. Optics and photonics is used in the meaning of generation, handling and detection of optical radiation including signal processing. (Excluded from the scope are: standardisation for specific items in the field of cinematography, photography, eye protectors, micrographics, fibre optics for telecommunication, electrical safety of optical elements, general lighting and photovoltaic.)

Optics and photonics as self-consistent fields and cross-sectional technologies are going to play an even more significant role in our lives. It is expected that the photon will be the basis for a technical revolution in this century like the electron was the one for the 20th century. Optics and photonics are "enabling technologies" which will influence a wide field of applications such as information technology, tele-communications, defense and security, lighting and energy, healthcare and life sciences, as well as industrial production and automation.

The range of products comprises highly sophisticated complete optical systems down to 'simple' semi-finished products or components. The market for optical products is a global one. The world-wide total photonics market size in 2011 was approx. 350 billion Euro (480 billions USD), at a growth rate estimated as 6,5 %.[1]

As some of the products are subject to legal regulations, for example, in the healthcare or machinery sector (laser safety), standards help the manufacturer to show conformity with the relevant legal requirements and they are therefore an important supportive measure for easy access to the market.

Standardisation supports legal deregulation. Industry, together with the other concerned parties, sets its own rules by means of private standardisation ('self-regulation') and reduces such the need for legal regulations. The European 'New Approach' is a prominent example for such 'task-sharing' between industry and government.

Since its establishment in 1978, ISO/TC 172 and its sub-committees have developed a set of approx. 290 International Standards.

Optics and photonics are key technologies for the 21st century and voluntary standardisation is an important supportive measure that promises enormous strategic benefits for this cross-sectional field of technology. ISO/TC 172 is prepared to provide this service, but it needs more support from corporate management.

[1] Source: Photonik-Branchenreport 2013, published by: SPECTARIS – Deutscher Industrieverband für optische, medizinische und mechatronische Technologien e.V., Werderscher Markt 15, 10117 Berlin; Verband Deutscher Maschinen- und Anlagenbau e.V. (VDMA), Lyoner Straße 18, 60528 Frankfurt am Main; ZVEI – Zentralverband Elektrotechnik- und Elektronikindustrie e.V., Lyoner Str. 9, 60528 Frankfurt am Main; Bundesministerium für Bildung und Forschung (BMBF), Referat Photonik, Optische Technologien, 11055 Berlin.

1 INTRODUCTION

1.1 ISO technical committees and business planning

The extension of formal business planning to ISO Technical Committees (ISO/TCs) is an important measure which forms part of a major review of business. The aim is to align the ISO work programme with expressed business environment needs and trends and to allow ISO/TCs to prioritize among different projects, to identify the benefits expected from the availability of International Standards, and to ensure adequate resources for projects throughout their development.

1.2 International standardization and the role of ISO

The foremost aim of international standardization is to facilitate the exchange of goods and services through the elimination of technical barriers to trade.

Three bodies are responsible for the planning, development and adoption of International Standards: ISO (International Organization for Standardization) is responsible for all sectors excluding Electrotechnical, which is the responsibility of IEC (International Electrotechnical Committee), and most of the Telecommunications Technologies, which are largely the responsibility of ITU (International Telecommunication Union).

ISO is a legal association, the members of which are the National Standards Bodies (NSBs) of some 164 countries (organizations representing social and economic interests at the international level), supported by a Central Secretariat based in Geneva, Switzerland.

The principal deliverable of ISO is the International Standard.

An International Standard embodies the essential principles of global openness and transparency, consensus and technical coherence. These are safeguarded through its development in an ISO Technical Committee (ISO/TC), representative of all interested parties, supported by a public comment phase (the ISO Technical Enquiry). ISO and its Technical Committees are also able to offer the ISO Technical Specification (ISO/TS), the ISO Public Available Specification (ISO/PAS) and the ISO Technical Report (ISO/TR) as solutions to market needs. These ISO products represent lower levels of consensus and have therefore not the same status as an International Standard.

ISO offers also the International Workshop Agreement (IWA) as a deliverable which aims to bridge the gap between the activities of consortia and the formal process of standardization represented by ISO and its national members. An important distinction is that the IWA is developed by ISO workshops and fora, comprising only participants with direct interest, and so it is not accorded the status of an International Standard.

2 BUSINESS ENVIRONMENT OF THE ISO/TC

2.1 Description of the Business Environment

The following political, economic, technical, regulatory, legal and social dynamics describe the business environment of the industry sector, products, materials, disciplines or practices related to the scope of this ISO/TC, and they may significantly influence how the relevant standards development processes are conducted and the content of the resulting standards:

ISO/TC 172 sets standards for terminology, requirements, interfaces and test methods in the field of optics and photonics. This includes complete systems, devices, instruments, ophthalmic goods including implants, optical and photonic components, auxiliary devices and accessories, as well as materials. Optics and

photonics is used in the meaning of generation, handling and detection of optical radiation including signal processing.

Excluded from the scope are: Standardisation for specific items in the field of cinematography (ISO/TC 36), photography (ISO/TC 42), eye protectors (ISO/TC 94/SC 6), micrographics (ISO/TC 171), fibre optics for telecommunication (IEC/TC 86), electrical safety of optical elements, general lighting and photovoltaic.

Optics and photonics as self-consistent fields and cross-sectional technologies are going to play an even more significant role in our lives. It is expected that the photon will be the basis for a technical revolution in this century like the electron was the one for the 20th century. Optics and photonics are "enabling technologies" which will influence a wide field of applications such as information technology, tele-communications, defense and security, lighting and energy, healthcare and life sciences, as well as industrial production and automation and will contribute to the welfare of the humanity.

Photonics is also considered a key enabler in exploiting the potential of nanotechnology. In this novel field lasers are e.g. used in nanotechnology fabrication processes, and in addition, nanoparticles can change the optical attributes of materials used in photonics. Scientists work on the development of nanotechnology enabled photonic devices, e.g. designs which are nanofabricated in optical materials with eventual application in optical communication and biophotonic chips.

The range of products covered by TC 172 comprises ‘simple’ semi-finished products or components up to highly sophisticated complete optical systems. Increasingly, the complexity of optical systems requires the definition of interfaces and the application of modular design. System competence is a sensitive capability for cross-sectional products. Interchangeability and interface definitions are crucial technical factors for such products. Mechanical, optical and software interfaces are most important and need clear and uniform definitions and appropriate standardised test procedures.

Business in optics comprises various sectors with a range of greatly differing product groups. Therefore, R&D of optical systems now requires an interdisciplinary network of experts from different fields, particularly in the area of medicine. Major product categories falling in the field in which ISO/TC 172 operates are: microscopes, telescopic systems, geodetic and surveying instruments, optical devices for medical purposes, ophthalmic goods including implants, lasers (for medical and industrial use and consumer products) as well as measuring and automation equipment.

Growth sectors in the market are medical optics, laser products, electro-optical systems and illumination and detection systems. Other areas of growth will include zoom lenses, detectors, optics for use outside the visible spectrum, arrays of optical elements, integrated optics and holographic optical elements. It is also expected that the use of non-visible radiation is of growing importance in the optical industry. Fastest growing markets are displays, photovoltaic and information technology for which optics and photonics products play an important role in terms of being an enabling factor.

The market area is characterised by fast changing product life cycles (high R&D expenditures) and fast changing product techniques and technology (e.g. new imaging and detection principles; use of additional spectral ranges).

There is an important portion of custom-made devices, e.g. for medical applications, space, astronomy, global navigation, semiconductor production (steppers).

Often, optical products have to comply with legal requirements. E.g.: Many optical systems are medical devices and have to comply with the local governmental regulations for health systems. In almost all cases, environmental aspects of materials and/or recycling after life time are of growing importance and have to be consistent with the laws.

ISO/TC 172 serves as a unique home for standardisation related to optics and photonics in order to preserve the uniformity of the standards‘ system for the optical industry. This requirement is also due to the high diversity of the fields of application of optical technologies.

2.2 Quantitative Indicators of the Business Environment

The following list of quantitative indicators describes the business environment in order to provide adequate information to support actions of the ISO/TC:

The market for optical products is a global one. The world-wide total photonics market size in 2011 was approx. 350 billions Euro (480 billions USD), at a growth rate estimated as 6,5 %.[1]

The following table provides an overview on main segments of the photonics market with their respective market shares and volumes.[1] The most right column assigns the activities by ISO/TC 172 subcommittees to these market segments. The main activities of the sub-committees and the main product fields covered by these, respectively, are decribed below.

Segment [2]	World Market 2005 [2] (%)	World Market 2011 [2] (%)	World Market 2005 [2] (billions Euro)	World Market 2011 [2] (billions Euro)	Products from these Subcommittees of ISO/TC 172 falling into the segments (those given in brackets contribute as provider of enabling technology)
Production technology	6%	6%	13,7	21,0	SC 3, SC 5, SC 9
Measurement and automated vision	8%	8%	18,2	28,0	SC 3, SC 5, SC 6
Optical components and systems	5%	5%	11,4	17,5	SC 3, SC 4, SC 5, SC 9
Safety and defense technologies	8%	7%	18,2	24,5	SC 3, SC 4, SC 6, SC 9
Medical technology and life science	8%	7%	18,2	24,5	SC 3, SC 5, SC 7, SC 9
Communication technology	5%	5%	11,4	17,5	SC 3, SC 6, SC 9
Information technology	21%	17%	47,9	59,5	SC 3, SC 6, SC 9
Displays	27%	25%	61,6	87,5	(SC 3, SC 9)
Light sources	8%	6%	18,2	21,0	(SC 3, SC 9)
Photovoltaic	4%	14%	9,1	49,0	(SC 3, SC 9)
Total	100%	100%	228,0	350,0	

SC 1 Fundamental standards and SC 3 Optical materials and components

Subcommittee SC 1 covers the standardization of terminology, requirements and test methods which apply to the whole field of ISO/TC 172, such as drawing specifications, general optical test methods, environmental test methods as well as data transfer and codification. Subcommittee SC 3 covers the standardization of terminology, requirements and test methods for optical materials, optical components and coatings.

The world-wide market for optical materials and components includes lenses (mounted and unmounted), prisms, mirrors and optical instruments.

Actually, optical systems consist more and more of special components such as aspherical, cylindrical and so-called free-form surfaces used for different applications. Therefore, new requirements arise for characterization and specification (for product and quality properties). In addition new metrology processes are required which have to be standardized. New optical material such as photonic crystal has been developed using nano-technologies. Its market size is still small, but it is expected to become larger near future and needs new standards.

[2] Categorization into segments and world market data taken from Reference 1.

SC 4 Telescopic systems

This includes monocular and binocular telescopic systems supported by hand or tripod, tele-scopic sights that are mounted on firearms, night vision devices, spotting scopes and astronomical telescopes. Telescopic systems containing integral light sources and electronic detectors, including amplifying detectors, and microprocessor control of these systems are included as well. Components and accessory devices used with these telescopic systems, such as eyepieces, tripods and light shields, as well as their interfaces are also included.

SC 5 Microscopes and endoscopes

The products include light and operating microscopes, and flexible and rigid endoscopes and endotherapy devices.

One of the important areas for light microscopes are confocal microscopes, but the trend for the next years will be in automation. Microscopes are and will increasingly be controlled by software only, and therefore new or revised standards will be required with regard to magnification, calibration etc. For the operating microscopes some of the industry trends are with navigation systems.

For rigid and flexible endoscopes and endotherapy devices some of the major technological and industrial trends are video, miniaturisation, computer-assisted surgery and energy systems.

SC 6 Geodetic and surveying instruments

Products in this area include total stations, laser tracker, laser scanner, levels, construction lasers, hand-held distance meters, global navigation satellite systems (GNSS), monitoring systems, mining solutions, machine control systems and airborne sensors. The segment depends a lot from the world-wide construction industry and shows usually a stable growth. All technologies in this area seem to grow likewise. If there are differences then there might be a sligthly technology trend for laser scanners, machine control systems and GNSS.

SC 7 Ophthalmic optics and instruments [3]

The market of ophthalmic goods is categorized into diagnostic and monitoring devices, surgical devices, and vision care products (prescription lenses and contact lenses).

The growth of this market is largely driven by technological advancements in the ophthalmology devices. The market witnessed an increase due to increased patient acceptance of surgical procedures including diagnosis and treatment. The global increase in the aging population has triggered the prevalence of eye disorders worldwide thus providing an impetus to the ophthalmology devices market by increased demand. However, the growth of this market is hampered by the factors like economic slowdown due to eurozone crisis which has negatively affected the ophthalmology device manufacturers. The reimbursement issues also pose threat to the ophthalmology devices market to a certain extent.

North America accounted for the largest share in the global market followed by Europe, APAC, and RoW. However, the developed regions like North America and Europe are expected to grow at a slower pace during the forecast period due the saturation in these markets. The Asian region on the other hand is anticipated to grow at a faster pace due to the changing lifestyles and rising per capita incomes boosting the demand for ophthalmology devices in this region.

[3] Business environment description in this section taken from: marketsandmarkets.com, March 2014.

SC 9 Electro-optical systems

Many different products fall in this category including lasers, surgical equipment used with lasers in the operating room, optical components such as lenses and mirrors, microlens arrays and diffractive optics.

Lasers find non-military applications in medicine, industry, information technology and elsewhere. Although liquid lasers (dye lasers in particular) have been significant in the past, today's lasers are almost always based on either solidstate or gaseous media. Within the solidstate category, there are several subdivisions. Although semiconductor devices are surely solidstate devices, semiconductor lasers are considered to be a category of their own, and not "solidstate" lasers. Fiber lasers are often treated similarly, considered to be a category of their own. In this narrow sense, "solidstate" lasers are only those based on bulk, non-semiconductor solid materials.

For the past decade or longer, an important trend has been the intrusion of fiber lasers into markets that were previously the exclusive domain of conventional, bulk solidstate lasers. Because the ratio of surface area to volume is so great for a fiber laser, heat removal is greatly facilitated and, as a result, the beam quality from a fiber laser is superior to that from a conventional solidstate laser. Fiber lasers can also be lighter and more rugged than conventional solidstate lasers. For these reasons, the trend of fiber lasers replacing conventional solidstate lasers is likely to continue into the future.

Because lasers find such a broad variety of applications, it is important the parameters of laser performance be carefully standardized. SC 9 has created and maintains standards for all these parameters, including beam quality (divergence), power, energy and temporal characteristics, polarization, positional stability, spectral characteristics, and lifetime.

Lasers have many advantages over conventional surgical instruments and are widely utilized in operating rooms throughout the world. But lasers create a fire hazard in the operating room, and patients die every year from accidental, laser-induced fires. To reduce this hazard, SC 9 creates and maintains standards for measuring the laser-induced flammability of drapes and tracheal tubes used in conjunction with laser surgery.

The optical components used with a laser, and especially those inside the laser, are crucial to the laser's performance. SC 9 creates and maintains standards for these components, which include mirrors, lenses, polarizers, windows as well as active components like modulators and nonlinear crystals. These standards define measurement techniques for scattering, absorptance, specular reflection and transmission, and optically induced damage.

3 BENEFITS EXPECTED FROM THE WORK OF THE ISO/TC

International Standards serve as the preferred basis of agreements and contracts in bi- or multilateral business relationships throughout the world and are therefore of particular importance for a expanding global market. Particularly for small and medium enterprises, it is important that reliable standards are available. Clear characterisation facilitates the negotiations with the customers, allows proper calculation of systems or parts of them or obviates disputes with the customers.

Manufacturers and users of optical products need clear and uniform terminology and test methods as well as standards to handle safety issues properly. From legal and health protective aspects some of the standards help the manufacturer to show conformity with relevant legal requirements or the requirements of other horizontal normative documents (e.g. IEC 60601).

Standardisation is an enormous occasion for legal deregulation. Industry, in co-operation with the other concerned parties, sets its own rules by means of private standardisation ('self-regulation') and reduces such the need for legal regulations. The European 'New Approach', in which essential requirements that are laid down by the European Union (EU) Council in EU directives are complemented by detailed 'harmonised standards' that have been developed under a mandate of the EU commission, is a prominent example for such 'task-sharing' between industry and government. The work items of sub-committees SC 7 *Ophthalmic*

optics and instruments and SC 9 *Electro-optical systems* are as far as possible treated in parallel with the corresponding committees of the European Committtee for Standardization, CEN.

Systemic aspects are becoming more and more relevant. The modular design of systems is supported by proper interface standards.

In addition the standards on minimum requirements and test methods for product characteristics are very helpful for quality assurance purposes. They help establishing quality management systems and support benchmarking.

Standards on performance and performance safety and performance testing support the confidence of the consumers in the product of this market section.

Even if all market partners benefit from the standardisation efforts, the recognition of the standards differs from field to field. End users of telescopic systems, for example, normally have a high recognition of product performance standards, whereas in the ophthalmic field, standards will be appreciated by industry and the 3 Os (opticians, optometrists and ophthalmologists).

4 REPRESENTATION AND PARTICIPATION IN THE ISO/TC

4.1 Membership

Countries/ISO members bodies that are P and O members of the ISO committee

4.2 Analysis of the participation

All major manufacturers and suppliers concerned are represented in ISO/TC 172. The most important group is represented by the manufacturers. But it is desirable to get more commitment of end users as experts.

The geographically oriented main market forces (i.e. North America, Europe, Asia Pacific) are represented by technical experts as well.

5 OBJECTIVES OF THE ISO/TC AND STRATEGIES FOR THEIR ACHIEVEMENT

5.1 Defined objectives of the ISO/TC

Elaboration of standards on requirements, terminology, interfaces and test methods in the field of optics and photonics. This includes complete systems, devices, instruments, ophthalmic optics, optical and photonic components, auxiliary devices and accessories, as well as materials. Optics and photonics is used in the meaning that the performance of the products under consideration is based on the generation, handling and detection of optical radiation including signal processing.

These International Standards shall provide means for a good infrastructure of the global market for optical systems and devices. The market needs specification of minimum performance requirements, clear and uniform terminology and test methods as well as standards to handle safety issues properly. From legal aspects some of these standards may help the manufacturers to show conformity with the national or regional legal requirements (e.g. with the European Directive on Medical Devices 93/42/EC). In addition the standards on test methods are very helpful for the documentation of characterising parameters for quality assurance purposes.

5.2 Identified strategies to achieve the ISO/TC's defined objectives

The technical committee is structured in seven sub-committees, two of which (SC 1 and SC 3) deal with cross-sectional tasks of horizontal nature, whereas five sub-committees cover product specific fields. The horizontal committees produce basic standards on optical and environmental test methods as well as basic

standards for optical drawings and optical components. The vertical sub-committees SC 4, SC 5 and SC 6 cover optical instruments. SC 7 deals with vision correction devices, ophthalmic instruments and eye implants. SC 9 covers lasers and electro-optical devices and systems.

It is expected that there will be much change in the design of optical devices even in the areas of traditional optical systems. Therefore new materials, surface treatments, bonding technologies, mounting technologies are used as well as new light sources and detectors. All sub-committees were requested to make up their mind which standards will be needed in their field in the future. In order to satisfy the needs of the market, the standards also must reflect the change from classical optics to modern optics and photonics.

Due to the rapidly developing nature of photonics, the TC needs to develop in some areas closer working relationships with governments, universities and industrial research and development.

The need to transfer and/or exchange information between internal and external partners involved in design, production and marketing of optical products yields the demand for a uniformly consistent and unambiguous electronic description of products and processes. ISO/TC 172 has therefore been working towards establishing an electronic Online Properties‘ Dictionary, which provides standardised data formats for the full range of information required for data exchange.

In order to provide efficient working structures, the sub-committees are broken down in working groups which often structure again in project groups. The work of the TC, the SCs and WGs is conducted by holding physical face-to-face meetings for making the basic decisions whereas the project groups work make intense use of electronic means of communication. As a general rule, work shall be conducted by correspondence or using web-conferencing facilities as far as possible, in order to minimise meeting times and costs.

A great help in fulfilling the task of TC 172 is the change in the development procedures by the full exploitation of the enabling potential of information and communication technology. This saves a considerable amount of time and money by a better preparation of face-to-face meetings that increasingly focus on problem-solving, prioritisation and strategic development rather than on document drafting.

In order to minimise the duplication of effort and to conserve scarce personal and financial resources, the TC itself as well as its sub-committees cultivate co-operation and internal and external liaisons with other ISO and IEC committees as well as international organisations. Due to the growing importance of electro-optical aspects, a close link with the relevant IEC committees is of great importance in order to avoid conflicting standards.

Two sub-committees of ISO/TC 172 enjoy close working relationships with their European counterparts: SC 7 with CEN/TC 170 *Ophthalmic Optics* and SC 9 with CEN/TC 123 *Lasers and photonics*. As far as possible the Vienna Agreement (ISO lead) is applied for their work items.

6 FACTORS AFFECTING COMPLETION AND IMPLEMENTATION OF THE ISO/TC WORK PROGRAMME

The range of applications of this cross-sectional technology is such wide that none of the affected industries identifies themselves in a total with this area. In particular, the co-operation of the SMEs is - due to financial problems - sometimes not satisfactory. This is particularly true for the work of SC 1 on environmental test methods as well as for the work of SC 5 on endoscopes. Sometimes it is difficult to find the minimum required actively participating members which are stipulated by the ISO Directives for acceptance of new work.

Not only the applications are numerous, there exist also a variety of types of optical instruments which cover a broad band of wavelengths from the UV to the infrared.

Validation of a test method is dependent upon funding being available to undertake the necessary pre- and co-normative research. The early start of standardisation accompanying R & D can sometimes lead to

completely new aspects (as could be seen in the development of ISO 11146) which might retard the completion of the standard, but helps industry and research anyhow to a better understanding of the technology and the basic physics.

In some sub-committees, e.g. SC 5 the expertise of most of the present experts of was primarily focused on classical optics. The initiated inclusion of work items directed to the field of “advanced” modern optics and photonics needs to find the specific expertise required for the elaboration of those projects. In addition, more application know how should be included.

Another limiting factor is that the technical content of the standards is produced by the experts from industry and, more often than not, the work in their companies takes priority over the commitment that the expert might undertake to fulfil their role in the standards committee. However, participation in the voluntary standardisation system means that once an expert is part of the system, he or she is no longer a volunteer. He or she has been sent to the committee by the management and has to fulfil his or her commitments. This, however, needs the attentive and continuous consideration of the management.

7 STRUCTURE, CURRENT PROJECTS AND PUBLICATIONS OF THE ISO/TC

This section gives an overview of the ISO/TC’s structure, scope, projects and publications. All of this information is updated regularly and is available on ISO’s website, ISO Online.

The link below is to the TC’s page on ISO’s website:
ISO TC 172 on ISO Online

Click on the tabs and links on this page to find the following information:

- About (Secretariat, Secretary, Chair, Date of creation, Scope, etc.)
- Contact details
- Structure (Subcommittees and working groups)
- Liaisons
- Meetings
- Tools
- Work programme (published standards and standards under development)

Reference information

Glossary of terms and abbreviations used in ISO/TC Business Plans

General information on the principles of ISO's technical work