ISO 10110, modified ANSI standards and additional standards dealing with optics elements - do they fill their purpose?

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Preface

Criticizing accepted negatively by people and mostly by organizations. But the aim of criticizing in many cases is to point on things that done wrong, from the point of the criticizing person or body. Good criticizing should of course include suggestions for improvement. All Quality theories established by Quality Gurus talking about improvement and continues improvement. So, when someone (me in this article) is pointing on things, that according to his point of view (me in this article) that done wrong, somehow, someway it should be referred by the organization that is responsible for the matter that is being criticized. For this article that was published by me two years ago, I received few responses but I didn't get any answer refers to all my mentioned points. Of course, maybe I'm wrong somehow in some criticizing matters but talking with colleges from different countries from the same optics area I'm dealing with, seems that my criticizing described below, mostly is correct.

The aim of any international (**ISO**) or national (**ANSI**) standard is to establish general or specific rules and/or procedures for some intendent uses that will be acceptable and understood everywhere, meaning for every intended user in any country all over the world or in specific country (**ANSI** in the United States, **BSI** in the United Kingdom or **DIN** in Germany). **ISO** and **ANSI** standards are written in English and directed to different interested bodies and countries. So, **ISO** standards are International, whereas **ANSI** standards are national and directed to American bodies, although they are used by other countries as well. All standards should be written in a language that is easy to read and understand, by anyone who needs them and even to those for whom English isn't their mother language!

Standards are important. They create a technical language for the intendent users. So, when this language is a clear, simple to understand and translated to requirements stated in relevant drawings or specifications for optical elements by optics designer, it can be easily to understood anywhere in the world by any manufacturer and inspector.

The three main interest parties to use those standards for optical elements and systems are
1) Optics designers,
2) Optics manufacturers, and
3) Optics inspectors.

And of course, the standards are also directed to inexperienced people that just started working as optics designers, optics manufacturers or optics inspectors, as well as experienced people who have worked in their profession for many years.

The requirements for optical elements according to their intended use are referred to the following main areas:
1) Raw material designation of the element (name of the manufacturer and material's parameters),
2) Mechanical dimensions of the element (diameter, length, central thickness, angle, chamfer, surface form, centring etc.),

3) Special designations for aspheric or diffractive elements (formula and parameters relevant for specific surface),
4) Coatings parameters (optical performances and environmental durability),
5) Cosmetics (scratches, digs, stain, etc.) for coated and uncoated surfaces.

The requirements for the above areas are set by specific technical groups/committees belonging to international (**ISO**) or national (**ANSI** and others) organizations. **OEOSC** (Committee for Optics and Electro-Optical Instruments) is a committee made up of U.S., and Technical Committee **172** (**ISO/TC 172**) is made up by **ISO**.

Glossary

ISO - International Organization for Standardization. ISO is an independent, non-governmental international organization with a membership of 164 national standards bodies (including ANSI, with about 585 participants). Through its members, it brings together experts to share knowledge and develop voluntary, consensus-based, market relevant International Standards that support innovation and provide solutions to global challenges.
(From: https://www.iso.org/about-us.html).

ANSI - American National Standards Institute. The Institute oversees the creation, promulgation and use of thousands of norms and guidelines that directly impact businesses in nearly every sector: from acoustical devices to construction equipment, from dairy and livestock production to energy distribution, and many more. ANSI is the official U.S. representative to the ISO.
(From: https://www.ansi.org/about_ansi/overview/overview?menuid=1).

ISO/TC 172 – ISO committee for the standardization of terminology, requirements, 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 involve the generation, handling and detection of optical radiation including signal processing.
(From: https://www.iso.org/committee/53686.html).

OEOSC - Committee for Optics and Electro-Optical Instruments. OEOSC is a committee made up of U.S. optical experts whose primary responsibility is to review drafts of proposed international optical standards so that it can formulate the U.S. opinion of the suitability of those drafts to become international standards and to transmit that opinion, through ANSI, to the ISO technical committee. The committee is also responsible for reviewing U.S. national optical standards to determine which of them should be offered as drafts for new international optical standards. The OEOSC is the U.S. Technical Advisory Group (TAG) to ISO Technical Committee 172, Optics and Optical Instruments. (From: https://webstore.ansi.org/sdo/oeosc).

Standard - An established norm or requirement in regard to technical or administrative systems. It is usually a formal document that establishes uniform engineering or technical criteria, methods, processes, and practices. A technical standard may be developed privately or unilaterally, for example, by a corporation, regulatory body, military, etc. Standards can also be developed by groups such as trade unions and trade associations. **(**From Wikipedia).

Specification - A set of documented requirements to be satisfied by a material, design, product, or service. A specification is often a type of technical standard. There are different types of technical or engineering specifications (specs), and the term is used differently in different technical contexts. They often refer to particular documents and/or particular information within them. **(**From Wikipedia).

MIL-Standard (MIL-STD) - A United States defense standard. It is used to help achieve standardization objectives by the U.S. Department of Defense. Defense standards are also used by other non-defense government organizations, technical organizations, and industry. **(**From Wikipedia).

MIL-Specification (MIL-Spec) - A document that describes the essential technical requirements for military-unique materiel or substantially modified commercial items. **(**From Wikipedia).

MIL-PRF (Performance Specification) - A performance specification states requirements in terms of the required results with criteria for verifying compliance but without stating the methods for achieving the required results. A performance specification defines the functional requirements for the item, the environment in which it must operate, and interface and interchangeability characteristics. **(**From Wikipedia).

Purpose of This Report

Each time a new standard or new version of an old standard is published, many articles with explanations about using them are published. Why? From my point of view, one reason is to explain to the intendent user how to use the standards, but the second reason from my point of view is because those standards are not clear enough, sometimes complicated and difficult to understand and use.

So, in this report, I will explain from my point of view why the **ISO** and **ANSI** standards do not serve well the intendent users and what should be done for improve them for easier use and greater satisfaction. It is my point of view, but many people in the industry, optics designers, producers and inspectors of optical elements I spoke with agree with what I write here.

I will not refer to every relevant published standard but to some general remarks and some specific remarks that basically can be attached to other standards as well.

The Heart of the Report

1. ISO 10110 “Optics and photonics — Preparation of drawings for optical elements and systems”

In 1996, **ISO** technical committee 172, subcommittee SC 1 approved and published the first 7 **ISO 10110** standard, Parts: 1 to 3, 5, 6, 9 and 11. In 1997, **ISO** published 3 additional Parts: 4, 8 and 12. Following the above 10 Parts, new Parts of **ISO 10110** have been published, and those of 1996 and 1997 have been revised, cancelled (Part 10), replaced (Part 18 instead of Parts 2, 3 and 4) or withdrawn (Part 13 and new material under the same name become Part 17). Two places for Parts 15 and 16 are still waiting for preparation and appearance.

Today, in 2022, **ISO 10110** has officially 13 Parts: 1, 5 to 9, 11, 12, 14 and 16 to 19. See the following list of standards:

Part 1 (2019) - "General" (previous editions: 2006, 1996) [(Part 10 (2004) was revised and unified with Part 1]
Part 5 (2015) - "Surface form tolerances" (previous editions: 2007, 1996)
Part 6 (2015) - "Centring tolerances" (previous edition: 1996)
Part 7 (2017) - "Surface imperfection tolerances" (previous editions: 2008, 1996)
Part 8 (2019) - "Surface texture" (previous editions: 2010, 1997)
Part 9 (2016) - "Surface treatment and coating" (previous edition: 1996)
Part 11 (2016) - "Non-toleranced data" (previous edition: 1996)
Part 12 (2019) - "Aspheric surfaces" (previous editions: 2007, 1997)

Part 14 (2018) - "Wavefront deformation tolerance" (previous editions: 2007, 2003)
Part 16 (2022) - "Diffractive Surfaces" (**under development**)
Part 17 (2004) - "Laser irradiation damage threshold"
Part 18 (2018) - "Stress birefringence, bubbles and inclusions, homogeneity, and striae"
[(Part 18 replaced previous Part 2 (1996), Part 3 (1996) and Part 4 (1997)]
Part 19 (2015) - "General description of surfaces and components"

Since the first publications of the **ISO 10110** standards, many publications were released that explain how to use the Parts of the standards. The broad one was ***ISO 10110*** *Optics and Optical Instruments – Preparation of drawings for optical elements and systems: A User's Guide*, edited by **Ronald K. Kimmel** and **Robert E. Parks** and published by **OSA** (in 1995, first edition by Optical Society of America). The second edition (in 2002) of this Guide refers to and explains the use of the first 13 Parts (1 to 13) of the **ISO 10110,** which of course, today in 2022 are not too relevant due to changes made for most of the **ISO 10110** Parts.

Following are general comments from my point of view:

- The **ISO 10110,** when first published and still in 2022, is a complicated standard and not comfortable to use. This is not only my opinion but that of many people involved in designing, manufacturing and inspection of optical elements in USA, Europe and Asia I am in contacted with.
- When the **ISO 10110** was established, it was based widely on the German **DIN 3140** standard. In establishing an **International Standard** (!), it should take into account what is going on with other important countries and manufacturers for easy and positive acceptance and implementation. Even today, 26 years after the first **ISO 10110** Parts, it is still not acceptable by many designers of optical elements!
- Involvement of the relevant intendent users: designers, manufacturers, and inspectors. I'm sure that the people involved in the past and today in establishing the **ISO 10110** Parts standard are very experienced in their profession, but I'm not sure if some of them is designer, manufacturer or inspector of optics elements.
- The standard to be used shouldn't explain and train the user about optics fundamentals. Many parts in **ISO 10110** try to do this.
- Too many standards in the package.
- Too many changes. A good and well prepared standard should remain unchanged for more years.
- Money. The standards aren't cheap, especially when there are so many of them. A good designer, manufacturer or inspector needs and should have all of them. And there are other standards dealing with optics matters.
- Inability of **ISO** and **ANSI/OEOSC** to agree on mutually acceptable standards. Separate standards for the same matter do not benefits designers, manufacturers and inspectors.

2. <u>Me and my comments on ISO 10110 Parts</u>

My comments refer to the first **ISO 10110** editions (1996 and 1997) and to the current package with the last editions as well. I'm not going to refer to all weaknesses of the **ISO** and/or **ANSI/OEOSC** standards for optics because there are too many. Part of the comments will be general, and part will be specific. I hope that in the future it will improve the process of establishing standards and maybe improve the **ISO 10110** standards when they are revised, and considerations shall be considered by **ANSI/OEOSC** for their optics standards.

- **<u>ISO 10110 – Part 1 (2019) - ''General''</u>.** Identification of requirements according to Table 1 (Properties to be listed if applicable)**:** from the first revision**,** designations of applicable requirements **0/**, **3/**, **6/** and others had to be equal to the ISO Parts numbers, meaning that, for example, instead of **3/** (which refers to surface form tolerance), its designation was and should be **17/** (which refers to the requirements of **ISO 10110 - Part 17)**! Now, for the new **ISO 10110 - Part 18** that refers to birefringence, bubbles and inclusions and homogeneity, its designation had and should be **18(0)/**, **18(1)/** and **18(2)/** respectively. The same applies to all other designations. It is much easier for the user to go directly to the referenced ISO Part number. In addition, Table 1 should be presented at the top of Part 1 and not at its middle. The last my remark for this Part refers to surface types in Table 1: what are the general surface (GS) and special surface (s), and what about Spherical Surface, Diffractive Surface, Flat Surface and Freeform Surface? Will **ISO** add designations for those surfaces in Table 1 in next revision of this Part?

- **ISO 10110 - Part 18 (2018) - ''Stress birefringence, bubbles and inclusions, homogeneity, and striae'' [(Part 18 replaced previous Part 2 (1996), Part 3 (1996) and Part 4 (1997)].** This Part deals with three properties of materials imperfections for optical elements. It doesn't refer specifically to the type of the material, but it should be noted in this standard that it refers to **glass** optical elements [**ISO 9802** and **ISO 12123** refer intentionally to glass, as do **ANSI/OEOSC OP3.001-2001 (R 2008)** and of course the old **MIL-G-174B**!]. This Part 18 doesn't refers to IR materials, to Moulded optical materials, chalcogenide materials and crystal materials. Why? Is there any plan for **ISO** to establish a new standard for those materials? In some ways this Part 18 of the **ISO 10110** is not required! The properties of optical materials are based on materials manufactured by companies that also determine all needed parameters (optical, mechanical, thermal and others) based on the physics of optics related to optical materials. The design of optical elements is based on the properties of data sheets of those materials of relevant manufacturers and not on ISO standard. When we define the needed material, we use the manufacturer's designations. Recently, **SCHOTT** (see **SCHOTT** Optical Glass 2020) adopted the Part 18 designations for Bubbles, Striae and Inclusions and Stress birefringence. Other manufacturers haven't yet. For years, we used the manufacturers' designations of optical material properties and it was o.k., so why change especially when not all manufacturers adopted the Part 18 designations? Do all manufacturers (including **HOYA**, **OHARA**, **CDGM** and others) agreed to Part 18 codes designations? The designations of Part 18 for materials properties are complicated and not easy to use comparing with manufacturers' codes. Part 18 determines codes indications also for finished assembly (11/1, 12/1 and 12/NH), why and for what? Paragraph 4.2 in Part 18 says that "…the designer directs the specification to the finished assembly of components rather than to a single component in the assembly". The design starts with the assembly requirements but it goes down to the single element and the requirements of the single element - that is what is important to the designer and to the element manufacturer. When the requirements for the elements were established properly, we never applied such requirements to the finished assembly. For bubbles and inclusions, Part 18 uses standard bubble grades based on the **Renard** sequence (R5) of size numbers. Who is going to calculate bubbles according to it? Using the old MIL requirements is much easier and comfortable than the **Renard** size numbers, so why make things more complicated instead of simpler with better results?
    a. **Additional standards for optical glass: MIL-G-174B (1986), ISO 12123:2018, ISO 9802:1996 (R 2013), ISO/CD 9802 (under development), ISO 11455 (1995), ISO 17411:2014, ISO 15368:2001, ANSI/OEOSC OP3.001-2001 (R 2008), ISO 10110 – Part 18 and maybe others.** Too many standards deal with optical glass. **ISO**, along with **ANSI** should establish one agreed standard that includes all needed requirements from optical materials (glass and other materials), including test methods, determination of parameters and requirement designations. **ISO** and **ANSI** should think about the customers of those standards and how to make the design, manufacturing and testing

easier to use. We shall have more total pages, but it would be cheaper compared to the cost of all standards together (**MIL** standards have no cost and are free to download).

b. My suggestion for the next revision is to change the name of **ISO 10110 - Part 18 (2018)** to "Materials for Optical Elements" and include in it data for optical glass and other optical materials: Moulded optical materials, IR materials, Chalcogenide materials and Crystal materials. About 30% of materials used for optical elements shouldn't be ignored.

- **<u>ISO 10110 – Part 11 (2016) - ''Non-toleranced data''</u>.** Each value of an optical element should have a tolerance. Basically, without a tolerance, the element cannot be manufactured; thus, not giving a tolerance is a mistake. In all cases when a tolerance doesn't exist, it is due to a mistake, and the designer should be told about. To use the tolerances in Table 1 in Part 11 would be a mistake that can lead to a wrong value that the designer didn't intend. As this table is the basic part of this standard, from my point of view, it is completely extraneous and not needed. But if this table is only a recommendation (which should be acceptable by every designer), it should be noted as such, and in addition, the two main pages of Part 11 (page 1 and 2), should be added to Part 1 – General. It will also save a 38 CHF (~39.5 USD) for everyone interested in it.
- **<u>ISO 10110 – Part 5 (2015) - ''Surface form tolerances'' and ISO 10110 - Part 14 (2018) - ''Wavefront deformation tolerance''</u>.** These two Parts should combined into one Part. Splitting the same matter into two standards is completely bizarre. All matters that the two standards refer to **ISO 14999-4** standard should be added to the combined standard so there wouldn't be any need to mention the **ISO 14999-4**. Many times, it is much easier and more understandable to put the requirements in explicit words than to put the requirements in codes.
  a. Did someone in **ISO** check with optics designers if any of them used or will use the requirements according to **Table 1** from **ISO 10110 – Part 5 (2015)**?
  b. Most interferometers use the helium-neon wavelength of 632.8 nm. Why would one refer to the green spectral line of mercury (546.07 nm), per the **ISO 7944** with a converted formula - according to paragraph **4.3** (wavelength) in **ISO 10110 – Part 5 (2015)**? Maybe the **ISO 7944** should be corrected, too?
- **<u>ISO 10110 - Part 7 (2017) - ''Surface imperfection tolerances''</u>.** This Part is maybe the most important and, in some ways the most problematic in the **ISO 10110** series. This part determines rules for labelling the surface imperfection tolerances on uncoated optical surfaces and on optical coatings in optical elements. This subject is complicated and controversial in some way for many years (since the early days of the **MIL-specs),** and will stay controversial for the next few years as well. The following are my comments on this Part:
  a. Splitting the Specification Method in two, Dimensional and Visibility is completely unnecessary. It doesn't help any user of this ISO Part. One method that specifies in millimetres the values of the codes and using the old MIL-specs codes (S-D) and values (80-50, for example) is enough, and the decision if to measure the imperfection visually or dimensionally can be noted in the drawing. This note is not too important because in most cases the imperfection is a cosmetic imperfection and doesn't have any influence on the functionality; however, the values are important, and the manufacturer should follow them. Additional note is for the S-D: ISO makes the same mistake of the Mil-specs and doesn't refer to actual width scratch in millimetres but to only those which are on the specified comparison standard set while the digs have apparent size of the imperfection is 10 times the grade number, in micrometers. Everyone in the industry knows that scratch no. 80 means 80 microns. The old incomprehensible discussion that could have been sold in this ISO part is by deciding that scratch no. 80 means 80

microns and both, S and D can be referred to the comparison standard set or to the actual measured values.

b. The dimensional specification for assemblies marked as **15/** in this Part (and in others) is extraneous. Elements include optical surfaces marked with **5/,** and this requirement always applies to the final assembly and to outer surfaces as well. The requirements don't change, so why to complicate things with unneeded requirements? Did someone saw somewhere this kind of requirement?

c. For Surface Imperfections, this ISO Part uses grades based on Renard sequence (R5) of size numbers. Who is going to calculate Scratches and Digs according to it, especially when most scratches are not of equal width and most digs are not exactly round? Using the old MIL-specs requirements is much easier and more comfortable than the Renard size numbers, so why to make things more complicated instead of simpler with better results?

d. This part refers also to **ISO/TR 21477** and **ISO 14997.** One good standard for Surface Imperfections will benefit its users. Who need three standards dealing with common matters?

- **ISO 10110 - Part 16 (2022) - ''Diffractive Surfaces''.** This ISO part, according to the ISO website (https://www.iso.org/standard/81561.html) is **under development** and cost 58 CHF (about 61 American Dollars). This means that if I buy this standard, which is very important, and until its final version there will be some changes in, I'll have to buy the final version and pay another some kind of money. My suggestion is to send to every buyer of the **under development** version, the final version without any additional payment. In future, in similar caseS, ISO should wait and release only the final version.

- **ISO 10110 - Part 17 (2004) - ''Laser irradiation damage threshold''.** This standard refers in paragraph 2 (normative references) to **ISO 11145**, **ISO 11254-1:2000** and **ISO 11254-2**.
  a. The **ISO 11254-1** standard refers to 2000 version, and others do not. Why? The best option is not to give the version but to put a note that the user should refer to the latest version of every standard (or a previous version if intentionally requested).
  b. Instead of splitting the standards dealing with **Laser Irradiation Damage Threshold** (**LIDT**), one standard including the requirements of **ISO 11254-1, ISO 11145**, **ISO 21254-1 (**replaced ISO 11254-1**)**, **ISO 21254-2 (**replaced ISO 11254-2**)**, **ISO 21254-3 (**replaced ISO 11254-3**)**, **ISO 11151-1** and **ISO 11151-2** should be established (with a note for last versions)!
  c. The bibliography of **ISO 11145:2018** refers to **ISO 11146-1:2005**, **ISO 11670:2003**, **ISO 13694:2018**, **ISO 15367-1:2003**, **IEC 60825-1** and **ISO 12005:2003**. The necessary elements of those standards should be added to the modified **ISO 10110 - Part 17**. There are too many standards dealing with matters important to the Laser irradiation damage threshold.

- **ISO 9211 for Optical Coatings.** This series include 8 standards for optical coatings:
  - **ISO 9211-1:2018** - Optics and photonics - Optical coatings - Part 1: Vocabulary
  - **ISO 9211-2:2010** - Optics and photonics - Optical coatings - Part 2: Optical properties
  - **ISO 9211-3:2008** - Optics and photonics - Optical coatings – Part 3: Environmental durability
  - **ISO 9211-4:2012 (R2018)** - Optics and photonics - Optical coatings - Part 4: Specific test methods
  - **ISO 9211-5:2018** - Optics and photonics - Optical coatings - Part 5: Minimum requirements for antireflecting coatings
  - **ISO 9211-6:2018** - Optics and photonics - Optical coatings - Part 6: Minimum requirements for reflecting coatings

- **ISO 9211-7:2018** - Optics and photonics - Optical coatings - Part 7: Minimum requirements for neutral beam splitter coatings
- **ISO 9211-8:2018** - Optics and photonics - Optical coatings - Part 8: Minimum requirements for coatings used for laser optics

Why split an important coating subject into eight standards when one standard that includes everything can benefit all interested users, optics designers, optics manufacturers and optics inspectors as well as the ISO (more buyers means more profit).

- **<u>ISO 9022 for Optical Coatings</u>.** This series include 15 (!) standards for Environmental test methods (missing numbers were revised by numbers 22 and 23):
  - **ISO 9022-1:2016 -** Optics and photonics - Environmental test methods - Part 1: Definitions, extent of testing
  - **ISO 9022-2:2015 -** Optics and photonics - Environmental test methods - Part 2: Cold, heat and humidity
  - **ISO 9022-3:2015** - Optics and photonics - Environmental test methods - Part 3: Mechanical stress
  - **ISO 9022-4:2014 (R 2019)** - Optics and photonics - Environmental test methods - Part 4: Salt mist
  - **ISO 9022-6:2015** - Optics and photonics - Environmental test methods - Part 6: Dust
  - **ISO 9022-7:2015** - Optics and photonics - Environmental test methods - Part 7: Resistance to drip or rain
  - **ISO 9022-8:2015** - Optics and photonics - Environmental test methods - Part 8: High internal pressure, low internal pressure, immersion
  - **ISO 9022-9:2016** - Optics and photonics - Environmental test methods - Part 9: Solar radiation and weathering
  - **ISO 9022-11:2015** - Optics and photonics - Environmental test methods - Part 11: Mould growth
  - **ISO 9022-12:2015** - Optics and photonics - Environmental test methods - Part 12: Contamination
  - **ISO 9022-14:2015** - Optics and photonics - Environmental test methods - Part 14: Dew, hoarfrost, ice
  - **ISO 9022-17:2015** - Optics and photonics - Environmental test methods - Part 17: Combined contamination, solar radiation
  - **ISO 9022-20:2015** - Optics and photonics - Environmental test methods - Part 20: Humid atmosphere containing sulfur dioxide or hydrogen sulfide
  - **ISO 9022-22:2012 (R 2017)** - Optics and photonics - Environmental test methods - Part 22: Combined cold, dry heat or temperature change with bump or random vibration
  - **ISO 9022-23:2016** - Optics and photonics - Environmental test methods - Part 23: Low pressure combined with cold, ambient temperature and dry or damp heat

Like the **ISO 9211** series, why to split important Coating Environmental Test Methods into fifteen standards when one standard including everything can benefit all interested users, optics designers, optics manufacturers and optics inspectors, as well as the ISO (more buyers means more profit). I will say again, the **ISO 9022** series can join the **ISO 9122** series for one very good standard.

Just to remind **ISO** members and readers of this report, **MIL-specs** [**MIL-C-675C (1980)**, **MIL-C-48497A (1980)**, **MIL-M-13508C (1973), MIL-F-48616 (1977) and MIL-PRF-13830B (1997**)] and some requirements in **MIL-STD-810H (2019)** dealing with durability of optical coatings have been used for many years and will be in use for many years ahead. They do not have so many standards, and they are free to download and use (at no cost); and of course, during the time they weren't declared that they become inactive for new design, those specs weren't revised every few (5 or more) years as happens to **ISO** standards. **MIL-STD-810** is the only one that is revised frequently.

3. ANSI Standards

According to the **ISO** (https://www.iso.org/about-us.html), it include **164** national standards bodies with about **585 ANSI** participants. Through its members, it brings together experts to share knowledge and develop voluntary, consensus-based, market relevant International Standards that support innovation and provide solutions to global challenges. **ANSI**, along with **OEOSC,** are very important organizations, and the **USA** is one of the most important countries for optics, and yet it cannot come to agreement with **ISO** about standards for optical instruments even though the optics is the same. Consequently, **ANSI/OEOSC** establish set of standards (see below) that is partly based on the **ISO 10110** standards with modifications to accommodate standard practice in the United States. Why can't the two organizations (**ISO** and **ANSI/OEOSC)** agree on uniform standards that will make the life of optics designers, manufacturers and inspectors easier? Those three groups are their customers, so they should think about them! Another thing for **ANSI** standards: why spread them out? One standard that includes all needed parameters would be better.

- **ANSI/OEOSC OP1.0110-1-2011 -** Optics and Electro-Optical Instruments - Preparation of Drawings for Optical Elements and Systems - Part 1: General (based entirely on ISO 10110-1 but modified to accommodate standard practice in the United States).
- **ANSI/OEOSC OP1.002-2017** - Optical Elements and Assemblies – Surface Imperfections
- **ANSI/OEOSC OP1.9211-4-2014 -** Optics and Photonics - Optical Coatings - Part 4: Specific Test Methods
- **ANSI/OEOSC OP1.0110-5-2015 -** Optics and photonics - Preparation of Drawings for Optical Elements and Systems - Part 5: Surface Form Tolerances
- **ANSI/OEOSC OP1.0110-8-2014 -** Optics And Photonics - Preparation of Drawings for Optical Elements and Systems - Part 8: Surface Texture; Roughness and Waviness
- **ANSI/OEOSC OP1.0110-9-2015 -** Optics and Electro-Optical Instruments - Preparation of Drawings for Optical Elements and Systems - Part 9: Surface treatment and coating (based entirely on ISO 10110-9, with some modifications to accommodate standard practice in the United States).
- **ANSI/OEOSC OP1.0110-10-2014 -** Optics and Electro-Optical Instruments - Preparation of Drawings for Optical Elements and Systems - Part 10: Table representing data of optical elements and cemented assemblies (based entirely on ISO 10110-9, with some modifications to accommodate standard practice in the United States).
- **ANSI/OEOSC OP1.0110-12-2014 -** Optics and Electro-Optical Instruments - Preparation of Drawings for Optical Elements and Systems - Part 12: Aspheric Surfaces (based entirely on ISO 10110-12, with the addition of a notation to allow the specification of Forbes aspheres, commonly called Qcon and Qbfs).
- **ANSI/OEOSC OP3.001-2001 (R 2008) -** American National Standard for Optics and Electro-Optical Instruments – Optical Glass.

Some comments on the above standards:

- **ANSI/OEOSC OP1.002-2017 - Optical Elements and Assemblies – Surface Imperfections.**
  - **a.** Some time ago I bought the PDF of this standard and the letters of the content are very small, so I have to use a magnification glass to read it. Why are the letters so small? If the next version will have bigger letters, like other standards do, please send me the new version free of charge.
  - b. This standard uses two different tolerancing systems: a Visibility Tolerancing System and Dimensional Tolerancing System with two different label for grades. For the

Visibility System, the standard uses numerical values (80-50, for example) and for Dimensional System the standard uses letters (F-F, for example). Those systems are based partially on old MIL-specs mentioned in this standard. For both MIL-specs and this standard, this is a bizarre situation. Why use two systems that are basically the same? Scratch is a Scratch and Dig is a Dig on transparent material, on opaque material and on any coating. The Dimensional Tolerancing System should be cancelled; there is no need for it, it only causes complications for all users, and it doesn't help anything. And, in addition, the Scratch or Dig numbers should be declared as dimensional numbers as is referred by almost all users, meaning that Scratch or Dig should be declared by micrometres (μm), meaning for example that Dig no. 50 means 500 μm and Scratch no. 80 means 80 μm. In addition, **Visibility Comparison Artifacts** may be used but without cancellation the basic μm values of the Scratch and Dig.

c. Mixed notation (paragraph **2.1.2.4** in the standard) has no purpose. It is completely extraneous and not needed.
d. In this edition, the names of the organizations and their representatives are given. For what reason? It is nice to know who was involved in this new version, but any comment to this standard should go to **ANSI/OEOSC** which is in charge and responsible for it.

- **ANSI/OEOSC OP1.9211-4-2014 - Optics and Photonics - Optical Coatings - Part 4: Specific Test Methods.**
  a. This standard is a modification of **ISO 9211-4:2012**. It also refers to **ISO 48**, **ISO 9211-1**, **ISO 29862** and **ISO 14997**. Who needs this **ANSI/OEOSC** standard if everything is based on ISO standards? In addition, at the bottom of each page it marks **ISO 2012**, but I couldn't find this standard (please help me find it if it exists).
  b. The most common requirements for the durability of optical coatings used by coaters and designers are based still for many optics designers on **MIL-specs** (**MIL-C-675C**, **MIL-C-48497A**, **MIL-M-13508C** and **MIL-F-48616**) and some requirements in **MIL-STD-810**. They are much easier to use, so why to ignore them?
  c. Crosshatch systems (based on the **ISO** standard) described in **Table 3** are common when painting on metals but not for optical coatings. I never saw this kind of requirement test for optical coating in manufacturing stage. Have you?
  d. The durability requirement for boiling distilled water according to **Table 4** (based on the **ISO** standard). Some time ago, someone asked me about this kind of test, which I wasn't familiar with, so I looked at the **ISO** standard and then asked some experts in optical coatings. Only one told me that it is sometimes used in development of optical coating for shorten the common humidity test. It maybe o.k. for the development stage but never in production stage, so perhaps Table 4 should be revised.
  e. Blindly following requirements that aren't acceptable by most users isn't clever and doesn't serve them well.

- **ANSI/OEOSC OP3.001-2001 (R 2008) - American National Standard for Optics and Electro-Optical Instruments - Optical Glass.** See my comments for **ISO 10110 - Part 18 (2018) - Stress birefringence, bubbles and inclusions, homogeneity, and striae** in this report.

Summary

This was a lot writing, but there is more - a lot more. The report is intended for the users of optics standards but mostly the organizations (**ISO**, **ANSI**) and people involved in creating these standards. I hope this report will reach some ears with strength to impact the right people and inspire changes in next revisions. Referring to this report, I hope it will benefit the large and important community of optics designers, manufacturers and inspectors. And if there are people in this community that agreed with me, do not hesitate to speak or write about.

Any comment will be accepted and can be send to: hausner555@gmail.com

References

- ✓ **Optical glass:** standards – present state and outlook by Peter Hartmann, SCHOTT AG, Advanced Optics, Hattenbergstrasse 10, Mainz55122, Germany [Adv. Opt. Techn. 2015; 4(4-6): 377-388].
- ✓ **ISO 10110 -** Optics and photonics - Preparation of drawings for optical elements and systems, **Part 1:2019**, **Part 5:2015**, **Part 6:2015**, **Part 7:2017**, **Part 8:2019**, **Part 9:2016**, **Part 11:2016**, **Part 12:2019**, **Part 14:2018**, **Part 16:2022**, **Part 17:2004**, **Part 18:2018** and **Part 19:2015.**
- ✓ **ISO 9211 -** Optics and photonics - Optical coatings, **Part 1:2018**, **Part 2:2010**, **Part 3:2008**, **Part 4: 2012 (R 2018)**, **Part 5:2018**, **Part 6:2018**, **Part 7:2018 and Part 8:2018**.
- ✓ **ISO 9022** - Optics and photonics - Environmental test methods, **Part 1:2016**, **Part 2:2015**, **Part 3:2015**, **Part 42014 (R 2019)**, **Part 6:2015**, **Part 7:2015**, **Part 8:2015**, **Part 9:2019**, **Part 11:2015**, **Part 12:2015**, **Part 14:2015**, **Part17:2015**, **Part 20:2015**, **Part 22:2012 (R 2017)** and **Part 23:2016**.
- ✓ **ANSI/OEOSC OP1.0110-1:2011 -** Optics and electro-optical instruments - Preparation of drawings for optical elements and systems - Part 1: General (Based entirely on ISO 10110-1, but modified to accommodate standard practice in the United States).
- ✓ **ANSI/OEOSC OP1.002:2017** - Optical elements and assemblies – Surface imperfections.
- ✓ **ANSI/OEOSC OP1.9211-4:2014 -** Optics and photonics - Optical coatings - Part 4: Specific test methods.
- ✓ **ANSI/OEOSC OP1.0110-5:2015** - Optics and photonics - Preparation of drawings for optical elements and systems - Part 5: Surface form tolerances.
- ✓ **ANSI/OEOSC OP1.0110-8:2014 -** Optics and photonics - Preparation of drawings for optical elements and systems - Part 8: Surface texture; roughness and waviness.
- ✓ **ANSI/OEOSC OP1.0110-9:2015 -** Optics and electro-optical instruments - Preparation of drawings for optical elements and systems - Part 9: Surface treatment and coating (Based entirely on ISO 10110-9, with some modifications to accommodate standard practice in the United States).
- ✓ **ANSI/OEOSC OP1.0110-10:2014 -** Optics and electro-optical instruments - Preparation of drawings for optical elements and systems - Part 10: Table representing data of optical elements and cemented assemblies (Based entirely on ISO 10110-9, with some modifications to accommodate standard practice in the United States).
- ✓ **ANSI/OEOSC OP1.0110-12:2014 -** Optics and electro-optical instruments - Preparation of drawings for optical elements and systems - Part 12: Aspheric surfaces. (Based entirely on ISO 10110-12, with the addition of a notation to allow the specification of Forbes aspheres, commonly called Qcon and Qbfs).
- ✓ **ANSI/OEOSC OP3.001-2001 (R 2008) -** American national standard for optics and electro-optical instruments – Optical glass.
- ✓ **MIL-G-174B:1986** - Glass, optical.

- ✓ **MIL-STD-34:1960 -** Preparation of drawings for optical elements and optical systems; general requirements for.
- ✓ **DIN 3140 -** Optical components.
- ✓ **BS 4301:1991 -** Preparation of drawings for optical elements and systems.
- ✓ **ASME/ANSI Y14.18M:1986 (R2003) -** Optical parts.
- ✓ **MIL-O-13830A:1963 -** Optical components for fire control instruments; general specification governing the manufacture, assembly, and inspection of.
- ✓ **MIL-PRF-13830B:1997 -** Optical components for fire control instruments; general specification governing the manufacture, assembly, and inspection of.
- ✓ **ANSI PH3.617:1991 -** Definition, methods of testing and specification for appearance imperfections of optical elements and assemblies.
- ✓ **MIL-M-13508C:1973 -** Military specification: mirror, front surfaced aluminized: for optical elements.
- ✓ **MIL-F-48616:1977 -** Military specification: filter (coatings), Infrared Interference, General Specification for.
- ✓ **MIL-C-48497A:1980 -** Military specification: coating, single or multilayer, interference: durability requirements for.
- ✓ **MIL-C-675C:1980** - Military specification: coating of glass optical elements (Anti-Reflection).
- ✓ **ISO 21254** - Lasers and laser-related equipment - Test methods for laser-induced damage threshold, **Parts 1÷3**.
- ✓ **ISO 11151-1:2015** - Lasers and laser-related equipment **-** Standard optical components **-** Part 1: Components for the UV, visible and near-infrared spectral ranges.
- ✓ **ISO 11151-2:2015** - Lasers and laser-related equipment **-** Standard optical components **-** Part 2: Components for the infrared spectral range.
- ✓ **ISO 11145:2018 -** Optics and photonics **-** Lasers and laser-related equipment **-** Vocabulary and symbols.
- ✓ **ISO 14997:2017** - Optics and photonics - Test methods for surface imperfections of optical elements.
- ✓ **ISO/TR 14999-1:2005** Optics and photonics **-** Interferometric measurement of optical elements and optical systems - Part 1: Terms, definitions and fundamental relationships.
- ✓ **ISO/TR 14999-2:2019** - Optics and photonics **-** Interferometric measurement of optical elements and optical systems - Part 2: Measurement and evaluation techniques.
- ✓ **ISO/TR 14999-3:2005** - Optics and photonics **-** Interferometric measurement of optical elements and optical systems - Part 3: Calibration and validation of interferometric test equipment and measurements.
- ✓ **ISO 14999-4:2015** - Optics and photonics **- -** Interferometric measurement of optical elements and optical systems - Part 4: Interpretation and evaluation of tolerances specified in ISO 10110.
- ✓ **ISO/TR 21477:2017** - Optics and photonics – Preparation of drawing for optical elements and systems – Surface imperfection specification and measurement systems.
- ✓ **ISO 7944:1998 (R 2014) -** Optics and optical instruments – Reference wavelength.
- ✓ **ISO 3:1973 (R 2020) -** Preferred numbers - Series of preferred numbers.
- ✓ **MIL-STD-810H: 2019 -** Department of Defense Test Method Standard: Environmental Engineering Consideration and Laboratory Tests.
- ✓ **ISO 1:2016** - Geometrical product specifications (GPS) **-** Standard reference temperature for the specification of geometrical and dimensional properties**.**
- ✓ **ISO 1101:2017** - Geometrical product specifications (GPS) - Geometrical tolerancing - Tolerances of form, orientation, location and run-out.
- ✓ **ANSI Y14.5:2018 -** Dimensioning and Tolerancing.

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