



# Surface Inspection Standards

Status report  
January 2022  
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# Status report 2022 topics

- ▶ Feedback on open issues for the ANSI and ISO standards
- ▶ Status of availability of standards
- ▶ Machine vision update



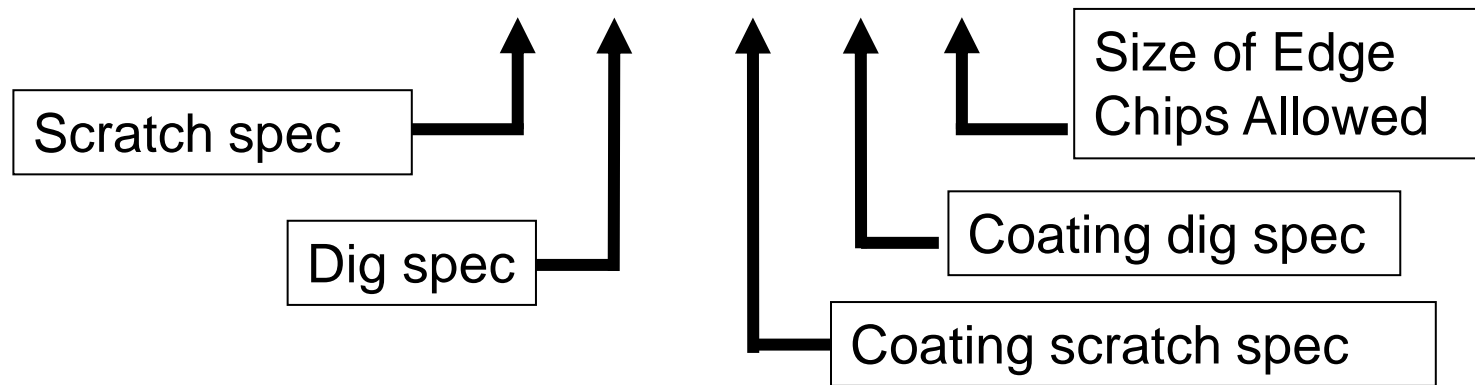
# Available scratch and dig specifications

Specification	Scratches	Digs
MIL-PRF-13830	Brightness comparison	Apparent size
ANSI OP1.002 visibility method	Brightness comparison	Apparent size
ANSI OP1.002 dimensional method	Width comparison or measure	Size comparison or measure
<b>ISO 14997 visibility method</b>	<b>Brightness comparison</b>	<b>Apparent size</b>
ISO 14997 dimensional method	Width comparison or measure	Size comparison or measure



# Visibility specification of surface imperfections per ISO 10110-7

- ▶ Notation: 5 / 60-40; C40-20; E0,5<sup>1</sup>



## Note 1: Use Davidson D-668 comparison standard

- ▶ The Note indicating the comparison set to be used is REQUIRED; there is no default comparison standard
- ▶ The scratch and dig numbers are as defined in MIL and ANSI
- ▶ Scratches and digs are accumulated just like in MIL and ANSI
- ▶ If desired, an inspection level can be added to the specification separated by a semicolon



# Area imperfections – gray, haze, stain and discoloration

- ▶ In addition to scratches, digs and edge chips, the surface must be inspected for large areas which appear different
  - Gray is a cloudiness of the surface which, when viewed under a microscope, are composed of fine dots and scratches
  - Haze is a white cloudiness which looks milky under the microscope
  - Stain is a blue–brown discoloration of an uncoated substrate
  - Discoloration is a regional shift in color of a coating
- ▶ These are generally grouped into a single category of “area imperfections”
- ▶ Most are not cause for rejection unless they impair the performance of the part
- ▶ None are remarkably well covered by any of the surface imperfection standards



# Area Imperfections are not well covered by any of the standards

- ▶ MIL-PRF-13830B is a little ambiguous about gray and stain
  - Clear guidance in the body of the standard “no evidence of gray or stain is allowed” if it is visible using the standard light box
  - Appendix B, Mirrors: no blemishes that adversely affect the field of view as seen with the eye in the specified viewing condition
  - Appendix C, Anti-reflection coatings: visual discolorations, smears, streaks, stains or cloudiness allowed if it does not affect transmission, reflection, or adhesion of the coating
- ▶ The ANSI standard is clearer, but not in a good way
  - “specified in individual notes for the surface”
  - Gray or stain allowed if it does not “interfere with the performance of the surface or entire component”
- ▶ The ISO standard doesn’t say anything at all about area imperfections



# Edge Imperfections are not treated well in the ISO standard

- ▶ ISO E 0.5 – edge chips allowed
  - must be less than 0.5 mm
- ▶ ANSI:
- ▶ Edge Chips are OK, if:
  - Don't enter CA
  - All chips  $> 0.5$  mm in any direction are stoned; area of all stoned chips  $< 2\%$  of surface area
  - Sum of all chip widths wider than 0.5mm are less than 30% of perimeter length
  - Edge chips on a rim face  $< 2$  mm deep, or 5% of part diameter, and area  $< 2\%$  of surface area
- ▶ Edge Separations ( $> 0.5$  mm wide)
  - Cannot intrude  $> 1$  mm, or half way from chamfer to CA
  - Sum of diameters of edge separations  $< 10\%$  of perimeter
- ▶ Default rim edge chamfer: 0.5 mm for surface angles less than 135 degrees

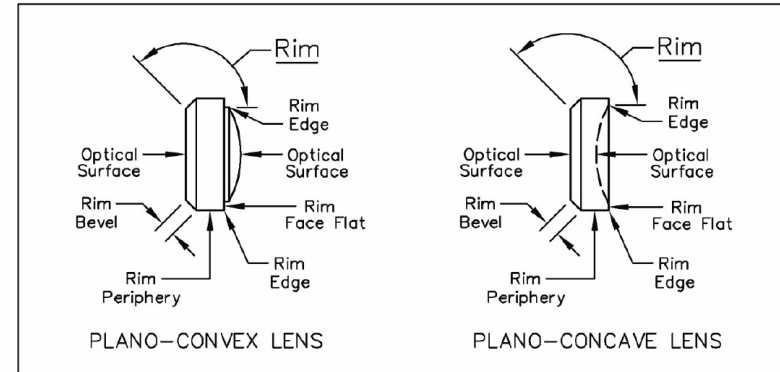


Figure 2. Surfaces and Rim Edges of a Round Lens Element.



# Other differences between MIL, ANSI and ISO versions of the visibility specification

- ▶ How long is a scratch?
  - ISO – scratches shorter than 2 mm are considered digs
  - ANSI – scratches shorter than the maximum allowed dig diameter are digs
  - MIL – no clear guidance on short scratches
- ▶ Scratch concentration rule in MIL/ANSI only applies on scratch specifications of #20 or less
- ▶ In the MIL/ANSI, for dig specifications #10 or less, all digs must be separated by 1 mm
- ▶ Inspection setup is the same, but described differently
  - MIL uses wattage, ISO and ANSI use lux
- ▶ MIL standard has very ambiguous concentration language
  - Some think that all max-grade digs must be separated by 20 mm or more



## Other complications not currently covered well

- ▶ Sleeks are not covered by any of the standards
- ▶ Very small imperfections below #10 scratch and #5 dig must be specified using dimensional methods
- ▶ Diamond turning features are often interpreted as surface imperfections
  - Ogive error (dig – covered in ANSI)
  - Pullouts (digs)
  - Deep dwell artifacts (scratches)
- ▶ Plastic and molded optics
  - Plastic optics have severe sleek issues
  - Not covered (intentionally) in current standards
- ▶ Diffractive optics
  - Can't easily do visibility, dimensional or machine vision inspections



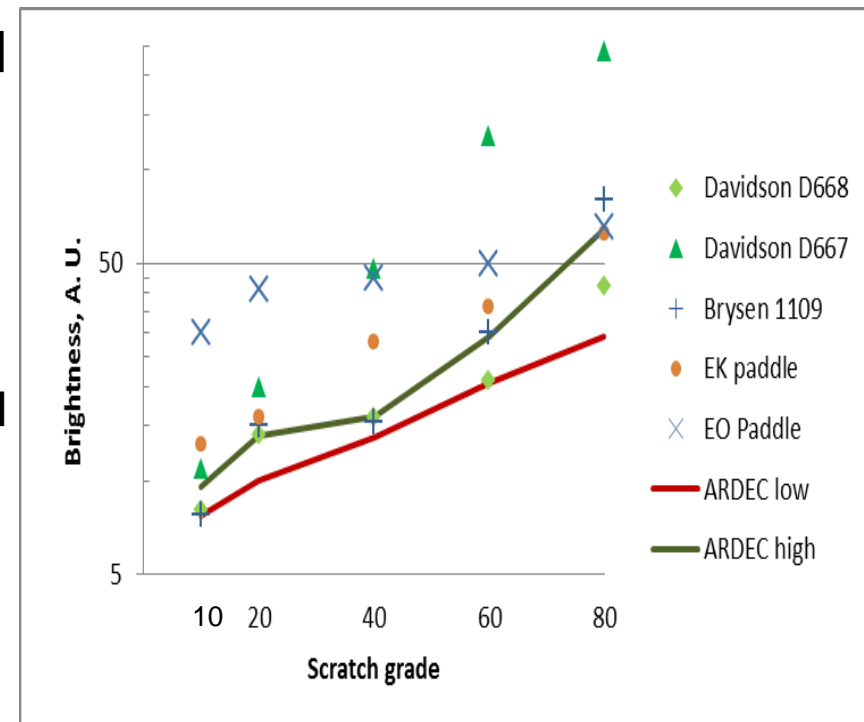
# My recommendation

- ▶ I think we need to revise OP1.002 to fix some of these deficiencies
- ▶ Clarify why the ANSI language is different from the MIL language
  - Accumulation and concentration rules
  - The visual cutoff rule
- ▶ Rectify missing imperfection rules
  - Sleeks
  - Area imperfections
  - Diamond Turning and Plastic optics imperfections
- ▶ Harmonize with the ISO visibility version
  - Scratch length limit
  - Scratch accumulation and Dig separation rules



# Availability of visibility comparison standards is a concern

- ▶ Both MIL-PRF-13830B and OP1.002 reference the same drawing, C7641866
  - Sets issued by the Army are “made” to this drawing
  - Davidson Optronics also offers D-668 comparison standards that are approved for military contracts
- ▶ ISO 10110-7 allows any comparison standard referenced on the drawing
- ▶ Other alternatives
  - Davidson D667
  - Brysen Optical, **now discontinued**
  - “Kodak” paddle, **now discontinued**
  - Jenoptik scratch and dig paddle
    - Was available from Edmund Optics and Thor Labs
    - **Now discontinued as well**





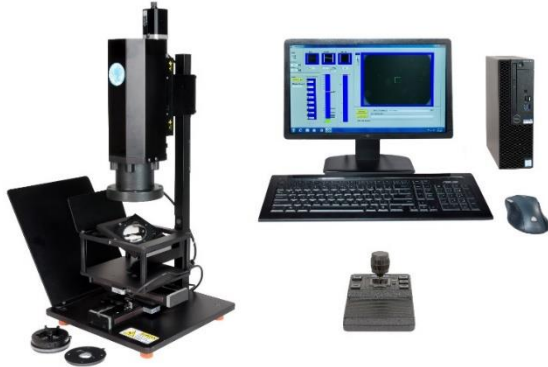
# SavvyInspector® project status

- ▶ More than 70 systems in the field now
  - Now distributed world-wide by TRIOPTICS GmbH
- ▶ Selling motorized flat inspection systems in 110x110, 200x200 and 200x410 mm versions
  - New optional automation features; autoscan, autoinspect, and autoreport
- ▶ Lens inspection systems sales are equal to flats systems in volume
  - Manual tip/tilt, with either manual or motorized x, y
- ▶ Now also offering a low-cost cleanroom compatible viewing station “black box” for ANSI and ISO inspections
  - Can add-on a “light bar” for Transmitted Method 1

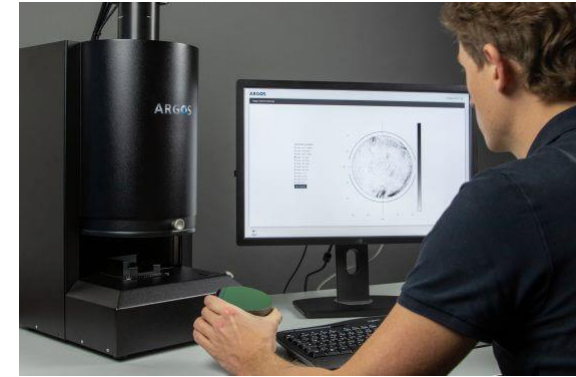




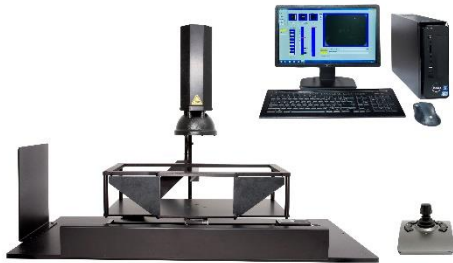
# SavvyInspector® SIF no longer the only game in town



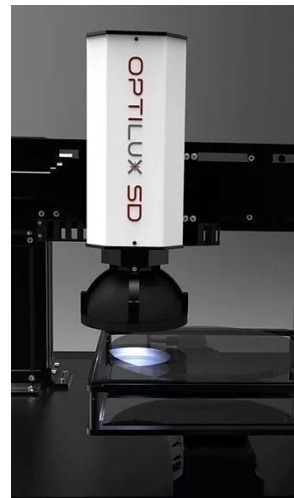
SIL-4 from Savvy Optics



ARGOS from Diotiq (DE)



SIF-16MA from Savvy Optics



Optilux from Redlux (UK)



OIS from Wavelength OE (SG)



# ISO TR for machine vision

- ▶ ISO DTR14997-2 for machine vision of surface imperfections should be published this year
- ▶ Daniel Keifhaber and I are co-leaders
- ▶ DTR out for ballot now