Procedure for surface quality testing of scanning mirrors at goods receipt
CONFIDENTIAL

1 Comments

This document describes the procedure for inspection and evaluation of an optical surface. This procedure is based on subjective comparison of the visibility of surface defects with a comparison standard. The document on hand follows the current MIL and ISO-Norms where possible.

The specification of surface defect visibility is regulated by MIL-PRF-13830B („scratch-dig") and DIN ISO 10110-7: 2018-05. The test methods are described in MIL-PRF-13830B and DIN ISO 14997: 2018-05, respectively.

As stressed by the current ISO-Norm, the test procedure by visual comparison of the defect with a master is subjective. It is to be expected that two inspectors will sometimes come to different assessments. The functional specifications of a scan system are valid independently from the assessment of surface defects.

2 Test setup and inspection tools

Similar to the above mentioned ISO and MIL norms, the following test setup for assessment of defect visibility is recommended:

1. The test object should be inspected in front of a diffuse, non-reflecting black background. A black box or a room with black walls is recommended.
2. Diffuse illumination from a spatially extended light source should be used. The MIL norm recommends two 15 watt cool white fluorescent light tubes. Alternatively a cold light source can be used (e.g. Schott KL 1600 LED).
3. The eye needs to have a distance of 45 cm to the inspected defect. The inspecting person should not be blinded by the light source.
4. The Illuminance of the light source (at the test object) should depend on the environment lighting. Reasonable parameters are listed in the following table. The operation parameters for the cold light source "Schott KL 1600 LED" are listed as well. Please notice the illumination control setting.

Index:		Name	Date	Checked by	Date
0	Created	GVO	2020-03-20	MV	2020-03-20
1	Section 3 updated	GVO	2020-04-17	MV	2020-04-17
2	Section 3,0 updated	GVO	2020-07-01	MV	2020-07-07
3	Section 5 updated	MGO	2021-07-13	MV	2021-07-19

Description	Illuminance without test light source[lx]	Allowed illuminance at test object [lx]	Distance to test object for Schott KL 1600 LED, illumination control setting on 2 [cm]
Very dark surrounding	Very small	< 2800	> 6
Surrounding with standard room illumination	300-500	< 6000	> 4

5. The rating of the surface defect is achieved by comparison with a reference standard. SCANLAB uses the reference standard „SDPK" from Thorlabs. The specifications using this reference standard are given in chapter 3.

Unfortunately, the "SDPK" reference standard has been discontinued and is no longer available. A potential alternative is reference D-668 provided by Davidson Optronics. SCANLAB has evaluated the comparability of the two reference standards within a survey. The results are:

   a. Comparability of scratch reference standards

   The D-668 reference samples S20 and S40 are of similar visual brightness and their brightness is evaluated to be below the S40 reference sample of the „SDPK" standard. These findings are in compliance with published results of brightness measurements using a Savvy Optics scatterometer [1].

   In order to test for a consistent level of "Scratch 40" quality using either reference standard, SCANLAB specifies to use the Davidson Optronics D-668 as follows: The D-668 reference sample S60 serves as a reject reference sample for scratches. This means that scratches having the same or higher visual brightness than the D-668 S60 reference scratch are rejected, whereas all scratches showing less visual brightness than the D-668 S60 reference sample lie within the permissible range. For example, a scratch with brightness higher than the D-668 S40 reference but lower than the D-668 S60 reference is within the permissible range.

   b. Comparability of dig reference standards

   Both reference standards are determined to be fully compatible for dig evaluation. No change is necessary when using the Davidson Optronics D-668 as a dig reference standard.

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[1] Aikens, D. M., "Understanding Scratch and Dig Specifications," Course Notes for SPIE SC700, Rev 10.9, 15-24, (2016).

3   Specification

The following table summarizes the specifications for the test area of the scanning mirrors referring to the Thorlabs SDPK standard:

Scratch max. class	40
Dig max. class	20

Surface quality compliance criteria for the specified test area:
- Surfaces should not have scratches or digs beyond the max. class
- The combined length of max. class scratches should not exceed 1/4 of 0,9*w. w is the mirror width as defined in the drawing
- The number N_d of max. class digs should not exceed N_d = Round_Up[0.9*w / (5 mm)]
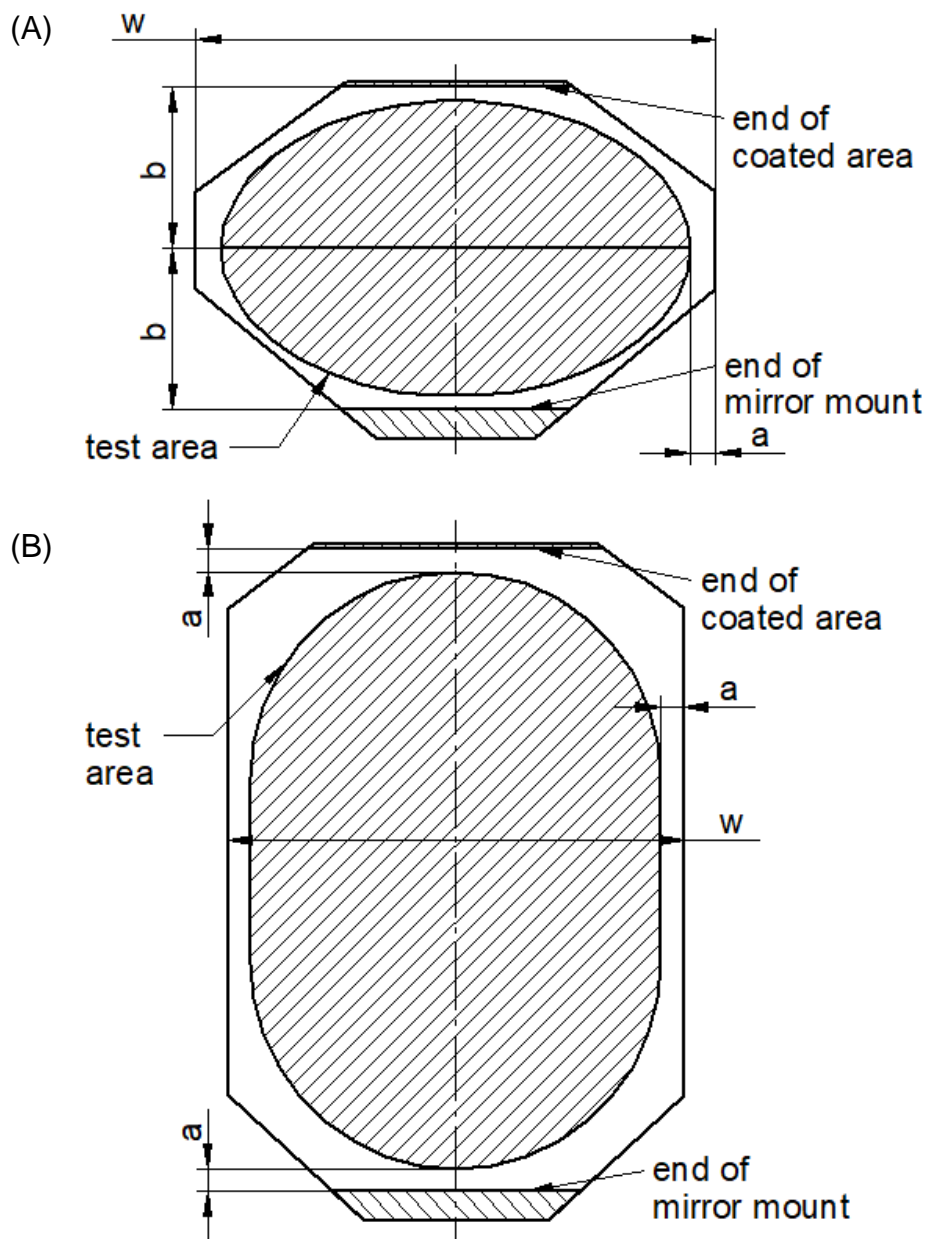
General definition of the test area:

Figure 1: General definition of test areas on scan mirrors; (A): 1st scan axis; (B): 2nd scan axis (schematic drawings, actual shape of mirrors might differ)

Axis 1:	Axis 2:
Elliptical test area with:	Stadium-like test area with:
Major axis = 90 % of mirror width w	Circle diameter = 90 % of mirror width w
Distance a = 5 % of mirror width w	Distance a = 5 % of mirror width w
Minor axis = Aperture diameter	

4 Possibility of future changes

At SCANLAB, the procedure of surface defect specification and testing is in the status of revision. The ISO standard describes two types of defect specifications: by visibility and by geometric size. As described above, the current surface quality specification is based on the visibility type. This allows for quick inspections and flexible testing setups. However, it is subjective in nature. For cases where this subjective evaluation does not lead to a mutual consent, SCANLAB plans to establish an additional specification of the geometric size type, since this can be evaluated in an objective manner if suitable measurement equipment is used. The specification values are not yet defined.