INTERNATIONAL STANDARD

ISO 9867

Third edition
2022-10

Textiles — Evaluation of the wrinkle recovery of fabrics — Appearance method

Textiles — Évaluation de la défroissabilité des étoffes — Méthode d'évaluation de l'aspect

Reference number
ISO 9867:2022(E)

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Published in Switzerland

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 38, *Textiles*, Subcommittee SC 2, *Cleansing, finishing and water resistance tests.*

This third edition cancels and replaces the second edition (ISO 9867:2009), which has been technically revised.

The main changes are as follows:

— Clause 3, Terms and definitions, has been added and subsequent clauses have been renumbered;

— requirements for “Wrinkle tester” has been added in 5.1 (former 4.1);

— Figure 1 has been improved;

— a “timer” has been added in the list of apparatus in Clause 5 (former Clause 4);

— the requirements of atmospheres for preconditioning, conditioning and testing have been revised;

— addition of “If the rating appears between two ratings, intermediate rating can be used in increments of a half for a rating (for example, No. 3,5).” in 9.4 (Former 8.4);

— the description of wrinkle rating has been added in Table 1;

— the annex on the “Summary of an international interlaboratory study on wrinkle recovery of fabrics” has been deleted and the former Annex B has been relabelled as Annex A.

Any feedback or questions on this document should be directed to the user’s national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Textiles — Evaluation of the wrinkle recovery of fabrics — Appearance method

1 Scope

This document specifies a method for evaluating the appearance of textile fabrics after induced wrinkling.

This document is applicable to all kinds of textile fabrics.

NOTE A digital description of the ISO wrinkle replicas is given in Annex A.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 105-A03, *Textiles — Tests for colour fastness — Part A03: Grey scale for assessing staining*

ISO 139, *Textiles — Standard atmospheres for conditioning and testing*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
wrinkle recovery
property of a fabric which enables it to recover from wrinkling deformations

4 Principle

A test specimen is wrinkled under a specified atmospheric condition in a wrinkling device under a pre-determined load for a prescribed period of time. After reconditioned, the test specimen is evaluated for appearance by comparison with three-dimensional wrinkle recovery replicas or wrinkle rating description.

5 Apparatus and materials

5.1 Wrinkle tester (see Figure 1), consisting of the following parts:

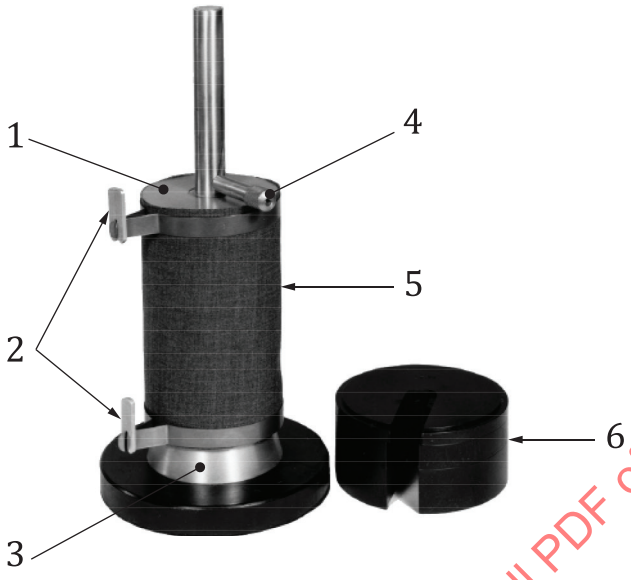
a) a circular top flange and a circular bottom flange, with the diameter of (89,0 ± 0,5) mm, and the distance of (110 ± 1) mm between the initial position of the top flange and the bottom flange to ensure that the top flange can rotate (180 ± 1)° while moving down to the bottom. The mass of the top flange is approximately 500 g;

b) a weight-piece, with a mass of 3 500 g;

c) specimen clamps, for holding the test specimen;

d) locking pin, for fixing the top flange in the initial position.

NOTE Equivalent devices can be used if they can be shown to lead to the same results.



Key

1 top flange
2 specimen clamps
3 bottom flange
4 locking pin
5 test specimen
6 weight-piece

Figure 1 — Wrinkle tester

5.2 Three-dimensional wrinkle recovery replicas (see Figure 2).

5.3 Lighting and evaluation area, in a darkened room, using the overhead lighting arrangement illustrated in Figure 3 and comprising the items described in the following list. The lamp dimensions should be chosen to extend beyond the overall surface of the test specimen and replicas, when used for the assessment.

a) **Two cool white (CW) fluorescent lamps**, without a baffle or glass, a minimum of 2 m in length each, placed side by side.

b) **One white enamel reflector**, without a baffle or glass.

c) **One thick plywood viewing board**, painted grey to match the Grade 2 on the grey scale for assessing staining in accordance with ISO 105-A03.

5.4 Clothes hangers with clips, to hang test specimens for conditioning and grading.

5.5 Timer, with an accuracy of 0,2 s.

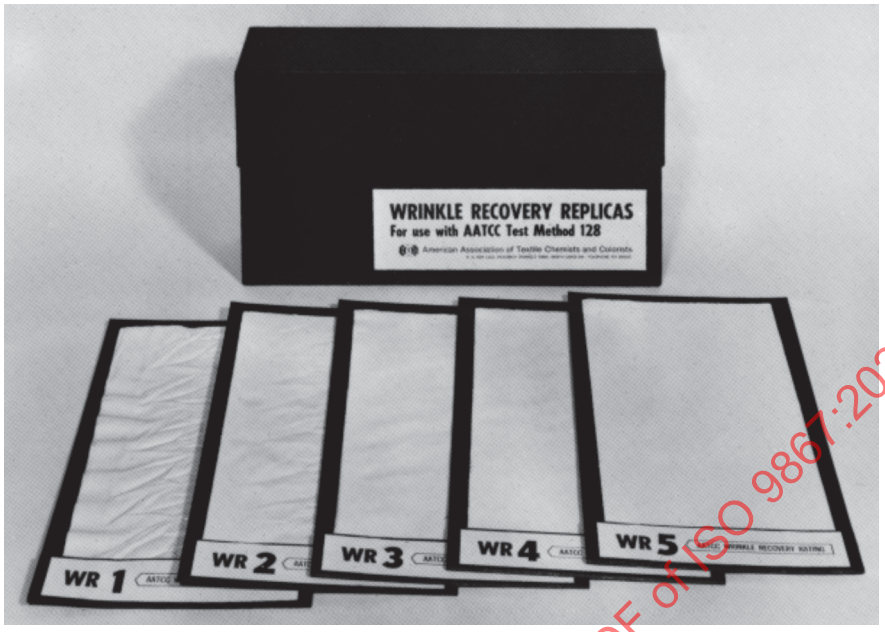
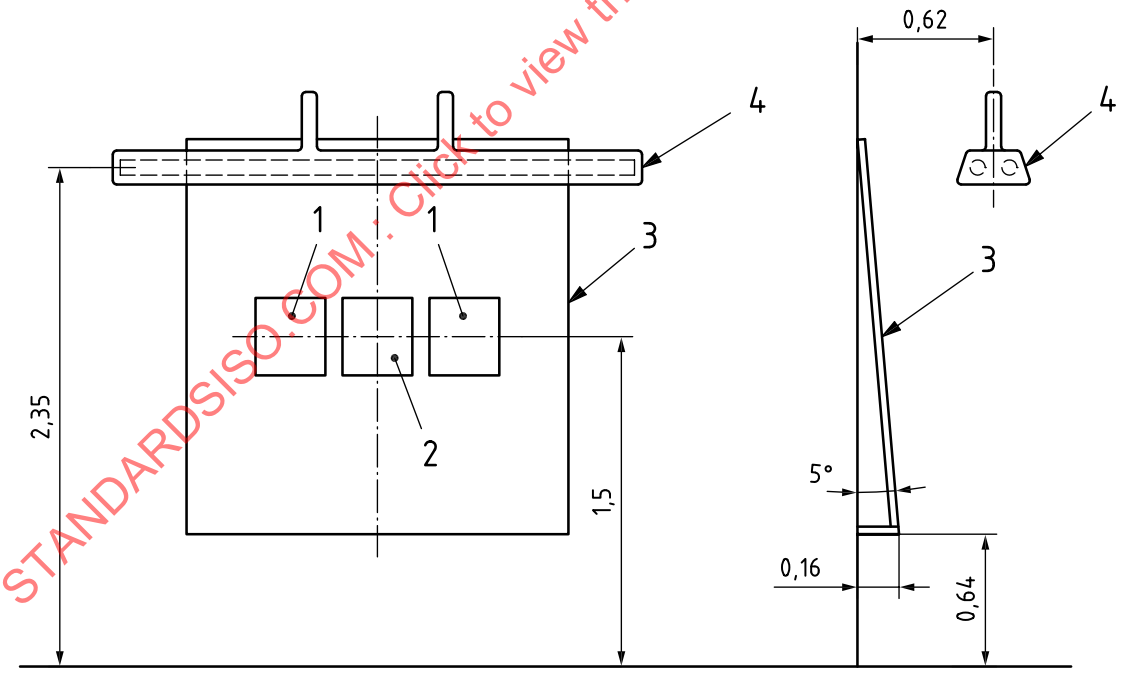


Figure 2 — Wrinkle recovery replicas

Dimensions in metres



Key

1 replica
2 test specimen
3 board for viewing
4 example of fluorescent lamp placement

Figure 3 — Lighting equipment for viewing test specimens

6 Atmospheres for conditioning, testing and evaluation

The atmospheres for preconditioning, conditioning, testing and evaluation shall be as specified in ISO 139.

7 Test specimens

7.1 Preparation

The test specimens shall be taken not less than 150 mm from the fabric selvedge. No test specimens are taken from the same longitudinal or transverse direction.

Cut three test specimens from the fabric to be tested, each measuring 150 mm × 280 mm, and each with the long dimension parallel to the warp direction (woven fabric), or the wale direction (knitted fabric), or the direction marked "length" (nonwoven fabric). Identify each specimen along one edge of the face side.

Cut the test specimens from an area of the fabric that is free from wrinkles. If any wrinkles are unavoidably present in the test specimens, press each test specimen lightly with a steam iron before conditioning.

7.2 Conditioning

Precondition and then condition the test specimens in accordance with ISO 139.

8 Procedure

8.1 Raise the top flange of the wrinkle tester (5.1) and hold it in the top position with the locking pin.

8.2 Wrap one long edge (i.e. the 280 mm side) of a preconditioned and conditioned test specimen (see 7.2) around the top flange of the wrinkle tester, with the face side of the test specimen on the outside, and clamp it in position using the steel spring and clamp provided. Arrange the ends of the test specimen so that they are opposite the opening in the spring clamp.

8.3 Wrap the opposite long edge of the test bspecimen around the bottom flange and clamp it as described in 8.2.

8.4 Adjust the test specimen by pulling on its bottom edge so that it lies smooth without sagging between the top and bottom flanges.

8.5 Withdraw the locking pin. The top flange is lowered gently to the bottom flange while horizontally rotating (180 ± 1)°.

8.6 Immediately place a weight-piece with the mass of 3 500 g on the top flange and record the time.

There can be differences in the weights supplied with different wrinkle testers. If necessary, add additional weights to the top flange to achieve a total mass of 3 500 g on the top flange.

8.7 After (20,0 ± 0,1) min, remove the weight-piece, the springs and the clamps. Raise the top flange and gently remove the test specimen from the wrinkle tester so as not to distort any induced wrinkles.

8.8 With a minimum of handling, place the shorter edge (i.e. the 150 mm side) under the clips on the clothes hanger (5.4) and allow the test specimen to hang vertically in the long direction.

8.9 After 24 h in the standard atmosphere (see Clause 6), gently remove the hanger with the specimen and transfer it to the evaluation area (5.3).

9 Evaluation

9.1 Three trained observers shall rate each test specimen independently.

Since previous tests have proven that specimens change in appearance during the first few hours, it is important that accurate times be observed and that a minimum time elapse while the three observers are evaluating the specimens. Because of these changing conditions, the duration of recovery before rating for this method has been standardized at 24 h.

9.2 Mount the test specimen on the viewing board [5.3 c)] as illustrated in Figure 3, with the warp, wale or marked "length" direction vertical. Place three-dimensional wrinkle recovery replicas (5.2), one on each side of the test specimen, to facilitate comparative rating. Mount replicas 1, 3 or 5 on the left side and 2 or 4 on the right side.

The overhead fluorescent light shall be the only light source for the viewing board, and all other lights in the room shall be turned off.

It has been the experience of many observers that light reflected from the side walls near the viewing board can interfere with the rating results. It is recommended that the side walls be painted black, or that blackout curtains be mounted on either side of the viewing board, to eliminate reflective interference.

9.3 The observer shall stand directly in front of the specimen, 1,20 m away from the bottom front of the board.

NOTE It has been found that normal variations in the height of the observer above and below the arbitrary 1,50 m eye level have no significant effect on the rating given.

9.4 Assign the number of the replica which most closely matches the appearance of the test specimen (see Table 1). If the rating appears between two ratings, intermediate rating can be used in increments of a half for a rating (for example, No. 3,5).

NOTE A No. 5 rating is equivalent to the WR-5 replica and represents the smoothest appearance and best retention of the original appearance. A No. 1 rating is equivalent to the WR-1 replica and represents the poorest appearance and poorest retention of the original appearance.

9.5 Similarly, the observer independently rates the other two test specimens. The other two observers proceed in the same manner, assigning ratings independently.

Table 1 — Fabric smoothness ratings

Rating No.	Fabric appearance
5	no change, equivalent to the WR-5 replica
4	slight wrinkles, equivalent to the WR-4 replica
3	clear wrinkles with no distinct wave, equivalent to the WR-3 replica
2	obvious wrinkles with distinct wave covering a large proportion of specimen surface, equivalent to the WR-2 replica
1	severe wrinkles with distinct wave covering the whole specimen surface, equivalent to or worse than the WR-1 replica

10 Expression of results

Calculate the average of the nine observations for each sample and express the results to the nearest half-rating.

11 Test report

The test report shall include the following information:

a) a reference to this document, i.e. ISO 9867:2022;

b) all details necessary for the identification of the sample tested;

c) the average of the nine observations made for each sample, to the nearest half-rating;

d) the conditioning atmosphere used for testing;

e) details of any deviation from the specified procedure;

f) date of the test.

Annex A
(informative)

Digital description of the ISO wrinkle replicas

A.1 General

This annex provides the digital description of 3-dimensional (3D) replicas. The data are not intended to be used to assess specimens. When assessing specimens, the 3D replicas are to be used.

A.2 Processes of measurement and analysis

A.2.1 A 3-dimensional scanning system was used to measure digital images of ISO wrinkle replicas as shown in Figure A.1. Specifications for the scanning system are given in Table A.1.

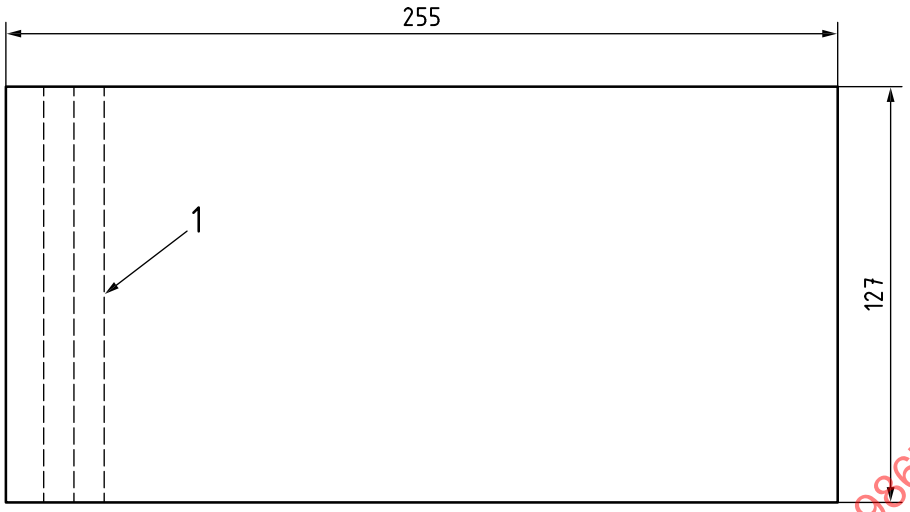
Figure A.1 — 3-Dimensional scanning system

Table A.1 — Specification of the 3-dimensional scanning system

Camera	1 024 × 768 pixels, black and white (B/W)
Special pattern	Structural beam by halogen lamp
Adjustment of focus	Using the laser-point light source
Measurement time	Approximately 70 s to 80 s
Resolution	±0,05 mm

A.2.2 The measuring area is shown in Figure A.2.

Dimensions in millimetres

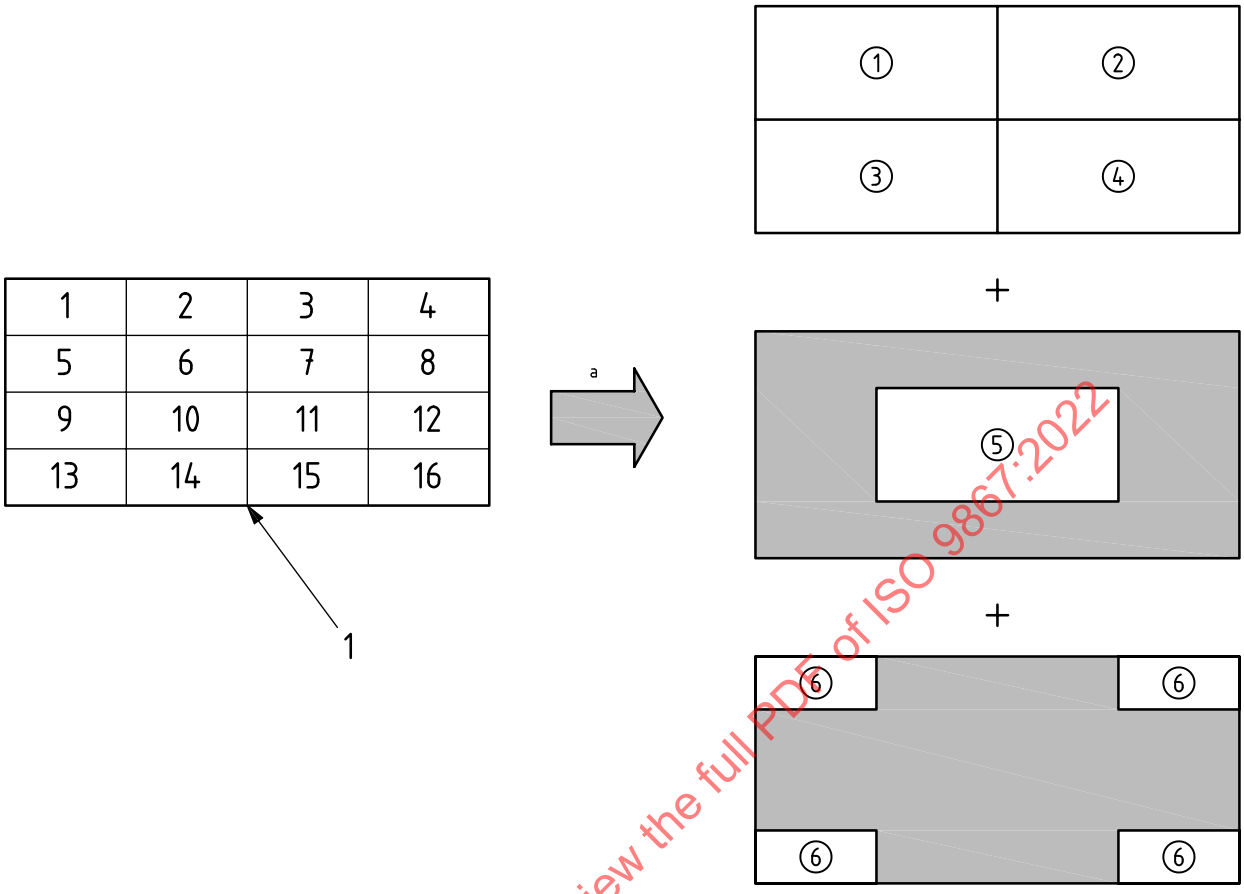


Key

1 measuring lines

Figure A.2 — Measuring area of wrinkle replica

A.2.3 The 3-dimensional measured images are separately stored as six regions to be divided intentionally for analysis. See Figure A.3.



Key

1 measuring area and number of sections

[a] 6 areas (① to ⑥).

Figure A.3 — Six regions for wrinkle replica analysis

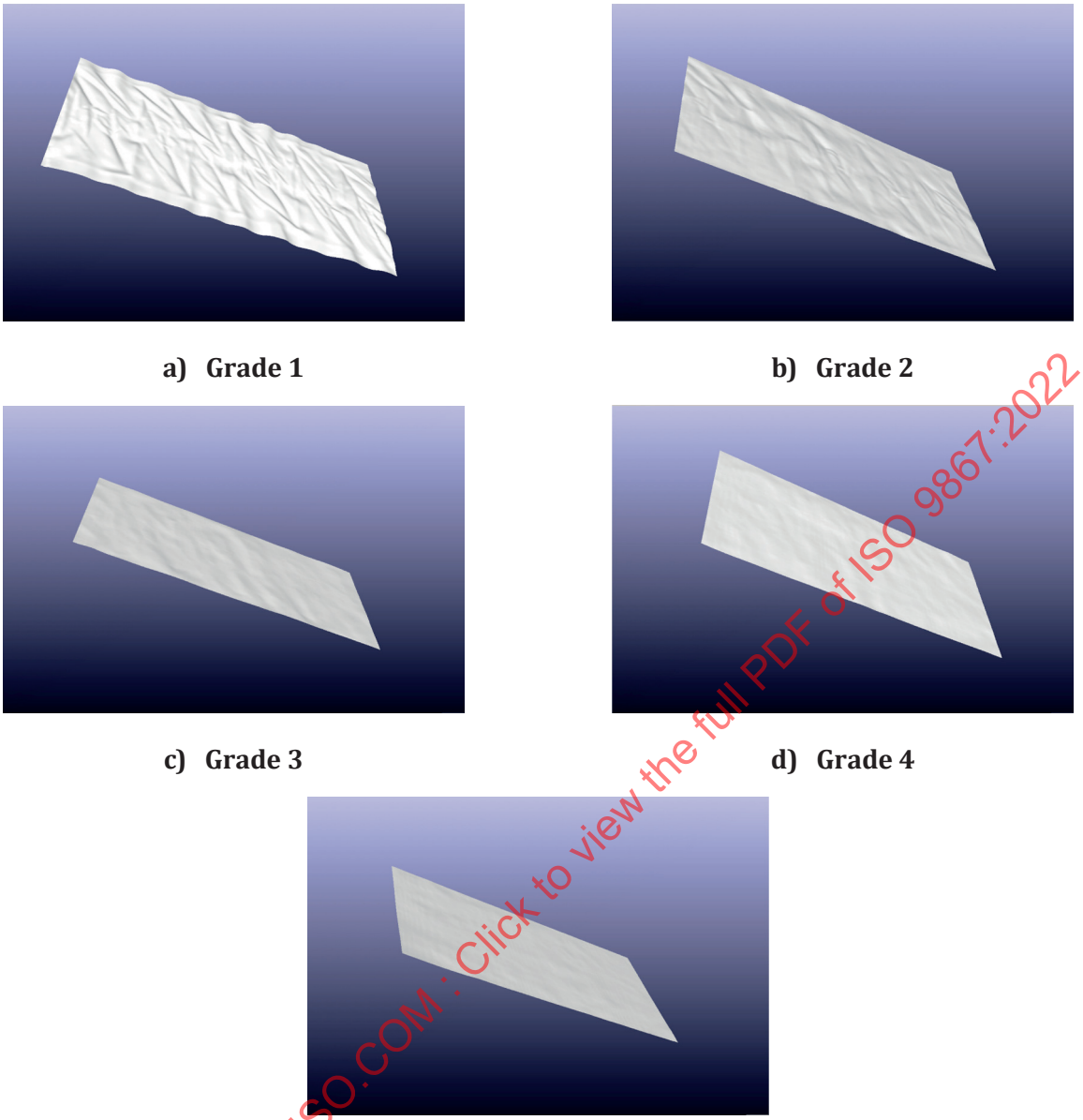
A.2.4 A geometric shape of each standard replica is measured using a 3-dimensional laser scanning system at an interval of 1 mm. The number of measuring points along each line is determined by the intervals.

To analyse the replicas, define six shape parameters that have an influence on the grade of replica. These parameters are mean values of heights, maximum values of heights, variation of heights, mean values of height frequency, maximum values of height frequency and variation of height frequency. For each region, six parameters can be obtained.

A.3 Analysis of wrinkle with 1 mm measurements

A.3.1 Measured images of wrinkle replicas

Figure A.4 shows measured images of wrinkle replicas using a 3-dimensional scanning system at intervals of 1 mm.



a) Grade 1

b) Grade 2

c) Grade 3

d) Grade 4

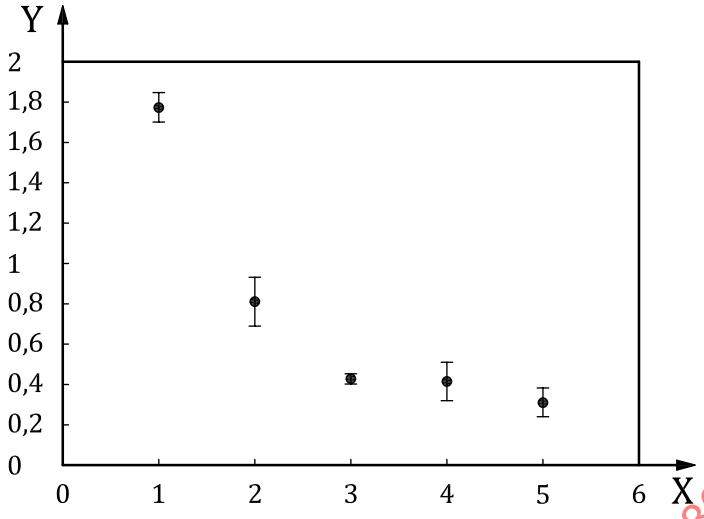
e) Grade 5

Figure A.4 — Measured images of wrinkle replicas

A.3.2 Analysis of parameters

A.3.2.1 Mean value of height ($\bar{h}$)

An analysis of variance (ANOVA) test and Tukey's method were performed to confirm differences in this parameter between grades. From the results of the ANOVA test, the difference in grades was confirmed at the 95 % confidence level. The results of Tukey's method indicated no significant differences between grades 3 and 4 and between grades 4 and 5. The parameter is transformed to a logarithmic form to minimize this actual state. The transformed parameter is also analysed with the ANOVA test and Tukey's method. While differences in the transformed parameter between grades are again confirmed at the 95 % confidence level in the ANOVA test, the difference between grades 3 and 4 remains unconfirmed in the same conditions in Tukey's method. Figure A.5 presents the relationship between wrinkle grade and original mean value of height. Figure A.6 shows the relationship between wrinkle grade and transformed mean value of height.

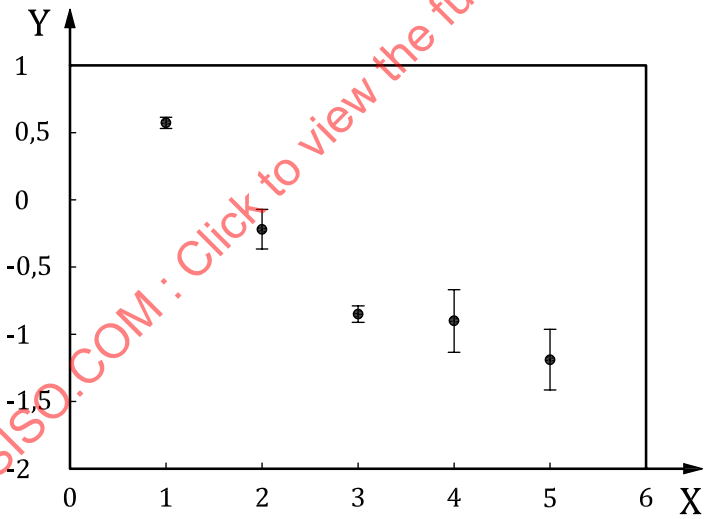


Key

X grade

Y $\bar{h}$

Figure A.5 — Relationship between grade and original $\bar{h}$



Key

X grade

Y $\ln(\bar{h})$

Figure A.6 — Relationship between grade and transformed $\bar{h}$

A simple regression analysis is performed to verify the apparent linear relationship between grades of replicas and both the original and transformed mean value of height. From the results of this analysis, the *R*-squared value of the original data rises from 74,10 % to 84,40 % with the logarithmic transformed data, as given in Table A.2.

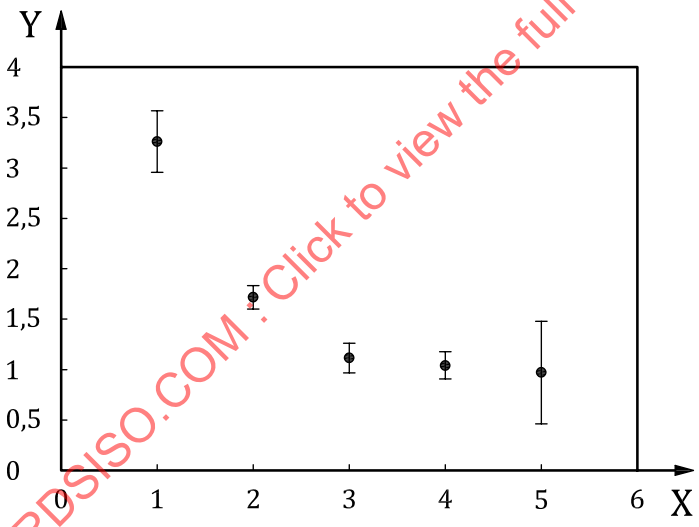
Table A.2 — Results of a simple regression analysis on $\bar{h}$

	Original data	Transformed data
Regression equation	Grade = 4,67 − 2,23 × $\bar{h}$	Grade = 1,96 − 2,01 × ln($\bar{h}$)
R-squared value	74,10 %	84,40 %

A.3.2.2 Maximum value of height (h_{max})

An ANOVA test and Tukey's method were performed to confirm any difference of this parameter between grades. While the difference was confirmed at the 95 % confidence level with the ANOVA test, grades 3 and 4, grades 3 and 5 and grades 4 and 5 were clearly not classified in a way comparable with Tukey's method. As with the mean value of height, the maximum value of height parameter was also transformed to a logarithmic form and analysed with the ANOVA test and Tukey's method. While the difference of the transformed maximum value of height between grades is confirmed at the 95 % confidence level in the ANOVA test, the differences between grades 3, 4 and 5 are still not confirmed at the 95 % confidence level with Tukey's method.

Figure A.7 shows the relationship between the wrinkle grade and the original maximum value of height. Figure A.8 shows the relationship between the wrinkle grade and the transformed maximum value of height.

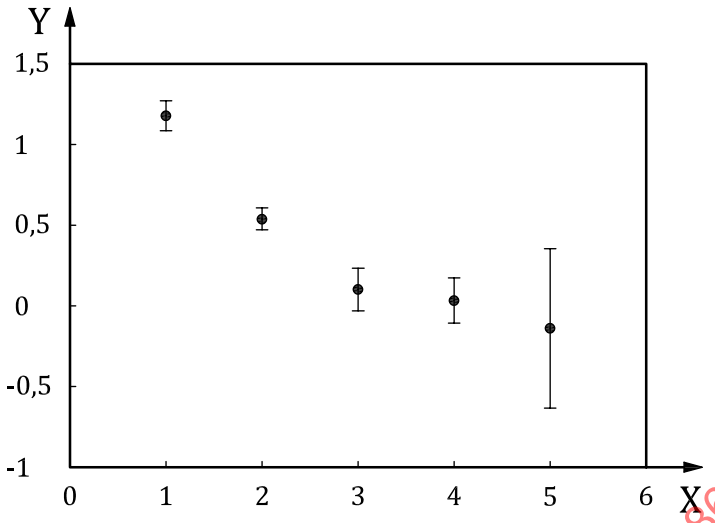


Key

X grade

Y h_{max}

Figure A.7 — Relationship between grade and original h_{max}



Key

X grade

Y $\ln(h_{max})$

Figure A.8 — Relationship between grade and transformed h_{max}

A simple regression analysis is performed to confirm the linear relationship between the grade of replicas and both the original and transformed maximum value of height. The results indicate that the *R*-squared value with the original data rises from 68,30 % to 72,00 % with the logarithmic transformed data, as given in Table A.3.

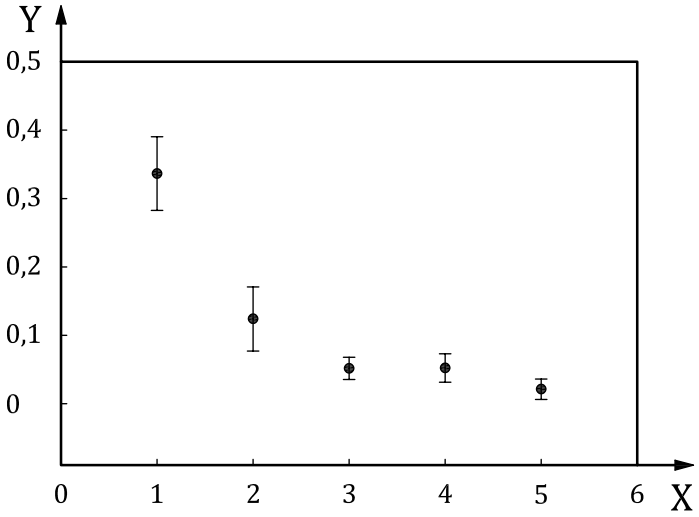
Table A.3 — Results of a simple regression analysis on h_{max}

	Original data	Transformed data
Regression equation	Grade = 5,10 − 1,30 × h_{max}	Grade = 3,79 − 2,29 × $\ln(h_{max})$
R-squared value	68,30 %	72,00 %

A.3.2.3 Variation of height (h_{var})

The ANOVA test and Tukey's method were performed to confirm differences in the variation of height between grades.

While the difference between grades is confirmed at the 95 % confidence level with the ANOVA test, the difference between grades 3 and 4 and grades 4 and 5 is not confirmed at the 95 % confidence level with Tukey's method, as was the case with the mean value of height. Each value was also transformed to a logarithmic form, and similar analyses were conducted. While the ANOVA test with transformed data has results that are equivalent to the original data, the differences between grades 2 and 3 and grades 3 and 4 are still not confirmed at the 95 % confidence level with Tukey's method for the transformed data. Figure A.9 shows the relationship between the wrinkle grade and the original variation of height. Figure A.10 shows the relationship between the wrinkle grade and the transformed variation of height.

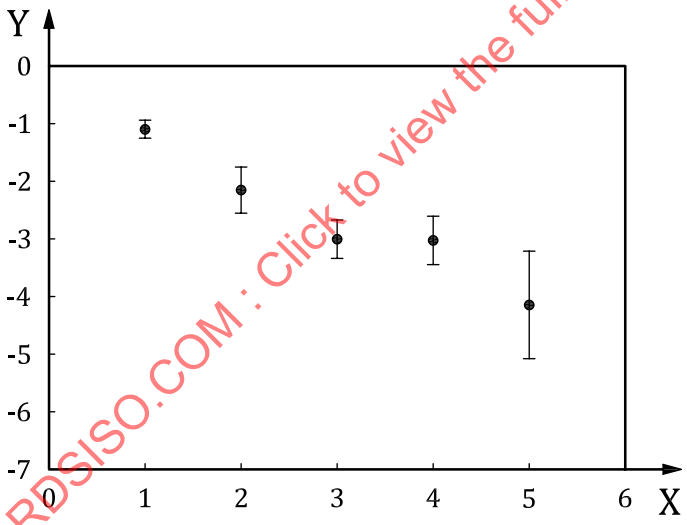


Key

X grade

Y h_{var}

Figure A.9 — Relationship between grade and original h_{var}



Key

X grade

Y $\ln(h_{var})$

Figure A.10 — Relationship between grade and transformed h_{var}

Both the original and transformed data were again analysed using simple regression analysis to verify the linear relationship between both grades and the variation of height. From the results, the *R*-squared value with the original data rises from 69,90 % to 77,40 % with the logarithmic transformed data, as given in Table A.4.

Table A.4 — Results of a simple regression analysis on h_{var}

	Original data	Transformed data
Regression equation	Grade = 4,16 – 9,90 × h_{var}	Grade = 0,017 – 1,11 × $\ln(h_{var})$
R-squared value	69,60 %	77,40 %

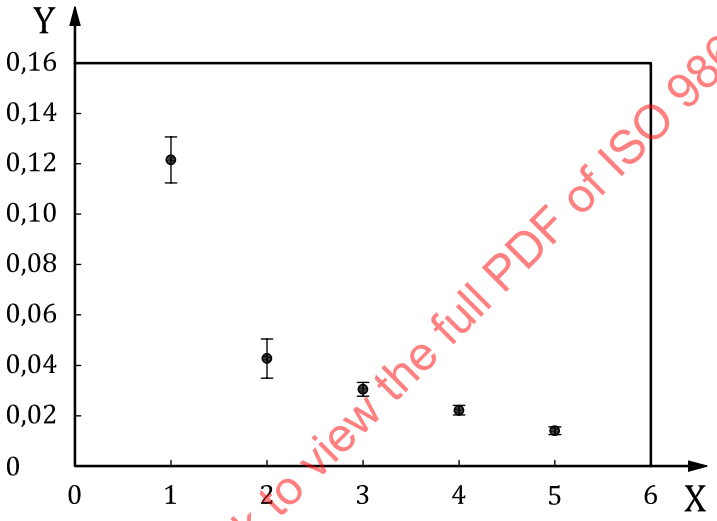
A.3.2.4 Mean value of height frequency ($d\bar{h}$)

The ANOVA test and Tukey's method were performed to confirm differences in the mean value of height frequency between grades.

While the difference between grades was confirmed at the 95 % confidence level with the ANOVA test, grades 3 and 4 and grades 4 and 5 are not classified at the 95 % confidence level with Tukey's method.

Each value was also transformed to its natural logarithmic form, and similar analyses were performed.

With the ANOVA test and Tukey's method, all grades with transformed data are clearly distinguished at the 95 % confidence level. Figure A.11 shows the relationship between the wrinkle grade and the original mean value of height frequency. Figure A.12 shows the relationship between the wrinkle grade and the transformed mean value of height frequency.

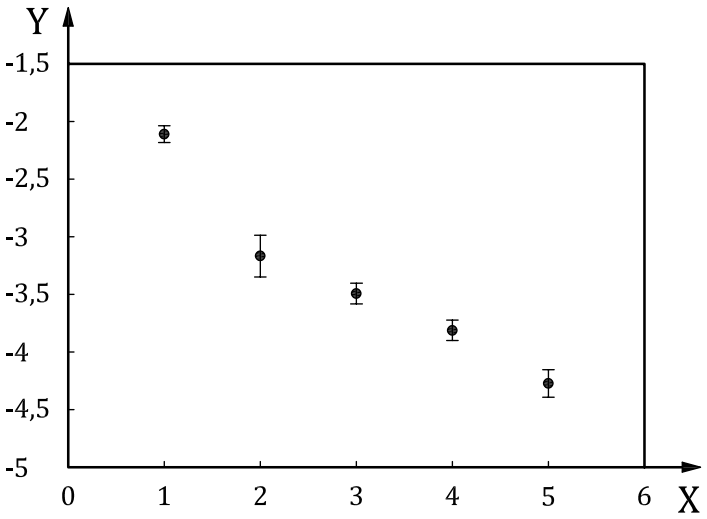


Key

X grade

Y $d\bar{h}$

Figure A.11 — Relationship between grade and original $d\bar{h}$



Key

X grade

Y $\ln(\mathrm{d}\bar{h})$

Figure A.12 — Relationship between grade and transformed $\mathrm{d}\bar{h}$

Both the original and transformed data were analysed with the simple regression analysis to verify the linear relationship between grades and the mean value of height frequency of both the original and transformed data.

From the results of this analysis, the *R*-squared value with the original data increases from 72,20 % to 91,10 % with the transformed data, as given in Table A.5.

Table A.5 — Results of a simple regression analysis on $\mathrm{d}\bar{h}$

	Original data	Transformed data
Regression equation	Grade = 4,42 − 30,70 × $\mathrm{d}\bar{h}$	Grade = −3,18 − 1,83 × $\ln(\mathrm{d}\bar{h})$
R-squared value	72,20 %	91,10 %

A.3.2.5 Maximum value of height frequency ($\mathrm{d}\bar{h}_{\max}$)

The ANOVA test and Tukey's method were performed to confirm the difference in the maximum value of height frequency between grades. While the difference between grades was confirmed at the 95 % confidence level with the ANOVA test, grades 3 and 4 and grades 4 and 5 are not distinguished at the 95 % confidence level with Tukey's method. Each value was transformed to a logarithmic form and an identical analysis was conducted.

While the difference between grades was confirmed at the 95 % confidence level with the ANOVA test, grades 3 and 4 were still not distinguished at the 95 % confidence level with Tukey's method.

Figure A.13 shows the relationship between the wrinkle grade and the original maximum value of height frequency. Figure A.14 shows the relationship between the wrinkle grade and the transformed maximum value of height frequency.