Designation: D4510 – 05 (Reapproved 2009)

Standard Test Method for Counting Partial Cleavages in Wool and Other Animal Fibers[1]

This standard is issued under the fixed designation D4510; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method covers a procedure, using the microprojector, for the counting of partial cleavages in wool and other animal fibers.

1.2 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.3 *This standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]
D123 Terminology Relating to Textiles
D2258 Practice for Sampling Yarn for Testing
D2525 Practice for Sampling Wool for Moisture
D4845 Terminology Relating to Wool

2.2 *Other Document:*
Wool Products Labeling Act of 1983[3]

3. Terminology

3.1 For all terminology relating to D13.13, Wool and Wool Felt, refer to Terminology D4845.

3.1.1 The following terms are relevant to this standard: cashmere, coarse hair, cashmere coarse hair content, cashmere down, cashmere hair.

3.2 For all other terminology related to textiles, see Terminology D123.

4. Summary of Test Method

4.1 This test method describes a procedure:

4.1.1 The segmenting of various test specimens in preparation for testing,

4.1.2 The projection on a screen of magnified images of the randomly sampled short segments of fiber from the small test specimens, and

4.1.3 The measurement of the number of partially cleaved fibers.

5. Significance and Use

5.1 Test Method D4510 for the counting of partial cleavages, may be used for the acceptance testing of commercial shipments of wool and other animal fibers, but caution is advised, since information on between-laboratory precision is limited. Comparative tests as directed in 5.1.1 may be advisable.

5.1.1 In case of a dispute arising from differences in reported test results when using this test method for acceptance testing of commercial shipments, the purchaser and the supplier should conduct comparative tests to determine if there is a statistical bias between their laboratories. Competent statistical assistance is recommended for the investigation of bias. As a minimum, the two parties should take a group of test specimens that are as homogeneous as possible and that are from a lot of material of the type in question. The test specimens should then be randomly assigned in equal numbers to each laboratory for testing. The average results from the two laboratories should be compared using Students t-test for unpaired data and an acceptable probability level chosen by the two parties before the testing is begun. If a bias is found, either its cause must be found and corrected or the purchaser and the supplier must agree to interpret future test results in the light of the known bias.

5.2 Chemically damaged or tendered fibers are recognizable microscopically by qualified operators and should not be counted as partial cleavages. Such fibers exhibit total loss of cuticle, severe surface erosion, tenderizing cracks, longitudinal fibrillation, or a combination of these features (see Figs. 1 and 2). In a study of deliberately over-carbonized wool at one laboratory, it was found that when more than 24 tendered fibers

[1] This test method is under the jurisdiction of ASTM Committee D13 on Textiles and is the direct responsibility of Subcommittee D13.13 on Wool and Felt.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Act of Congress, "Wool Products Labeling Act of 1939," 76th Congress, Third Session, approved October 14, 1939.

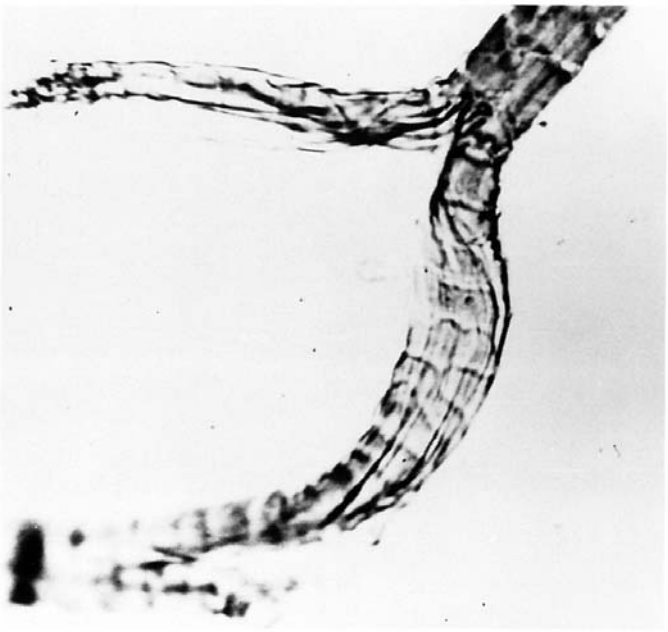
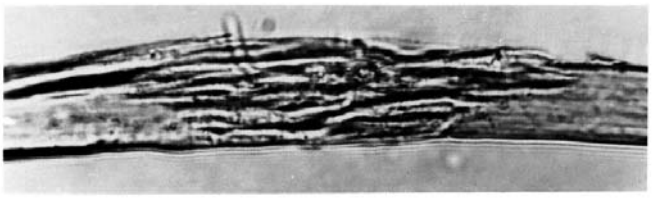
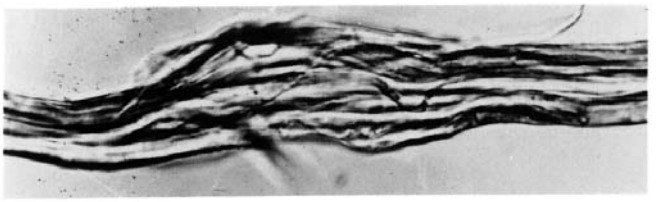


FIG. 1 (A) Partial Cleavage—But do not count if it is at the end of a fiber. The split may have been caused by other means



SPLIT FIBER



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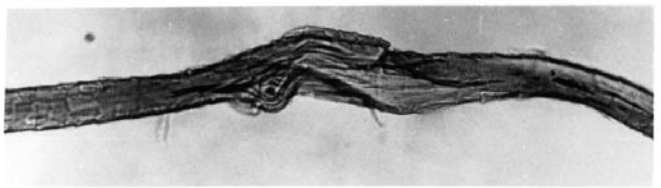


SPLIT FIBER

FIG. 1 (B–D) Split Fiber *(continued)*

were seen in 1 m, partial cleavage counts were significantly higher than on similar fibers that were not overcarbonized.

6. Apparatus and Material

6.1 *Microprojector*[4]—The microscope shall be equipped with a fixed body tube, a focusable stage responsive to coarse and fine adjustments, a focusable substage with condenser and iris diaphragm, and a vertically installed adequate light source to give a precise magnification of 500×, that is, a 12.5 × eyepiece and a 21 × 0.50 numerical aperture objective.

6.2 *Stage Micrometer*[5]—calibrated in intervals of 0.01 mm for accurate setting and control of the magnification.

6.3 *Fiber-Sectioning Apparatus:*

6.3.1 *Heavy-Duty Sectioning Device*[6,7]— An instrument comprised of a metal plate with a slot and compressing key and equipped with a propulsion mechanism by which the fiber bundle may be extruded for sectioning. The instrument is designed to hold a sliver of top or equivalent bulk of fibers, or yarn. (Fig. 3)

6.3.2 *Safety Razor Blades*—Single-edge or double-edge blades (if used with blade holder).

6.3.3 *FRL Fiber Cutter*[8]—A device comprised of two razor blades, a threaded pin and an assemblage that will hold the blades rigidly in position. The device, which is operated by applying pressure vertically downward, cuts fibers approximately 250 µm in length (Fig. 3).

6.4 *Microscope Slides,* 25 by 75 mm (1 by 3 in.).

6.5 *Cover Glasses,* No. 1 thickness, 22 by 50 mm (⅞ by 2 in.).

6.6 *Mounting Medium*[9]—Colorless immersion oil with a refractive index of 1.480 ± 0.005 at 20°C (68°F), and a viscosity of 78.81 SUS at 37.8°C (100°F).

6.7 *Length Gage,* made of stiff, white paper 155 mm long, and having thin transverse lines inscribed on it 10 mm from each end, so that the distance between the lines shall be 135.0 ± 2.5 mm. The length gage shall be of convenient width (for example, 30 mm). A satisfactory length gage may also be constructed of cardboard by inscribing thereon concentric circles having diameters of 135 mm and 155 mm. This length

[4] Available from R&B Instruments, Leeds Wortly Low Mills, 318 Whitehall Road, Leeds L512 4RJ England.

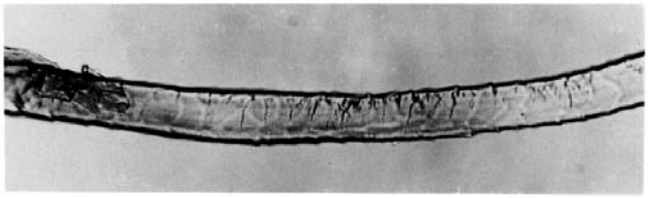
[5] Available from most scientific laboratory instrument supply companies.

[6] Available from Joe Opherkens, 426 Adams, Ogden, UT 84403.

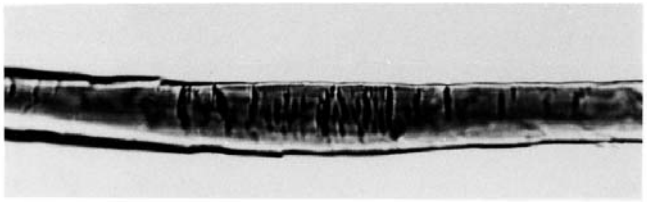
[7] Shirley Fibre Microtome available from Crosroe, Inc., P.O. Box 6408, Tower Drive, Greenville, SC 29606.

[8] Available from Albany International Research Co., 777 West St., P.O. Box 9114, Mansfield, MA 02048-9114.

[9] Available from Yocom-McColl Testing Laboratories, Inc.



FIBER WITH TRANSVERSE CRACKS



FIBER WITH TRANSVERSE CRACKS

FIG. 2 Fiber With Transverse Cracks

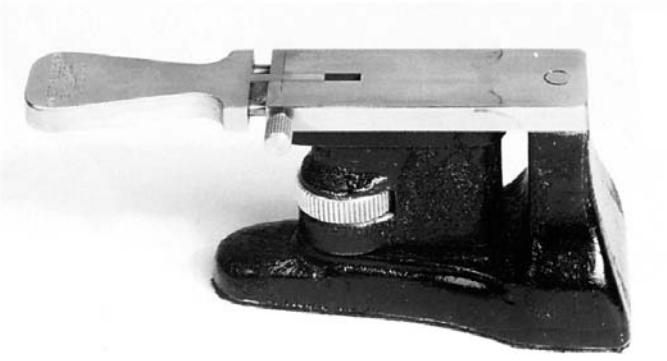


FIG. 3 Heavy Duty Cross-Section Device

gage has been found most suitable for the projected field of vision of the microprojector recommended with this length gage.

6.8 *Dissecting Needle.*

7. Sampling Bulk Wool

7.1 *Lot Sample for Bulk Wool*—As a lot sample for the acceptance testing of bulk wool, such as wool top, intermediate products, and rovings, take at random the number of shipping containers directed in an applicable material specification or in an agreement between the purchaser and supplier, such as an agreement to use Practice D2525. Consider shipping containers to be the primary sampling unit.

NOTE 1—An adequate specification or other agreement between the purchaser and the supplier requires taking into account the variability between shipping containers, within shipping containers, and between test specimens taken from a single laboratory sample so as to provide a sampling plan with a meaningful producers' risk, consumers' risk, acceptable quality level, and limiting quality level.

7.2 *Laboratory Sample for Bulk Wool*— Consider each unit in the lot sample as a unit in the laboratory sample.

7.3 *Test Specimens for Bulk Wool*—Take two test specimens from each unit in the laboratory sample as described in Practice D2525.

8. Sampling

8.1 *Wool Yarns:*

8.1.1 *Lot Sample for Wool Yarn*—As a lot sample for acceptance testing, take at random the number of shipping cases directed in an applicable material specification or other agreement between the purchaser and the supplier, such as an agreement to use Practice D2258. Consider shipping cases to be the primary sampling units. (Note 1)

8.1.2 *Laboratory Sample for Wool Yarn*— As a laboratory sample for acceptance testing, take at random from each shipping case in the lot sample the number of packages directed in an applicable material specification or other agreement to use Practice D2258. Preferably, the same number of packages should be taken from each shipping case in the sample. If differing numbers of packages are to be taken from shipping cases in the lot sample, determine at random which shipping cases are to have each number of packages drawn.

8.1.3 *Test Specimens for Wool Yarn*—From each package in the laboratory sample, take two test specimens as follows. Inspect each package after withdrawing at least five layers of yarn from the outside of the package. If there is visible evidence of damage to the package, continue to withdraw units of five layers and reinspect. Take specimens of about 1 m (1 yd.) long. Discard specimen lengths that are damaged. Discard at least 2 m (2 yds) of strand between specimens from a single package.

8.2 *Wool Fabric:*

8.2.1 *Lot Sample for Wool Fabric*—As a lot sample for acceptance testing, take at random the number of rolls of fabric directed in an applicable material specification or other agreement between the purchaser and the supplier. Consider rolls of fabric to be the primary sampling units. (Note 1)

8.2.2 *Laboratory Sample for Wool Fabric*— As a laboratory sample for acceptance testing, take a full width swatch approximately 1 meter (1 yd) long from the end of each roll of fabric in the lot sample, after first discarding all fabric from the outside of the roll that contains creases, fold marks, delamination, or disturbed weave.

8.2.3 *Test Specimens for Wool Fabric*— Cut two specimens from each swatch in the laboratory sample with each specimen between 230 mm (9.0 in.) square, with one side of the specimens parallel to the warp ends in the swatch, and with the specimens from a single swatch spaced along a diagonal line on the swatch so that each specimen will contain different warp ends and filling picks.

9. Calibration of Microprojector

9.1 Adjust the microprojector to produce a magnification of 500× in the plane of the projected image. Do this by placing a

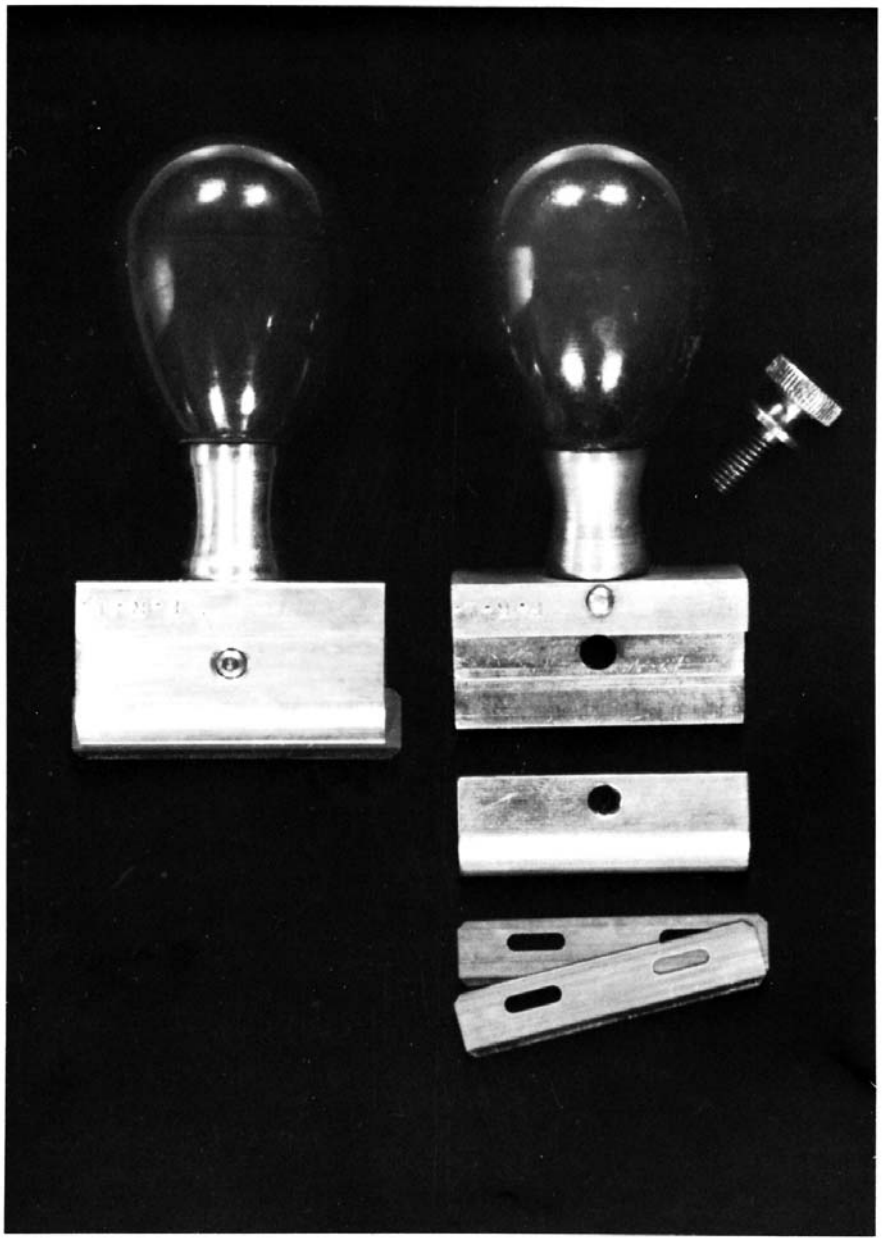


FIG. 4 FRL Fiber Cutter

stage micrometer on the stage of the microprojector and bringing the microscope into such adjustment that the lines of the micrometer are sharply focused in the center of the image plane. An interval of 0.20 mm on the stage micrometer will then measure 100 mm on the image plane, or 0.01 mm on the stage micrometer will measure 5 mm on the image plane. All measurements must be made with the specimen in a plane at the same distance from the stage as the lines on the stage micrometer.

10. Preparation of Slides by Use of Heavy-Duty Cross-Section Device

10.1 *Compacting Specimen:*

10.1.1 *Bulk Wool Specimen*—Draw small quantities of fiber at random, packing the slot to the required level; place the specimen in the slot of the metal plate, compress with the key, and secure with the set screw.

10.1.2 *Yarn Specimen*—Pack the assemblage of yarn pieces into the slot, compress and secure as directed in 10.1.1.

10.1.3 *Fabric Specimen*—Tease out and segregate the warp and filling yarns when of different or unknown composition. Pack the assemblage of warp or filling yarn pieces into the slot, compress, and secure as directed in 10.1.1. If it is known that warp and filling yarns are identical, then the undisturbed piece of fabric or the teased yarns of the fabric constitute the test specimen.

10.2 *Preliminary Sectioning of Specimen*— Cut off the gripped fibers at the upper and under surfaces of the plate. Extrude the fiber bundle about 0.50 mm to take up slack in the fibers and the propulsion mechanism. Moisten the projecting fibers with a few drops of mounting medium. With a sharp razor blade, cut off this projecting fiber bundle flush with the upper surface of the fiber-holding plate, and discard the section.

10.3 *Final Sectioning of Specimen*—Extrude the fiber bundle approximately 0.25 mm (250 µm). With the razor blade, cut off the projecting fibers flush with the plate, leaving the fiber pieces adhering to the razor blade.

10.4 *Mounting the Fibers on the Slide*— Place a few drops of mounting medium on a clean glass slide. With a dissecting needle, scrape the fiber pieces from the blade onto the slide. Thoroughly disperse the fibers in the oil with the dissecting needle (Fig. 4), and cover the specimen with a cover glass.

NOTE 2—Use sufficient oil in the preparation of the slide to ensure thorough distribution of the fibers, but an excess must be avoided, as practically no oil should be permitted to flow out or be squeezed out beyond the borders of the cover glass. If the number of fibers is too great to permit distribution on the slide, or if an excess of oil has been used, wipe away a portion of the mixture after thorough dispersion of the fibers.

NOTE 3—Fiber bundles may be extruded to other convenient lengths for use with other appropriate measuring length gages, as long as the interior distance of the length gage is between 200 and 300 µm on the projected image of the segment (see 6.7.).

11. Preparation of Slides by Use of the FRL Fiber Cutter

11.1 *Cutting Specimens:*

11.1.1 *Fabric*—Using the equipment described in 6.3.3, with the razor blades in alignment and firmly secured, force the blades vertically downward into the warp fringe close to the edge of the fabric. Repeat the operation for the filling yarns. If the warp and filling yarns are the same, the cut may be made diagonally, sectioning the warp and filling yarns of the fabric at the same time. Make a duplicate cut at the opposite side of the fabric. The individual cuts should include between 1500 and 2000 fibers, approximately 250 µm long.

11.1.2 *Yarns and Other Fiber Assemblies*— Cut the prepared woolen or worsted specimens with the pieces arrayed as a unit, or other specimens of yarn, roving and the like, in a manner similar to the procedure described in 10.1.1.

11.2 *Release of Cut Section*—Release the top plate of the device, then the blades, holding the ends between the thumb and the forefinger of one hand. By careful separation of the blades, the fiber sections will adhere to the edge of either blade.

11.3 *Mounting the Fibers on the Slide*— See 10.4.

12. Procedure for Counting Partial Cleavages with the Microprojector

12.1 Place the finished slide on the stage of the microprojector, the cover glass to be in the same orientation as stage micrometer. Scan only those fiber segments that touch or intercept a 100 mm target circle drawn on the surface on which the field is projected.

12.2 Place one end of the paper length gage at the leading end of the image of the fiber segment (in the direction the segment is being traversed), or at the bottom end if the segment is vertical in the field of vision. Examine the portion of the segment marked off by the chosen section of the length gage to determine if a partial cleavage is present. Use particular care to focus critically through the entire thickness of each segment so that a partial cleavage at any place on the circumference of a segment can be seen.

12.3 Do not utilize segments that are shorter than the chosen section of the length gage and do not count partial cleavages on such short segments. Do not utilize segments of any length that are clearly recognizable as having been severely damaged or tendered by bacterial, chemical, felting or other extraneous action (See 5.3 and Fig. 1, Fig. 2, Fig. 4, Fig. 5, Plate 14).

12.4 Count as partial cleavages only transverse damage. Do not record more than one partial cleavage per segment unless partial cleavages are separated by a distance of 25 mm or more along the segment length, as measured on the projected image of the segment.

12.5 Examine sufficient segments to constitute a total length of fiber of at least 1 m (3704 segments if a length gage of 135 mm is used).

12.6 Record the total number of eligible segments counted, including those bearing partial cleavages. Record separately the total number of partial cleavages counted.

13. Calculation

13.1 Calculate to the nearest whole number of partial cleavages per meter. If a length gage of 135 mm is used, calculate and record the length of fiber in meters, using Eq 1.

$$L = N/3704 \quad (1)$$

where:

L = length of fiber examined, m,
N = number of segments examined, and
3704 = the number of segments if a length gage of 135 mm is used (see 12.5). Calculate the average number of partial cleavages per meter using Eq 2.

$$A = S/L \quad (2)$$

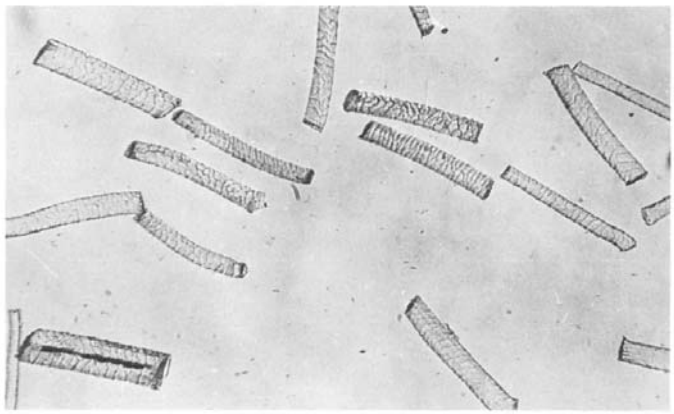
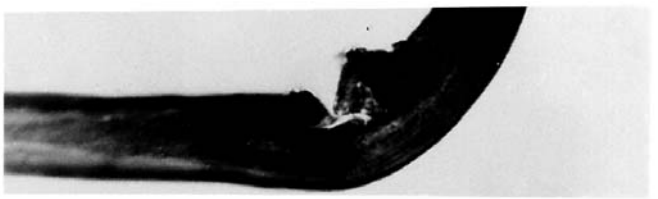
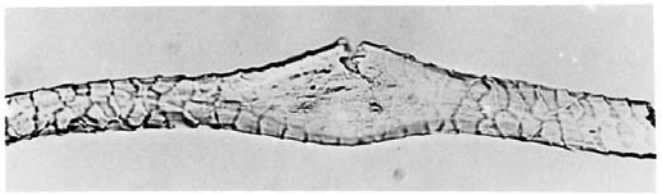


FIG. 5 Dispersion of Fibers on Slide

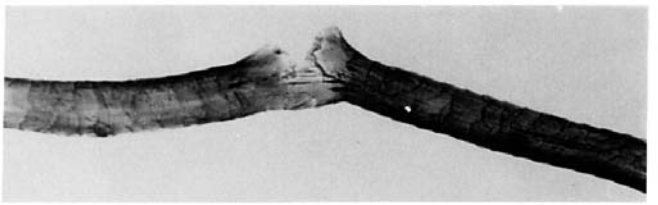
SEMI-RUPTURE : TOP VIEW



TYPICAL SEMI-RUPTURE



APPARENT SEMI-RUPTURE BUT DO NOT COUNT.
CAUSED BY CRACKING



TYPICAL SEMI-RUPTURE

FIG. 6 (A–B)—Semi-Rupture

where:

A = average number of partial cleavages per meter,
S = total number of partial cleavages observed, and
L = length of fiber examined, m.

13.2 If agreed upon by all parties concerned, results may be calculated on other bases, such as the percentage of partial cleavages present per 1000 segments.

14. Report

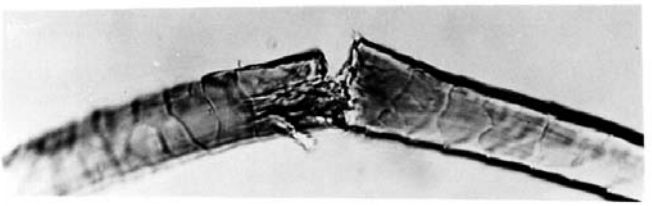
14.1 State that the specimens were tested as directed in Method D4510. Describe the material or product sampled and the method of sampling used.

14.2 Calculate to the nearest whole number the number of partial cleavages observed per meter of fiber length examined, or on other bases if agreed upon by all parties concerned.

15. Precision and Bias

15.1 *Intralaboratory Test Data*[7]—A within-laboratory test was run in 1969 at one laboratory in which samples of four materials were tested by two operators, each of whom performed three separate meter tests of each material. The components of variance for partial cleavage per meter results expressed as standard deviations were calculated to be:

Single − operator component − 5.0 counts per meter
Within − laboratory component − 3.6 counts per meter



TYPICAL SEMI-RUPTURE

FIG. 6 (C–E) *(continued)*

15.2 *Precision*—For the components of variance reported in 15.1, two averages of observed values should be considered significantly different at the 95 % probability level if the difference equals or exceeds the critical differences listed in Table 1.

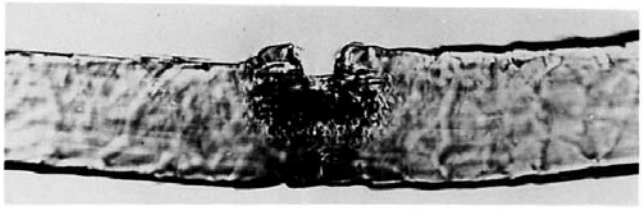
NOTE 4—The tabulated values of the critical differences should be considered to be a general statement. Before a meaningful statement can be made about two specific laboratories, the amount of statistical bias between them, if any, must be established, with each comparison being based on recent data obtained on randomized specimens from one sample of the material to be tested.

15.3 *Bias*—The procedure in this test method for counting partial cleavages in wool and other animal fibers has no known bias and may be used as a reference method.

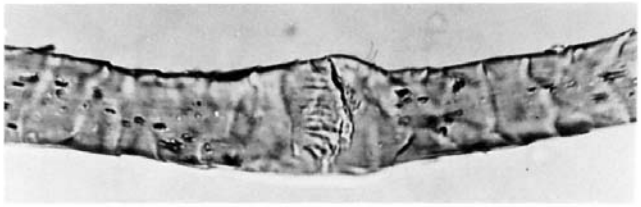
16. Keywords

16.1 animal fibers; damage; partial cleavages; wool

SEMI-RUPTURE AND DEVELOPING SPLIT



TYPICAL SEMI-RUPTURE



SEMI-RUPTURE: TOP VIEW

FIG. 6 (F–H) *(continued)*

TABLE 1 Critical Difference,[A] Counts per Meter for the Conditions Noted

Number of Observations in Each Average	Single-Operator Precision	Within-Laboratory Precision
1	11.6	14.3
3	6.71	10.7
6	4.75	9.63
10	3.68	9.15

[A] The critical differences were calculated using z = 1.960