Designation: D 4203 – 00

# Standard Specification for Styrene-Acrylonitrile (SAN) Injection and Extrusion Materials[1]

This standard is issued under the fixed designation D 4203; 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 specification covers unfilled, filled, and reinforced styrene acrylonitrile (SAN) materials suitable for injection molding and extrusion.

1.2 This specification is not intended for the selection of materials, but only as a means of calling out materials to be used in the manufacture of parts. Materials are to be selected by personnel with expertise in the plastics field where the economics, the environment to be encountered, the inherent properties of the materials, the part design, the part performance required, and the manufacturing process to be employed all enter into the selection.

1.3 The properties included in this specification are those required to identify the compositions covered. There may be other requirements necessary to identify particular characteristics important to specialized applications. These will be agreed upon between the user and the supplier, by using the suffixes specified in Section 7.

1.4 The values stated in SI units are to be regarded as the standard. The values in parentheses are given for information only (see IEEE/ASTM SI 10.)

1.5 The following precautionary caveat pertains only to the test methods portion, Section 15, of this specification: *This standard does not purport to address all of the safety concerns, 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.*

NOTE 1—Although this specification and ISO 4894/1 differ in approach or detail, data obtained using either are technically equivalent.

## 2. Referenced Documents

2.1 *ASTM Standards:*

D 256 Test Method for Determining the Pendulum Impact Resistance of Notched Specimens of Plastics[2]

D 618 Practice for Conditioning Plastics and Electrical Insulating Materials for Testing[2]

D 638 Test Method for Tensile Properties of Plastics[2]

D 648 Test Method for Deflection Temperature of Plastics Under Flexural Load[2]

D 790 Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials[2]

D 792 Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement[2]

D 883 Terminology Relating to Plastics[2]

D 1238 Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer[2]

D 1525 Test Method for Vicat Softening Temperature of Plastics[2]

D 1600 Terminology for Abbreviated Terms Relating to Plastics[2]

D 2584 Test Method for Ignition Loss of Cured Reinforced Resins[3]

D 3641 Practice for Injection Molding Test Specimens of Thermoplastic Molding and Extrusion Materials[3]

D 3892 Practice for Packaging/Packing of Plastics[3]

D 4000 Classification System for Specifying Plastic Materials[3]

E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications[4]

E 105 Practice for Probability Sampling of Materials[4]

IEEE/ASTM SI 10 Standard for Use of the International System of Units (SI): The Modern Metric System[5]

2.2 *ISO Standards:*[6]

ISO 75 Plastics and Ebonite—Determination of Temperature of Deflection Under Load

ISO 178 Plastics—Determination of Flexural Properties of Rigid Plastics

ISO 180/1A Plastics—Determination of Izod Impact Strength of Rigid Materials

ISO 294 Plastics—Injection Moulding Test Specimens of Thermoplastic Materials

[1] This specification is under the jurisdiction of ASTM Committee D20 on Plastics and is the direct responsibility of Subcommittee D20.15 on Thermoplastic Materials (Section D20.15.03).

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[2] *Annual Book of ASTM Standards*, Vol 08.01.

[3] *Annual Book of ASTM Standards*, Vol 08.02.

[4] *Annual Book of ASTM Standards*, Vol 14.02.

[5] *Annual Book of ASTM Standards*, Vol 14.04.

[6] Available from American National Standards Institute, 11 W. 42nd St., 13th Floor, New York, NY 10036.

***A Summary of Changes section appears at the end of this standard.**

ISO 306 Plastics—Determination of Vicat Softening Temperature of Thermoplastics
ISO 527 Plastics—Determination of Tensile Properties
ISO 1133 Plastics—Determination of the Melt Flow Rate of Thermoplastics
ISO 1183 Plastics—Methods for Determining the Density and Relative Density of Non-Cellular Plastics
ISO 4894/1 Plastics—Styrene/Acrylonitrile (SAN) Copolymer Molding and 4894/2 Extrusion Materials Part 1: Designation, Part 2: Determination of Properties

## 3. Terminology

3.1 *Definitions*—Definitions are in accordance with Terminology D 883 and abbreviations are in accordance with Terminology D 1600, unless otherwise indicated. The abbreviation for styrene-acrylonitrile plastics is SAN.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *lot*—a unit of manufacture; may consist of a blend of two or more production runs or batches of material.

## 4. Classification

4.1 SAN compounds are typically general-purpose materials used in either molding or extrusion processes and applications. There is currently no group, class, or grade distinctions and no basic property table given.

NOTE 2—Where no basic property table exists, the generic family designation will be followed by three zeros, for example: SAN000.

4.1.1 They are usually grouped as reinforced or unreinforced. Therefore, SAN materials are classified by Table A for reinforced materials and Table B for unreinforced materials. Specialty products such as antistatic, barrier, etc. would also utilize the suffix system described in Section 7.

**TABLE A SAN Compounds (Reinforced)**

| Designation Order Number | Property | Cell Limits | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 0 | 1 | 2 | 3 | 4 | 5 | 9 |
| 1 | AN Content, % AN, min | Unspecified | 10 | 20 | 30 | 40 | 50 | [A] |
| | (ISO, % AN, min) | (Unspecified) | (10) | (20) | (30) | (40) | (50) | [A] |
| 2 | Deflection temperature under load, ASTM D 648, °C, min[B] | Unspecified | 90 | 95 | 100 | 105 | 110 | [A] |
| | (ISO 75, °C, min) | (Unspecified) | (90) | (95) | (100) | (105) | (110) | [A] |
| 3 | Specific gravity, ASTM D 792, min | Unspecified | 1.1 | 1.2 | 1.4 | 1.6 | 1.8 | [A] |
| | (ISO 1183, min) | (Unspecified) | (1.1) | (1.2) | (1.4) | (1.6) | (1.8) | [A] |
| 4 | Tensile strength, ASTM D 638, MPa, min[B] | Unspecified | 60 | 80 | 100 | 120 | 140 | [A] |
| | (ISO 527, MPa, min) | (Unspecified) | (60) | (80) | (100) | (120) | (140) | [A] |
| 5 | Flexural modulus, ASTM D 790 MPa, min[B] | Unspecified | 3000 | 4500 | 6000 | 7500 | 9000 | [A] |
| | (ISO 178, MPa, min) | (Unspecified) | (2800) | (4200) | (5600) | (7000) | (8500) | [A] |

[A] If specific value is required, it must appear on drawing or contract, or both.

[B] MPa × 145 = psi.

**TABLE B SAN Compounds (Unreinforced)**

| Designation Order Number | Property | Cell Limits | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 0 | 1 | 2 | 3 | 4 | 5 | 9 |
| 1 | AN Content,% AN, min | Unspecified | 10 | 20 | 30 | 40 | 50 | [A] |
| | (ISO, % AN, min) | (Unspecified) | (10) | (20) | (30) | (40) | (50) | [A] |
| 2 | Vicat softening point, ASTM D 1525, °C, min | Unspecified | 90 | 100 | 105 | 110 | 120 | [A] |
| | (ISO 306, °C, min) | (Unspecified) | (85) | (95) | (100) | (105) | (110) | [A] |
| 3 | Flow rate, ASTM D 1238, g/10 minutes, min | Unspecified | 2 | 5 | 10 | 15 | 20 | [A] |
| | (ISO 1133, g/10 minutes, min) | (Unspecified) | (5) | (15) | (25) | (40) | (50) | [A] |
| 4 | Tensile strength, ASTM D 638, MPa, min[B] | Unspecified | 50 | 60 | 70 | 80 | 95 | [A] |
| | (ISO 527, MPa, min) | (Unspecified) | (50) | (60) | (70) | (80) | (95) | [A] |
| 5 | Flexural modulus, ASTM D 790, MPa, min[B] | Unspecified | 2600 | 3000 | 3400 | 3800 | 4200 | [A] |
| | (ISO 178, MPa, min) | (Unspecified) | (2400) | (2800) | (3200) | (3600) | (3900) | [A] |

[A] If specific value is required, it must appear on drawing or contract, or both.

[B] MPa × 145 = psi.

4.1.2 Each compound is given a five-digit cell classification representing the physical properties in the order in which they are listed in the cell table.

4.2 Reinforced and lubricated versions of the SAN materials are classified in accordance with Table A, which specifies the properties after the addition of reinforcements or lubricants at the nominal level indicated (see 4.2.1).

4.2.1 A single letter shall be used for the major reinforcement or combination, or both, along with two digits that indicate the percentage of addition by mass, with the tolerance as tabulated below:

| Symbol | Material | Tolerance |
|---|---|---|
| C | Carbon- and graphite-fiber reinforced | ±2 % |
| G | Glass-reinforced | ±2 % |
| L | Lubricants (PTFE, for example) graphite, silicone and molybdenum disulfide | by agreement between the supplier and the user |
| M | Mineral-reinforced | ±2 % |
| R | Combinations of reinforcements or filler, or both | ±3 % for the total reinforcement |

NOTE 3—This part of the system uses percent of reinforcements or additives, or both, in the callout of the modified basic material. The types and percentages of reinforcements and additives should be shown on the supplier's technical data sheet unless this information is proprietary in nature. If necessary, additional callout of these reinforcements and additives can be accomplished by the use of the suffix part of the system, as described in Section 7.

4.2.2 Specific requirements for reinforced, filled, or lubricated materials shall be shown by a six-character designation. The designation shall consist of the letter A and the five digits comprising the cell numbers for the property requirements in the order in which they appear in Table A.

4.2.2.1 Although the values listed are necessary to include the range of properties available in existing materials, users should not infer that every possible combination of the properties exists or can be obtained.

NOTE 4—An example of this classification for a reinforced SAN is as follows:

The designation SAN000G30A34421:
SAN000 = Styrene acrylonitrile material,
G30 = Glass reinforced at 30 % nominal level,
A = Table A for property requirements,
3 = % AN, 30 %, min,
4 = Deflection temperature under load, 105°C, min,
4 = Specific gravity, 1.6, min,
2 = Tensile strength, 80 MPa, min, and
1 = Flexural modulus, 3000 MPa, min,
If no properties are specified, the designation would be SAN000G30A00000.

4.3 Table B classifies all unreinforced SAN materials. Table B shall be used in the same manner as Table A.

NOTE 5—An example of this classification for an unreinforced SAN is as follows:

The designation SAN000B22320 indicates:
SAN000 = Styrene acrylonitrile material,
B = Cell Table B, property requirements,
2 = % AN, 20 %, min,
2 = Vicat softening temperature, 100°C, min,
3 = Flow rate, 10 g/10 min, min
2 = Tensile strength, 60 MPa, min, and
0 = Flexural modulus, unspecified,

4.3.1 Mechanical properties of pigmented or colored SAN materials can differ from the mechanical properties of natural SAN material, depending on the choice and concentration of colorants. The main property affected is ductility, as illustrated by a reduction in Izod impact strength and tensile-elongation values. If specific properties of pigmented SAN materials are necessary, prior testing between the materials supplier and end user should be initiated. Once these agreements are reached, a classification using Cell Table B should be employed to ensure proper property compliance.

4.4 ISO test methods and correlated cell values have been included for informational purposes. They have been provided for those international users wishing to determine the corresponding ISO test values for a particular SAN callout.

NOTE 6—Using the example ASTM callout in Note 5, (ISO) SAN000B22320 would indicate:

(ISO) = ISO line-property requirements,
SAN000 = Styrene acrylonitrile material,
B = Table B,
2 = % AN, 20%, min,
2 = Vicat softening point, 95°C, min,
3 = Flow rate, 25 g/10 min, min,
2 = Tensile strength, 60 MPa, min,
0 = Flexural modulus, unspecified.

NOTE 7—Internationally, ANSI has been working with ISO to harmonize specification and designation documents in three specific areas, including SAN. A correlation was carried out and has been appended for information purposes. This study provided the basis for the correlated ISO values found in the cell tables and the novel approach of being able to determine a specified product's property requirements by either ASTM or ISO test methods.

## 5. Ordering Information

5.1 The SAN compound shall be as agreed upon between the purchaser and seller, and the following information should be included in the purchase order:

5.1.1 Quantity and packaging;

5.1.2 Cell classification, as described in Table A or Table B;

5.1.3 Color reference should be made to color chip number, if available;

5.1.4 Form, for example, pellets, granules, or powder; and

5.1.5 This ASTM designation, "D 4203," and the year of issue.

## 6. Materials and Manufacture

6.1 The SAN compounds are produced by the polymerization of the monomers acrylonitrile and styrene.

6.2 The SAN compound shall be uniform in composition, as defined by the cell classification, and shall be of size, shape, and color, as specified by the product specification, or purchase order or contract.

6.3 Colorants may be added in concentrate form to the SAN compounds. Additives necessary for compounding may also be present.

## 7. Suffix Requirements

7.1 When requirements are needed that supersede or supplement the cell-table requirements, they shall be specified through the use of suffixes. In general, the first suffix letter indicates the special requirement needed and the second letter indicates the condition or test method, or both, with a three-digit number indicating the specific requirement. The suffixes that may be used are listed in the Suffix Symbols and Requirements Table 3 of Classification System D 4000.

## 8. Basic Requirements

8.1 Basic requirements from the cell tables, as they apply, are always in effect unless these requirements are superseded by specific suffix requirements, which always take precedence.

## 9. General Requirements

9.1 The material composition shall be uniform and shall conform to the requirements specified herein. Specification changes due to the effects of colorants shall be noted by the materials supplier and the end user and, where necessary, shall be covered by suffixes.

## 10. Detail Requirements

10.1 Test specimens and testing parameters for the materials shall conform to the requirements prescribed in Cell Table A, and Table B, and suffix requirements as they apply.

10.2 Observed or calculated values obtained from analysis, measurement, or test shall be rounded off to the nearest unit in the last right-hand place of figures used in expressing the specified limiting value in accordance with the rounding method of Practice E 29.

## 11. Sampling

11.1 Sample the materials in accordance with the sampling procedure prescribed in Practice E 105 . Statistical sampling shall be considered as an acceptable alternative.

## 12. Number of Tests

12.1 One set of specimens, as prescribed in the test methods, shall be considered sufficient for each lot. The average result for the specimens tested shall meet the requirements of the applicable Table when tested in accordance with the test methods listed in Section 15.

## 13. Specimen Preparation

13.1 The test specimens shall be injection molded in accordance with Practice D 3641. Molding conditions shall be 240 ± 5°C melt temperature and 60 ± 5°C mold temperature for all grades. Test specimens shall be molded in one piece and shall not be a composite of thinner sections. If ISO requirements are necessary, sample preparation shall be in accordance with ISO 294and ISO 4894/2.

## 14. Conditioning

14.1 Test specimens shall be conditioned in the standard laboratory atmosphere in accordance with Procedure A of Practice D 618 before performing the required tests. The minimum conditioning time shall be 24 h.

14.2 Conduct tests in the standard laboratory atmosphere of 23 ± 2°C and 50 ± 5 % relative humidity in accordance with Test Methods D 618, unless otherwise specified.

## 15. Test Methods

15.1 *ASTM Methods*:

15.1.1 The melt-flow rate shall be determined at 230°C and 3.8 kg load.

15.1.2 The Vicat softening point shall be determined for a 1-kg load, 12.5 by 3.2-mm (½by ⅛-in.) injection-molded, unannealed specimen, Rate B (2°C/min).

15.1.3 The heat-deflection temperature shall be determined for a 1.82-MPa load, 12.5 by 3.2-mm (½by ⅛-in.) injection-molded, unannealed, specimen.

15.1.4 The tensile strength at yield shall be determined on a 3.2-mm (⅛-in.) thick injection-molded Type I specimen, tested at 5 mm/min (0.2 in./min).

15.1.5 The flexural modulus shall be determined on a 12.5 by 3.2-mm (½ by ⅛-in.) injection-molded specimen, (50.8-mm) 2-in. span, tangent, Method I, at 1.3 mm/min (0.05 in./min).

15.1.6 The glass content of glass-reinforced materials shall be determined in accordance with Test Method D 2584.

15.2 *ISO Methods*:

15.2.1 The melt-flow rate shall be determined by Condition No. 19; 220°C and 10.0 kg load.

15.2.2 The Vicat softening point shall be determined for a 1.0 kg load, 10.0 by 4.0-mm injection-molded, unannealed specimen, Method B, Rate 50°C/h.

15.2.3 The heat-deflection temperature shall be determined for a 1.8-MPa load, 10.0 by 4.0-mm injection-molded, unannealed specimen, Method A, Rate 2°C/min.

15.2.4 The tensile strength at yield shall be determined on a 4.0-mm thick injection-molded Type 1A or 1B (or the identical ISO 3167 Type A or B) specimen, tested at 5 mm/min.

15.2.5 The flexural modulus shall be determined on a 4.0-mm thick injection-molded specimen, 60.0-mm span, tangent, 1.0 mm/min.

15.3 Reinforcement (other than glass) and Additive Concentration-Method to be agreed upon between the supplier and user.

## 16. Certification and Inspection

16.1 Inspection and certification of the material supplied with reference to a specification based on this specification shall be in accordance with the requirements specified herein.

16.2 Lot-acceptance inspection shall be the basis on which acceptance or rejection of the lot is made. The lot-acceptance inspection shall consist of those tests that ensure process control during manufacture as well as those necessary to ensure certifiability in accordance with 16.4.

16.3 Periodic-check inspection shall consist of the tests specified for all requirements of the material under this specification. Inspection frequency shall be adequate to ensure that the material is certifiable in accordance with 16.4.

16.4 Certification shall be that the material was manufactured, sampled, tested, and inspected in accordance with this specification and that the average values meet the requirements at a confidence level of 95 %.

16.5 A report of the test results shall be furnished when requested. The report shall consist of results of the lot-acceptance inspection for the shipment and results of the most recent periodic-check inspection.

## 17. Rejection and Rehearing

17.1 Material that fails to conform to the requirements of this specification may be rejected. Rejection should be reported to the producer or supplier promptly and in writing. In case of dissatisfaction with the results of the tests, the producer or supplier may make claim for a rehearing.

17.2 In case of a dispute of test results, ASTM methods and cell values shall apply.

## 18. Packaging and Package Marking

18.1 For packing, packaging, and marking, the provisions of Practice D 3892 apply.

## 19. Keywords

19.1 call-out; SAN; styrene/acrylonitrile

## APPENDIX

**(Nonmandatory Information)**

## X1. SAN COPOLYMERS

X1.1 *Introduction*—This study was initiated with the goal being to develop a correlation between ASTM and ISO cell designations for SAN copolymers. Contained within this report is the data necessary to harmonize those cell limits set by ASTM and ISO. The four candidates, the injection-molding parameters followed in order to produce test specimens, and each test method will be addressed individually. A summary data table can be found at the end of the report.

X1.2 *SAN Candidates*—The four SAN candidates chosen for this cell-harmonization study were picked on the basis of their percent acrylonitrile content and their melt-flow indices. The reason for this choice is to create a range beginning with a soft-melt-flow material, continuing with two medium-flow materials and concluding with a stiff-flow material. Three major SAN producers participated in this study by supplying SAN pellet material in the soft-, medium-,and stiff-melt-flow categories, respectively.

| Material | % AN[A] |
|---|---|
| SAN 1 | 24 |
| SAN 2 | 29 |
| SAN 3 | 33 |
| SAN 4 | 33 |

[A] % AN values were obtained through CHN analysis.

Their melt-flow indices, along with the test methods used, will be presented under their own title in the Testing Methods and Results section.

X1.3 *Injection Molding of Physical-Testing Specimens*—Prior to molding, all four of the materials in their pellet form were dried for 18 h at a temperature of 85°C. After this drying period, the four pellet samples were placed in heatsealed polyethylene bags until molding began.

X1.3.1 The injection molding of all test specimens was executed on the same molding machine using the same parameters. The injection-molding conditions are listed in Table X1.1.

X1.3.2 The mold design was such that both the ASTM and the ISO test specimens could be molded simultaneously. In a single cycle, the following test specimens were molded: one ASTM tensile bar, one ½ by ⅛ by 5 in. bar, one ½by ½ by 5 in. bar, two ISO tensile bars, one 80 by 10 by 4-mm bar, and one 110 by 10 by 4-mm bar. All of the ASTM specimens were side-gated while all of the ISO specimens were end-gated. A sufficient number of each type of specimen was molded in order to carry out the necessary testing.

X1.4 *Testing Procedures*—All tests were performed using the recommended procedures outlined by both ASTM and ISO. The tests chosen give a broad view of the properties inherent in each of the materials and will form the basis on which a comparison can be made. The test method and its ASTM and ISO designations are listed in Table X1.2. In the following section, Testing Methods and Results, a summary containing key aspects of the method, as well as the results obtained by that method will be revealed.

**TABLE X1.1 Injection-Molding Parameters**

| Barrel Temperatures | (°F) |
|---|---|
| nozzle | 400 |
| zone 1 | 390 |
| zone 2 | 380 |
| zone 3 | 380 |
| Mold Temperature | (°F) |
| | 110 |
| Pressures | (psi) |
| hold | 1000 |
| plasticate | 150 |
| injection profile | 20 % FLAT |
| hold profile | 50 % FLAT |
| Times | (s) |
| injection | 2.55 |
| hold | 20 |
| cooling | 40 |
| Screw speed | (r/min) |
| | 150 |
| Shot Size | (oz) |
| | 2.5 |

X1.5 *Testing Methods and Results:*

X1.5.1 *Melt Flow Rate*—Test Method D 1238 (procedure A) and ISO 1133 outline the melt-flow rate procedure. The apparatus used was a plastometer having dimensions which met both ASTM and ISO standards. Refer to Table X1.3 for dimension values.

X1.5.1.1 The materials used for testing were in the form of pellets. These samples were oven dried for approximately 17.5 h at a temperature of 80°C prior to testing. The testing temperatures and applied loads were 230°C/3.8 kg for ASTM and 220°C/10.0 kg for ISO standards. The test results are displayed in Table X1.4.

X1.5.2 *Tensile Strength*—Test Method D 638 and ISO 527 outline the procedures used for determining tensile properties. The testing machine accommodated both methods of testing. Prior to testing, both the ASTM and ISO specimens were conditioned at 40/23/61. The atmospheric conditions during

**TABLE X1.2 Testing Methods with Their Designations**

| SAN Specifications | ASTM | ISO |
|---|---|---|
| | D 4203 | 4894/2 |
| Testing procedures: | | |
| Melt-Flow Rate | D 1238 | 1133 |
| Tensile Strength | D 638 | 527 |
| Flexural Modulus | D 790 | 178 |
| Izod Impact Strength | D 256 | 180 |
| Vicat Softening Temperature | D 1525 | 306 |
| DTUL | D 648 | 75 |

**TABLE X1.3 Dimensions of the Plastometer**

| | Diameter | Length |
|---|---|---|
| Test bore | 9.55 ± 0.001 mm | 162 mm |
| Die | 2.095 ± 0.005 mm | 8.0 ± 0.025 mm |
| Test plunger | 9.48 ± 0.1 mm | |

**TABLE X1.4 Melt Flow Rate Results**

| | ASTM | ISO |
|---|---|---|
| SAN 1 | 7.6 gms/10min | 20.4gms/10min |
| SAN 2 | 3.7 | 9.3 |
| SAN 3 | 14.32 | 34.4 |
| SAN 4 | 8.4 | 21.0 |

testing were also 23°C and 61 % relative humidity. ASTM requires a constant crosshead speed of 5 mm/min (0.2 in./min). This speed is in agreement with ISO standards as well. Five test specimens per material per method were tested. The type of test specimen, its principal dimensions and the test results can be found in Table X1.5.

X1.5.3 *Flexural Modulus*—Test Methods D 790 and ISO 178 describe procedures for determining flexural properties. Table X1.6 lists particulars concerning the testing apparatus set-up.

X1.5.3.1 The conditioning of the test specimens (both ASTM and ISO) was at >40/23/50 as is recommended by both organizations. The ASTM method and procedure classification for this test is Method I and Procedure A. The test-specimen dimensions and the calculated flexural modulus are compiled in Table X1.7.

X1.5.4 *Izod Impact Strength*—Test Method D 256 and ISO 180/1A outline the procedures used to determine Izod impact strength. In accordance with the guidelines contained within the ASTM procedure Method C was chosen. Method C was chosen due to historical SAN Izod values of 0.35 to 0.4 ft $lb_f$ /in. which lie below the minimum value of 0.5 ft $lb_f$ /in. for Method A. The milling machine used to notch the test specimens created a notch with an included angle of 45 ± 1° and a radius of curvature at the apex of 0.25 ± 0.05 mm. The depth of the notch was adjusted to meet the 0.1 ± 0.02 in. specification set by ASTM and the required depth of 0.079 in. set by ISO. Conditioning of all the test specimens at 40/23/50 was executed. A total of six test specimens per material per method were examined and averaged to yield the data presented in Table X1.8.

**TABLE X1.5 Tensile Strength Results**

| | Method | Type | Width (in.) | Thickness (in.) | Tensile Strength @ Break/Std. Dev. (psi) |
|---|---|---|---|---|---|
| SAN 1 | ASTM | I | 0.508 | 0.128 | 9 999/304 |
| SAN 2 | ASTM | I | 0.509 | 0.129 | 10 740/203 |
| SAN 3 | ASTM | I | 0.508 | 0.128 | 10 910/279 |
| SAN 4 | ASTM | I | 0.508 | 0.126 | 11 396/62 |
| SAN 1 | ISO | I | 0.395 | 0.155 | 9 808/198 |
| SAN 2 | ISO | I | 0.395 | 0.155 | 10 790/80 |
| SAN 3 | ISO | I | 0.395 | 0.155 | 11 061/87 |
| SAN 4 | ISO | I | 0.396 | 0.155 | 10 943/56 |

**TABLE X1.6 Particulars of Flexural Apparatus**

| | ASTM | ISO |
|---|---|---|
| Span length | 2.0 in. | 2.36 in. |
| Radii of supports and loading nose | 0.125 | (same) |
| Rate of crosshead motion | 0.05 in./min | 0.04 in./min |

**TABLE X1.7 Flexural Test Specimen Dimensions and Tangent Modulus**

| | Method | Width (in.) | Depth (in.) | Tangent Modulus (psi)/Std. Dev. |
|---|---|---|---|---|
| SAN 1 | ASTM | 0.498 | 0.130 | 533 000/0.03 |
| SAN 2 | ASTM | 0.499 | 0.129 | 548 000/0.02 |
| SAN 3 | ASTM | 0.499 | 0.130 | 564 000/0.05 |
| SAN 4 | ASTM | 0.499 | 0.130 | 558 000/0.03 |
| SAN 1 | ISO | 0.387 | 0.156 | 499 000/0.01 |
| SAN 2 | ISO | 0.387 | 0.156 | 500 000/0.03 |
| SAN 3 | ISO | 0.387 | 0.155 | 535 000/0.05 |
| SAN 4 | ISO | 0.386 | 0.155 | 533 000/0.06 |

**TABLE X1.8 Izod-Impact Results**

| | Method | End | Width (in.) | Izod Impact/Std. Dev. (ft lbf/in.) | Average Izod Impact (ft lbf/in.) |
|---|---|---|---|---|---|
| SAN 1 | ASTM | gate | 0.129 | 0.2570/0.06 | 0.2613 |
| | | dead | 0.130 | 0.2656/0.03 | |
| SAN 2 | ASTM | gate | 0.130 | 0.2590/0.04 | 0.2544 |
| | | dead | 0.130 | 0.2498/0.14 | |
| SAN 3 | ASTM | gate | 0.129 | 0.2729/0.01 | 0.2813 |
| | | dead | 0.131 | 0.2896/0.04 | |
| SAN 4 | ASTM | gate | 0.129 | 0.2663/0.06 | 0.2584 |
| | | dead | 0.131 | 0.2505/0.03 | |
| SAN 1 | ISO | N/A | 0.156 | 0.2679/0.07 | 0.2679 |
| SAN 2 | ISO | N/A | 0.156 | 0.3005/0.09 | 0.3005 |
| SAN 3 | ISO | N/A | 0.156 | 0.3417/0.10 | 0.3417 |
| SAN 4 | ISO | N/A | 0.156 | 0.3212/0.14 | 0.3212 |

X1.5.5 *Vicat Softening Temperature*—Test Method D 1525 (Rate B) and ISO 306 (Method B) provide guidelines for determining vicat softening temperatures (VST). The apparatus used met both organizations' specifications. The required minimum thickness of 0.12 in. was ensured by placing two layers of the grip end of a molded tensile bar on the testing surface. ASTM Rate B denotes an immersion-bath heating rate of 120°C/h and an applied load of 1 kg. ISO Method B indicates an applied load equivalent to 5 kg and a heating rate of 50°C/h. Dow 200 silicone oil served as the immersion-bath medium. The vicat softening temperature for each of the materials is shown in Table X1.9.

X1.5.6 *DTUL*—Test Method D 648 and ISO 75 (Method A) describe the procedure necessary to determine the deflection temperature under load. The apparatus used met the specifications set by both ASTM and ISO. All of the test specimens

**TABLE X1.9 Vicat Results**

| | ASTM (°C) | ISO (°C) |
|---|---|---|
| SAN 1 | 105.0 | 98.2 |
| SAN 2 | 106.6 | 97.1 |
| SAN 3 | 103.4 | 96.8 |
| SAN 4 | 104.9 | 97.1 |

**TABLE X1.10 DTUL Results**

| | Method | Dimensions (in.) | Maximum Fiber Stress | Deflection Temp. (°C) |
|---|---|---|---|---|
| SAN 1 | ASTM | 0.130 × 0.498 × 5 | 264 psi | 78.4 |
| SAN 2 | ASTM | 0.130 × 0.499 × 5 | 264 psi | 77.3 |
| SAN 3 | ASTM | 0.130 × 0.498 × 5 | 264 psi | 76.8 |
| SAN 4 | ASTM | 0.130 × 0.498 × 5 | 264 psi | 77.2 |
| SAN 1 | ISO | 0.156 × 0.393 × 4.331 | 1.8 N/mm$^2$ | 79.1 |
| SAN 2 | ISO | 0.156 × 0.393 × 4.331 | 1.8 N/mm$^2$ | 80.8 |
| SAN 3 | ISO | 0.156 × 0.393 × 4.331 | 1.8 N/mm$^2$ | 79.5 |
| SAN 4 | ISO | 0.156 × 0.393 × 4.331 | 1.8 N/mm$^2$ | 78.7 |

**TABLE X1.11 Summary Data Table for the SAN Candidates**

| | SAN 1 | SAN 2 | SAN 3 | SAN 4 | |
|---|---|---|---|---|---|
| ASTM: | | | | | |
| Tensile Strength | 9 999 | 10 740 | 10 910 | 11 396 | psi |
| Flex. Modulus | 533 000 | 548 000 | 564 000 | 558 000 | psi |
| Izod Impact Strength | 0.26 | 0.25 | 0.28 | 0.26 | ft lbf/in. |
| Vicat Softening Temp. | 105.0 | 106.6 | 103.4 | 104.9 | °C |
| DTUL | 78.4 | 77.3 | 76.8 | 77.2 | °C |
| Melt Flow | 7.6 | 3.7 | 14.3 | 8.4 | g/10 min |
| ISO: | | | | | |
| Tensile Strength | 9 808 | 10 790 | 11 061 | 10 943 | psi |
| Flex. Modulus | 499 000 | 500 000 | 535 000 | 533 000 | psi |
| Izod Impact Strength | 0.27 | 0.30 | 0.34 | 0.32 | ft lbf/in. |
| Vicat Softening Temp. | 98.2 | 97.1 | 96.8 | 97.1 | °C |
| DTUL | 79.1 | 80.8 | 79.5 | 78.7 | °C |
| Melt Flow | 20.4 | 9.3 | 34.4 | 21.0 | g/10 min |
| % AN | 24 | 29 | 33 | 33 | |

**TABLE X1.12 Summary Factor Table for ASTM vs. ISO[A]**

| | | | | | |
|---|---|---|---|---|---|
| Tensile Strength | 0.98 | 1.03 | 1.01 | 0.96 | 0.995 avg |
| Flex. Modulus | 0.93 | 0.91 | 0.95 | 0.96 | 0.94 avg |
| Izod Impact Strength | 1.03 | 1.18 | 1.21 | 1.24 | 1.17 avg |
| Vicat Softening Temp. | 0.94 | 0.91 | 0.94 | 0.93 | 0.93 avg |
| DTUL | 1.01 | 1.05 | 1.04 | 1.02 | 1.03 avg |
| Melt Flow | 2.68 | 2.51 | 2.40 | 2.50 | 2.52 avg |

[A] ISO/ASTM

were conditioned at 40/23/61 + ≥4/23/desiccator prior to testing. The immersion medium, Dow 200 silicone fluid, was heated at a rate of 2°C/min. Included in Table X1.10 are the specimen dimensions, maximum fiber stress and deflection temperature.

## SUMMARY OF CHANGES

This section identifies the location of selected changes to this specification. For the convenience of the user, Committee D20 has highlighted those changes that may impact the use of this specification. This section may also include descriptions of the changes or reasons for the changes, or both.

*D 4203–95:*

(*1*) Changes made in this version were the addition of an ISO equivalency statement and keywords, as well as editorial changes.

*D 4203–00:*

(*1*) In Section 2, removed reference to Practice D 1898 and replaced with Practice E 105.

(*2*) In 13.1, melt and mold temperatures were specified as 240 ± 5°C and 60 ± 5°C, respectively.

(*3*) In 15.2.4, replaced “Type 1” with “Type 1A or 1B (or the identical ISO 3167 Type A or B).”