



Designation: D 5138 – 99a

Standard Specification for Liquid Crystal Polymers¹

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1. Scope*

1.1 This specification covers liquid crystal polymeric materials suitable for injection molding and extrusion. This specification allows the use of recycled, reconstituted, recycled-regrind, recovered, or reprocessed liquid crystal polymer, or combination thereof, provided that the requirements as stated in this specification are met. It is the responsibility of the supplier and the buyer of recycled, reconstituted, recycled-regrind, recovered, or reprocessed liquid crystal polymer, or combination thereof, to ensure compliance.

1.2 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 shall be agreed upon between the user and the supplier, by using suffixes as given in Section 5.

1.3 This specification is intended to be a means of calling out plastic materials used in the fabrication of end-use items or parts. It is not intended for the selection of materials. Material selection should be made by those having expertise in the plastics field after careful consideration of the design and the performance required of the part, the environment to which it will be exposed, the fabrication process to be employed, the costs involved, and the inherent properties of the material other than those covered by this specification.

1.4 The values stated in SI units are to be regarded as the standard.

1.5 The following precautionary caveat pertains only to the test method portion, Section 11, 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—There are no ISO standards covering the primary subject matter of this specification.

¹ This specification is under the jurisdiction of ASTM Committee D-20 on Plastics and is the direct responsibility of Subcommittee D20.15 on Thermoplastic Materials.

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2. Referenced Documents

2.1 ASTM Standards:

D 256 Test Method for Determining the Pendulum Impact Resistance of Notched Specimens of Plastics²

D 618 Practice for Conditioning Plastics and Electrical Insulating Materials for Testing²

D 638 Test Method for Tensile Properties of Plastic²

D 648 Test Method for Deflection Temperature of Plastics Under Flexural Load²

D 790 Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials²

D 883 Terminology Relating to Plastics²

D 1238 Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer²

D 1600 Terminology for Abbreviated Terms Relating to Plastics²

D 1898 Practice for Sampling of Plastics²

D 3418 Test Method for Transition Temperatures of Polymers by Thermal Analysis³

D 3641 Practice for Injection Molding Test Specimens of Thermoplastic Molding and Extrusion Materials³

D 3835 Test Method for Determination of Properties of Polymeric Materials by Means of a Capillary Rheometer³

D 3892 Practice for Packaging/Packing of Plastics³

D 4000 Classification System for Specifying Plastic Materials³

D 5033 Guide for the Development of Standards Relating to the Proper Use of Recycled Plastics⁴

D 5630 Test Method for Ash Content in Thermoplastics⁴

E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications⁵

2.2 IEC and ISO Standards:⁶

IEC 112 Recommended Method for Determining the Comparative Tracking Index of Solid Insulation Materials

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 08.03.

⁵ Annual Book of ASTM Standards, Vol 14.02.

⁶ Available from the 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.

TABLE LCP Liquid Crystal Polymers—Classification

Group	Description	Class	Description	Grade ^A	Description
01	unsubstituted or methyl substituted, wholly aromatic copolyester, polyether, or polyester amide	1	high temperature DTUL ^B >260°C	0	
		2	medium temperature DTUL = 220–260°C	0	
		3	general purpose DTUL <220°C	0	
02	mixed aromatic/aliphatic copolyesters, polyethers, or polyester amides	1	high temperature DTUL >260°C	0	
		2	medium temperature DTUL = 220–260°C	0	
		3	general purpose DTUL <220°C	0	
03	aromatic copolyesters, polyethers, or polyesteramides with aliphatic sidechain	1	high temperature DTUL >260°C	0	
		2	medium temperature DTUL = 220–260°C	0	
		3	general purpose DTUL <220°C	0	
04	blends	1	high temperature DTUL >260°C	0	
		2	medium temperature DTUL = 220–260°C	0	
		3	general purpose DTUL <220°C	0	
00	other	0	other	0	

^A Description unspecified.

^B DTUL is deflection temperature under load measured at 1.8 MPa and is determined in accordance with Table A or Table B.

IEC 243 Recommended Methods of Test for Electrical Strength of Solid Insulating Materials at Power Frequencies

ISO 62 Plastics—Determination of Water Absorption

ISO 75-1 Determination of Temperature of Deflection Under Load—General Test Method

ISO 75-2 Determination of Temperature of Deflection Under Load—Plastics and Ebonite

ISO 178 Plastics—Determination of Flexural Properties of Rigid Materials

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

ISO 294-1 General Principles for Injection Molding

ISO 527-1 Plastics—Determination of Tensile Properties—Test Conditions for Moulding and Extrusion of Plastics

ISO 527-2 Plastics—Determination of Tensile Properties—Test Conditions for Moulding and Extrusion of Plastics

ISO 604 Plastics—Determination of Compressive Properties

ISO 3146 Plastics—Determination of Melting Behaviour (Melting Temperature or Melting Range) of Semi-Crystalline Polymers

ISO 3167 Plastics—Multipurpose Test Specimens

2.3 *Military Standard*:⁷

M24519 Molding Plastics—Electrical Thermoplastics

2.4 *Underwriters Laboratories (UL)*:⁸

UL 94 Test for Flammability of Plastic Materials for Parts in Devices and Appliances

2.5 *National Technical Information Service (NTIS)*:⁹
AD297457 Procedure and Analytical Method for Determining Toxic Gases Produced by Synthetic Compounds

3. Terminology

3.1 *Definitions*—For definitions of technical terms pertaining to plastics used in this specification, see Terminologies **D 883** and **D 1600**.

3.2 *Definition of Term Specific to This Standard*:

3.2.1 *liquid crystal polymer (LCP)*—A family of thermoplastic polymers which upon heating to the processing temperature, exhibit ordered structure and under shear, highly aligned chains that are retained in the solid state. Liquid crystal polymers are polymers that in the molten state exhibit birefringence in polarized light.

4. Classification

4.1 The LCP materials are classified into groups according to their chemical composition. These groups are subdivided, whether reinforced or not, into classes based on thermal performance as shown in Table LCP.

NOTE 2—An example of this classification is as follows: The designation LCP0120 would indicate liquid crystal polymer as found in Terminology **D 1600**:

- 01 (group)—Unsubstituted, or methyl substituted, wholly aromatic copolyester, polyether, or polyester amide.
- 2 (Class)—Medium temperature, DTUL = 220–260°C.
- 0 (Grade—Other)

4.1.1 To facilitate the incorporation of future or special materials, the “other” category for Group (00), Class (0), and Grade (0) is shown in Table LCP.

⁷ Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

⁸ Available from Underwriters Laboratories, 333 Pfingsten Rd., Northbrook, IL 60062–2096.

⁹ Available from NTIS, 5285 Port Royal Rd., Springfield, VA 22161.

4.2 The LCP materials are also classified according to mechanical properties as shown in Table A, after specifying any addition of fillers, reinforcements, or lubricants at the nominal level indicated (see 4.2.1).

NOTE 3—Test specimens shall be prepared in accordance to ISO 3167, with Specimen A.

NOTE 4—A similar callout can be developed using Table B.

4.2.1 Reinforcements and additive materials shall use a symbol (single-letter) that shows the major reinforcement or combination, or both, along with two digits that indicate the percentage of addition by mass with the tolerances as tabulated as follows:

Symbol	Material	Tolerance (Based on Total Mass)
C	carbon and graphite fiber	±2 %
G	glass	±2 %
L	lubricants (for example PTFE, graphite, silicone, and molybdenum disulfide)	depends upon material and process to be specified
M	mineral	±2 %
R	combinations of reinforcements or fillers, or both	±3 % for the total

NOTE 5—This part of the system uses percent reinforcements or additives, or both, in the control of the modified basic material. The types and percentages of reinforcements and additives should be shown on the suppliers' technical data sheet unless they are proprietary in nature. If necessary, additional control of these reinforcements and additives can be established by the use of the suffix part of the system, Section 5.

4.2.2 Specific requirements shall be shown by a six-character designation. The designation will consist of the letter A and the five digits comprising the cell numbers for the property requirements in the order as they appear in Table A.

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

4.2.3 When the grade or class of the basic material is not known or is not important, the "0" classification will be used.

NOTE 6—An example of this classification for a reinforced LCP is as follows: The designation LCP0120G30A22450 would indicate:

LCP 0120—Unsubstituted or methyl substituted, wholly aromatic copolyester, polyether, or polyester amide, medium temperature from Table LCP

G30—Glass reinforced at 30 % nominal level

- A —Table A property requirements
 - 2 —Tensile strength, min, 100 MPa
 - 2 —Flexural modulus, min, 8 GPa
 - 4 —Notched izod impact, min, 15 kJ/m
 - 5 —Deflection temperature under load, min, 260°C at 1.8 MPa,
 - 0 —Unspecified
- If no properties are specified, the designation would be LCP0120G30A00000.

5. Suffixes

5.1 When requirements are needed that supersede or supplement the requirements in Table LCP and A (or B), they shall be specified through the use of suffixes. In general, the first suffix letter indicates the special requirements needed and the second letter indicates the conditions or test method, or both, with a three-digit number indicating the specific requirement. The suffixes that may be used are listed in Table 3 of Classification System D 4000.

5.1.1 Additional suffixes will be added to this specification as test methods and requirements are developed or requested, or both.

6. General Requirements

6.1 The composition of the specified material shall be uniform and shall conform to the requirements specified herein.

6.2 The basic material requirements from Tables LCP and A (or B), as they apply, are always in effect unless these requirements are superseded by specific suffix requirements which always take precedence.

7. Detail Requirements

7.1 The material shall conform to the requirements prescribed in Tables LCP and A (or B), and the suffix requirements as they apply.

7.2 For the purposes of determining conformance with this specification, all specified limits in this specification are absolute limits, as defined in Practice E 29.

7.3 With the absolute method, an observed value or a calculated value is not rounded, but is to be compared directly with the specified limiting value. Conformance or nonconformance with this specification is based on this comparison.

TABLE A Property Requirements for Liquid Crystal Polymer Based on ISO Test Methods

			0	1	2	3	4	5	6	7	8	9
1	Tensile strength, min, MPa	ISO 527	unspecified	70	100	120	140	160	180	200	220	specify value
2	Flexural modulus, min, GPa	ISO 178	unspecified	4	8	12	16	20	24	28	32	specify value
3	Notched izod impact, min, kJ/m ²	ISO 180/1A	unspecified	5	9	12	15	18	25	37	50	specify value
4	DTUL ^A at 1.8 MPa, min, °C	ISO 75/A	unspecified	140	180	220	240	260	300	340	380	specify value
5	To be determined		unspecified									specify value

^A DTUL = Deflection temperature under load tested flatwise on 80 by 10 by 4-mm specimen.