



# Standard Specification for Cellulose Acetate Molding and Extrusion Compounds<sup>1</sup>

This standard is issued under the fixed designation D 706; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This specification covers requirements for cellulose acetate thermoplastic compounds plasticized with either diethyl phthalate or dimethyl phthalate and are suitable for injection molding and extrusion. These compounds have an acetyl content between 39 and 40 %. It does not include materials compounded for special application. Cellulosic plastic materials, being thermoplastic, are reprocessible and recyclable. This specification allows for the use of those cellulosic materials, provided that all specific requirements of this specification are met.

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 may be specified by using the suffixes as given in Section 5.

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

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

1.5 The following safety hazards 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 is no equivalent or similar ISO standard.

## 2. Referenced Documents

### 2.1 ASTM Standards:

- D 256 Test Method for Determining the Pendulum Impact Resistance of Notched Specimens of Plastics<sup>2</sup>
- D 570 Test Method for Water Absorption of Plastics<sup>2</sup>
- D 618 Practice for Conditioning Plastics and Electrical Insulating Materials for Testing<sup>2</sup>
- D 635 Test Method for Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position<sup>2</sup>
- D 638M Test Method for Tensile Properties of Plastics [Metric]<sup>2</sup>
- D 790 Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials<sup>2</sup>
- D 792 Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement<sup>2</sup>
- D 883 Terminology Relating to Plastics<sup>2</sup>
- D 1003 Test Method for Haze and Luminous Transmittance of Transparent Plastics<sup>2</sup>
- D 1600 Terminology for Abbreviated Terms Relating to Plastics<sup>2</sup>
- D 1729 Practice for Visual Evaluation of Color Differences of Opaque Materials<sup>3</sup>
- D 1898 Practice for Sampling of Plastics<sup>2</sup>
- D 3641 Practice for Injection Molding Test Specimens of Thermoplastic Molding and Extrusion Materials<sup>4</sup>
- D 3892 Practice for Packaging/Packing of Plastics<sup>4</sup>
- D 4000 Classification System for Specifying Plastic Materials<sup>4</sup>
- D 5033 Guide for the Development of Standards Relating to the Proper Use of Recycled Plastics<sup>5</sup>
- E 308 Practice for Computing the Colors of Objects by Using the CIE System<sup>3</sup>

## 3. Terminology

3.1 *Definitions*—The terminology used in this specification is in accordance with Terminologies D 883 and D 1600.

## 4. Classification

4.1 This specification covers the following groups, classes, and grades (see Table CA):

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<sup>2</sup> *Annual Book of ASTM Standards*, Vol 08.01.

<sup>3</sup> *Annual Book of ASTM Standards*, Vol 06.01.

<sup>4</sup> *Annual Book of ASTM Standards*, Vol 08.02.

<sup>5</sup> *Annual Book of ASTM Standards*, Vol 08.03.

4.1.1 *Group 1*—High impact strength, diethyl phthalate plasticizer.

4.1.2 *Group 2*—High tensile strength, diethyl phthalate plasticizer.

4.1.3 *Group 3*—High impact strength, dimethyl phthalate plasticizer.

4.1.4 *Group 4*—High tensile strength, dimethyl phthalate plasticizer.

4.1.5 *Class*—According to plasticizer content and properties specified in Table CA.

4.1.6 *Grade 1*—For injection molding (general purpose).

4.1.7 *Grade 2*—For extrusion (see requirements in 6.4).

## 5. Suffixes

5.1 When requirements are needed that are not covered in Table CA, they shall be indicated through the use of suffixes.

5.2 A list of suffixes can be found in Classification System D 4000 (Table 3) and may be used for additional requirements as appropriate. Additional suffixes will be added to that classification system as test methods and requirements are developed and requested.

5.3 Color and opacity shall be within the limits defined in 6.3.

5.4 Commonly used suffixes for cellulose acetate are shown as follows:

F = flammability requirements as designated by the following digits:

*First Digit*

1 = rate of burning—Test Method D 635, specimen size: 125 mm long by 12.7 wide by 3.2 mm thick.

*Second Digit*

1 = burn rate 5 cm/min, max.

T = transmittance requirements as designated by the following digits:

*First Digit*

1 = total luminous transmittance determined in accordance with Procedure A of Test Method D 1003.

*Second Digit*

1 = total transmittance, 80 % min.

5.5 An example of this classification system for a high-impact cellulose acetate formulation would be as follows:

CA0122F11 (1)

CA = Table CA Property Requirements.

01 = Group 01—High Impact Strength, diethyl phthalate plasticizer.

2 = Class 2—Plasticizer Range from 35 to 40 % (see Table CA, Footnote 1).

2 = Grade 2—Extrusion Application.

F11 = Flammability requirement—Burn rate maximum of 5 cm/min when tested in accordance with Test Method D 635

NOTE 2—CA0122 corresponds to the following physical property requirements in Table CA:

Specific gravity: 1.25-1.28.

Tensile stress at yield: 18 MPa min.

Flexural modulus: 930 MPa min.

Izod impact strength: 200 J/m min.

Water absorption: 4.7 % max.

Weight loss on heating: 10.0 % max.

## 6. Materials and Manufacture

6.1 Materials supplied shall be as uniform in composition and size, and as free of contamination, as can be achieved by good manufacturing practice.

6.2 These materials may contain colorants in the nominal amounts ordinarily employed, but such additives shall not alter the ability of the materials to meet the specified properties.

6.3 The color of material supplied shall be comparable, within commercial match tolerances, to the color of standard samples prepared by the manufacturer.

6.4 Grade 2 materials shall be verified by the manufacturer to be of extrusion quality.

## 7. Physical Requirements

7.1 Test specimens of the material shall conform to the requirements prescribed in Table CA.

7.2 Molded specimens, for those tests requiring them, shall be prepared in accordance with Section 10.

7.3 Conformance to the requirements of this specification shall be determined in accordance with Section 11.

## 8. Sampling

8.1 The material shall be sampled in accordance with Sections 9 to 12 of Practice D 1898. Adequate statistical sampling prior to packaging shall be considered an acceptable alternative.

8.2 For sampling purposes, a batch or lot shall be considered a unit of manufacture as prepared for shipment and may consist of a blend of two or more production runs of material.

## 9. Number of Tests

9.1 Routine testing of each batch or lot shall be limited to properties designated in Table CA of this specification.

9.2 One set of samples for those tests that are designated (Section 12) shall be considered sufficient for testing the batch or lot. The average results from those samples shall comply with the requirements prescribed in this specification.

9.3 If any failure occurs, the materials may not be certified to this specification.

## 10. Specimen Preparation

10.1 Physical property requirements in Table CA are based on injection molded specimens 3.2 mm thick. Specimens machined from compression-molded blanks or extruded strips may be used, provided it can be shown that the results are comparable.

10.2 Prior to molding cellulose acetate, dry the material to a moisture content of 0.2 % or less. The primary reason for drying the material is to eliminate visual defects such as surface imperfections and bubbles. Material spread in a tray to a maximum depth of 50 mm and exposed in a circulating-air oven at 75 to 90°C for 3 h should be satisfactory. Formulations containing either very low or very high levels of plasticizer may require slightly higher or lower drying temperatures respectively. Control the injection molding cycles in accordance with Practice D 3641, using a melt temperature 25 to

35°C above the “cold point.” (The “cold point” is the lowest melt temperature at which it is possible to obtain a full shot when all other operating variables are held constant within the normal operating range.) Mold temperatures between 35 and 60°C have been found desirable. As a rule, thin-section moldings and higher material hardness (lower plasticizer content) require higher mold temperatures.

10.3 Test specimens injection molded from cellulosic materials are subject to “overpacking” if the gate size is too large, and this can result in brittleness in the gate area as well as throughout the entire specimen. To avoid this, the gate size should be significantly smaller than those recommended in Practice D 3641. A gate size 1.5 mm square has been found to produce satisfactory test specimens.

## 11. Test Methods

11.1 Determine the properties defined by this specification in accordance with the following test methods:

11.1.1 Unless otherwise specified, all tests shall be performed in the standard laboratory atmosphere as defined by Practice D 618.

11.1.2 Unless otherwise specified, test specimens shall be conditioned in accordance with Procedure A of Practice D 618.

11.1.3 *Color-Visual*—Practice D 1729

11.1.4 *Color-Quantitative*—Practice E 308

11.1.5 *Plasticizer Content*—The method for plasticizer content shall be as agreed upon between the manufacturer and the purchaser.

11.1.6 *Specific Gravity*—Test Methods D 792.

11.1.7 *Tensile Stress at Yield*—Test Method D 638M, Type I test specimen, 50-mm/min testing speed.

11.1.8 *Flexural Modulus*—Test Methods D 790, 1.27-mm/min testing speed.

11.1.9 *Impact Strength (Izod)*—Test Method A of Test Method D 256. Specimen size: 63.5 mm long by 12.7 mm wide by 3.2 mm thick.

11.1.10 *Water Absorption*—Test Method D 570, 24-h immersion.

NOTE 3—The ungated “tab end” (75 mm long) of a Test Method D 638M, Type I tensile bar will give comparable results and can be used if the primary specimen type is not available. Condition in accordance with Test Method D 570.

11.1.11 *Weight Loss on Heating*—Condition test specimens, 50.8 mm in diameter or 50.8 mm wide by 63.5 mm long by 3.2 mm thick, for 48 h over anhydrous calcium chloride at 23 ± 2°C or 4 h at 70 ± 2°C.

NOTE 4—The ungated, “tab end” (75 mm long) of a Test Method

D 638, Type I tensile bar will give comparable results and can be used if the primary specimen type is not available. Weigh three specimens and place them in a circulating-air oven for 72 h at 82 ± 2°C. Support the specimens flatwise on a screen in the oven. Upon removal from the oven, cool the specimens in a desiccator over anhydrous calcium chloride to 23 ± 2°C. Weigh the specimens and calculate the weight loss on heating as a percentage of the conditioned weight as follows:

$$\text{weight loss on heating, \%} = \frac{(W_1 - W_2)}{W_1} \times 100 \quad (2)$$

where:

$W_1$  = original weight, g, after initial conditioning, and

$W_2$  = weight, g, after 72 h in oven at 82°C.

## 12. Inspection and Certification

12.1 Inspection and certification of the material supplied with reference to a specification based on this classification system shall be for conformance to the requirements specified herein.

12.2 Lot-acceptance inspection shall be the basis on which acceptance or rejection of the lot is made. The lot-acceptance inspection shall consist of plasticizer content determination (see Table CA, Footnote 1) and color as specified in 6.3.

12.3 Periodic check inspection with reference to a specification based on this classification system shall consist of the tests for all requirements of the material under the specification. Inspection frequency shall be adequate to ensure that the material is certifiable in accordance with 12.4.

12.4 Certification shall be that the material was manufactured by a process in statistical control, sampled, tested, and inspected in accordance with this classification system and that the average values for the lot meet the requirements of the classification system (line call out).

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

## 13. Rejection

13.1 Material that fails to conform to all the requirements of this specification may not be certified.

## 14. Packaging, Packing, and Marking

14.1 The provisions of Practice D 3892 apply to packaging, packing, and marking of containers for plastic materials.

## 15. Keywords

15.1 cellulose acetate; classification system; line callout; plastic; recycled; specification

**TABLE CA Detailed Physical Property Requirements**

Material: CA (Cellulose Acetate) Plasticizer Base: Groups 01 and 02-Diethyl phthalate													
Group	Description	Class	Plasticizer Content <sup>A</sup> , %	Flow Designation <sup>B</sup>	Grade	Description	Specific Gravity, Test Methods D 792	Tensile Stress at Yield, Test Method D 638M, min, MPa	Flexural Modulus, Test Methods D 790, min, MPa	Izod Impact Strength, Test Method D 256 mm, J/m	Water Absorption, Test Method D 570, max, %		Weight Loss on Heating, Paragraph 11.1.11, max, %
											Weight Gain <sup>C</sup>	Soluble Loss	
01	High impact strength (diethyl phthalate based)	1	37-42	S2	1	injection	1.25-1.28	17	860	230	5.0	1.8	10.0
					2	extrusion	1.25-1.28	17	860	230	5.0	1.8	10.0
					0	other							
		2	35-40	S	1	injection	1.25-1.28	18	930	200	4.7	1.4	10.0
					2	extrusion	1.25-1.28	18	930	200	4.7	1.4	10.0
					0	other							
		3	33-37	MS	1	injection	1.25-1.29	19	1100	170	4.3	1.1	9.0
					2	extrusion	1.25-1.29	19	1100	170	4.3	1.1	9.0
					0	other							
		4	29-35	M	1	injection	1.26-1.29	23	1240	150	4.0	0.8	7.0
					2	extrusion	1.26-1.29	23	1240	150	4.0	0.8	7.0
					0	other							
		5	27-33	MH	1	injection	1.26-1.29	27	1380	130	3.5	0.6	6.0
					2	extrusion	1.26-1.29	27	1380	130	3.5	0.6	6.0
					0	other							
02	High tensile strength (diethyl phthalate based)	1	25-29	H	1	injection	1.27-1.30	32	1520	105	3.2	0.5	4.0
					2	extrusion	1.27-1.30	32	1520	105	3.2	0.5	4.0
					0	other							
		2	23-27	H2	1	injection	1.27-1.30	36	1580	90	3.0	0.4	3.0
					2	extrusion	1.27-1.30	36	1580	90	3.0	0.4	3.0
					0	other							
		3	21-25	H3	1	injection	1.27-1.30	39	1650	80	2.9	0.4	2.0
					2	extrusion	1.27-1.30	39	1650	80	2.9	0.4	2.0
					0	other							
		4	19-23	H4	1	injection	1.28-1.30	41	1860	55	2.7	0.3	2.0
					2	extrusion	1.28-1.30	41	1860	55	2.7	0.3	2.0
					0	other							
		5	17-21	H5	1	injection	1.28-1.30	43	2170	45	2.5	0.2	1.0
					2	extrusion	1.28-1.30	43	2170	45	2.5	0.2	1.0
					0	other							
6	12-18	H6	1	injection	1.28-1.30	45	2410	30	2.4	0.2	0.7		
			2	extrusion	1.28-1.30	45	2410	30	2.4	0.2	0.7		
			0	other									
0	other	-	0	other									

<sup>A</sup>The test method for plasticizer content, as well as the target level for the product supplied, shall be as agreed upon between the manufacturer and the purchaser. Limits of  $\pm 2\%$  shall be maintained unless a closer tolerance is practical.

<sup>B</sup>Flow designations are for information only and will be dropped from this specification at the next five-year review since Test Method D 569 (determination of flow temperature) has been withdrawn.

<sup>C</sup>Weight gain includes soluble matter loss.

TABLE CA (continued)

Material: CA (Cellulose Acetate) Plasticizer Base: Groups 03 and 04-Dimethyl phthalate							Specific Gravity, Test Methods D 792	Tensile Stress at Yield, Test Method D 638M, min, MPa	Flexural Modulus, Test Methods D 790, min, MPa	Izod Impact Strength, Test Method D 256 mm, J/m	Water Absorption, Test Method D 570, max, %		Weight Loss on Heating, Paragraph 11.1.11, max, %
Group	Description	Class	Plasticizer Content <sup>A</sup> , %	Flow Designation <sup>B</sup>	Grade	Description					Weight Gain <sup>C</sup>	Soluble Loss	
03	High impact strength (dimethyl phthalate based)	1	29-32	S2	1	injection	1.28-1.31	23	1520	155	5.0	1.8	2.5
					2	extrusion	1.28-1.31	23	1520	155	5.0	1.8	2.5
					0	Other							
		2	27-31	S	1	injection	1.29-1.32	26	1660	139	4.7	1.4	2.5
					2	extrusion	1.29-1.32	26	1660	139	4.7	1.4	2.5
					0	other							
		3	26-29	MS	1	injection	1.29-1.32	28	1800	123	4.3	1.1	2.0
					2	extrusion	1.29-1.32	28	1800	123	4.3	1.1	2.0
					0	other							
		4	24-27	M	1	injection	1.29-1.32	31	1930	107	4.0	0.8	1.5
					2	extrusion	1.29-1.32	31	1930	107	4.0	0.8	1.5
					0	other							
		5	22-26	MH	1	injection	1.29-1.32	34	2070	91	3.5	0.6	1.5
					2	extrusion	1.29-1.32	34	2070	91	3.5	0.6	1.5
					0	other							
04	High tensile strength (dimethyl phthalate based)	1	21-24	H	1	injection	1.29-1.32	37	2210	80	3.2	0.5	1.0
					2	extrusion	1.29-1.32	37	2210	80	3.2	0.5	1.0
					0	other							
		2	19-22	H2	1	injection	1.29-1.32	40	2420	69	3.0	0.4	0.8
					2	extrusion	1.29-1.32	40	2420	69	3.0	0.4	0.8
					0	other							
		3	17-21	H3	1	injection	1.29-1.32	43	2480	59	2.9	0.4	0.6
					2	extrusion	1.29-1.32	43	2480	59	2.9	0.4	0.6
					0	other							
		4	16-19	H4	1	injection	1.29-1.32	46	2590	49	2.7	0.3	0.4
2	extrusion				1.29-1.32	46	2590	49	2.7	0.3	0.4		
0	other												
00	Other	0	other	-	0	other							
					0	other							

<sup>A</sup>The test method for plasticizer content, as well as the target level for the product supplied, shall be as agreed upon between the manufacturer and the purchaser. Limits of  $\pm 2\%$  shall be maintained unless a closer tolerance is practical.

<sup>B</sup>Flow designations are for information only and will be dropped from this specification at the next five-year review since Test Method D 569 (determination of flow temperature) has been withdrawn.

<sup>C</sup>Weight gain includes soluble matter loss.

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