



# Standard Classification System and Basis for Specifications for Cellulose Acetate Molding and Extrusion Compounds (CA)<sup>1</sup>

This standard is issued under the fixed designation D706; 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.

*This standard has been approved for use by agencies of the U.S. Department of Defense.*

## 1. Scope\*

1.1 This classification system 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 classification system allows for the use of those cellulosic materials, provided that all specific requirements of this classification system are met.

1.2 The properties included in this classification system are those required to identify the compositions covered. Other requirements necessary to identify particular characteristics important to specialized applications are 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 can be made by those having expertise in the plastic field only 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 standard.

1.5 The following safety hazards caveat pertains only to the test method portion, Section 11, of this classification system. *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.*

<sup>1</sup> This classification system is under the jurisdiction of ASTM Committee D20 on Plastics and is the direct responsibility of Subcommittee D20.15 on Thermoplastic Materials.

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NOTE 1—There is no known ISO equivalent to this standard.

## 2. Referenced Documents

### 2.1 ASTM Standards:<sup>2</sup>

- D256 Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics
- D570 Test Method for Water Absorption of Plastics
- D618 Practice for Conditioning Plastics for Testing
- D635 Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position
- D638 Test Method for Tensile Properties of Plastics
- D790 Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
- D792 Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement
- D883 Terminology Relating to Plastics
- D1003 Test Method for Haze and Luminous Transmittance of Transparent Plastics
- D1600 Terminology for Abbreviated Terms Relating to Plastics
- D1729 Practice for Visual Appraisal of Colors and Color Differences of Diffusely-Illuminated Opaque Materials
- D3641 Practice for Injection Molding Test Specimens of Thermoplastic Molding and Extrusion Materials
- D3892 Practice for Packaging/Packing of Plastics
- D4000 Classification System for Specifying Plastic Materials
- D5740 Guide for Writing Material Standards in the Classification Format
- D7209 Guide for Waste Reduction, Resource Recovery, and Use of Recycled Polymeric Materials and Products (Withdrawn 2015)<sup>3</sup>
- E308 Practice for Computing the Colors of Objects by Using the CIE System

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

<sup>3</sup> The last approved version of this historical standard is referenced on [www.astm.org](http://www.astm.org).

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

### 3. Terminology

3.1 *Definitions*—The terminology used in this classification system is in accordance with Terminologies **D883** and **D1600**.

### 4. Classification

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

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.

### 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 **D4000** (Table 3) and can 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:

T = transmittance requirements as designed designated by the following digits:

*First Digit*

1 = total luminous transmittance determined in accordance with Procedure A of Test Method **D1003**.

*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:

CA0122FA053 (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.  
 FA053 = Flammability requirement from Classification System **D4000**—Burn rate maximum of 50 mm/min with 3 mm minimum thickness, when tested in accordance with Test Method **D635**

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 If these materials contain colorants in the nominal amounts ordinarily employed, 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.

### 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 classification system shall be determined in accordance with Section **11**.

### 8. Sampling

8.1 Sampling shall be statistically adequate to satisfy the requirements of **12.4**.

8.2 A batch or lot shall be constituted as a unit of manufacture as prepared for shipment and can consist of a blend of two or more “production runs.”

### 9. Number of Tests

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

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 classification system.

### 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 can 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 is recommended. Formulations containing either very low or very high levels of plasticizer can require slightly higher or lower drying temperatures respectively. Control the injection molding cycles in accordance with Practice **D3641**, 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 hardness materials (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. 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 classification system in accordance with the following test methods:

11.1.1 All tests shall be performed in the standard laboratory atmosphere as defined by Practice **D618**.

11.1.2 Test specimens shall be conditioned in accordance with Procedure A of Practice **D618**.

11.1.3 *Color-Visual*—Practice **D1729**

11.1.4 *Color-Quantitative*—Practice **E308**

11.1.5 *Plasticizer Content*—The method for plasticizer content shall be specified.

11.1.6 *Specific Gravity*—Test Methods **D792**.

11.1.7 *Tensile Stress at Yield*—Test Method **D638**, Type I test specimen, 50-mm/min testing speed.

11.1.8 *Flexural Modulus*—Test Methods **D790**, 1.27-mm/min testing speed.

11.1.9 *Impact Strength (Izod)*—Test Method A of Test Method **D256**. Specimen size: 63.5 mm long by 12.7 mm wide by 3.2 mm thick.

11.1.10 *Water Absorption*—Test Method **D570**, 24-h immersion.

NOTE 3—The ungated “tab end” (75 mm long) of a Test Method **D638**, 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 **D570**.

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 **D638**, 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, the results of the most recent periodic-check inspection, and the percent by weight of recycled plastic, as defined in Guide **D7209**, if requested.

NOTE 5—The ASTM publication *Manual on Presentation of Data and Control Chart Analysis*, 8<sup>th</sup> Edition, stock number: MNL7-8TH-EB, provides detailed information about statistical process control.

## 13. Rejection

13.1 Material that fails to conform to all the requirements of this classification system is not to be certified.

## 14. Packaging, Packing, and Marking

14.1 The provisions of Practice **D3892** 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						Specific Gravity, Test Methods <b>D792</b>	Tensile Stress at Yield, Test Method <b>D638</b> , min, MPa	Flexural Modulus, Test Methods <b>D790</b> , min, MPa	Izod Impact Strength, Test Method <b>D256</b> mm, J/m	Water Absorption, Test Method <b>D570</b> , max, %		Weight Loss on Heating, Paragraph <b>11.1.11</b> , max, %
Group	Description	Class	Plasticizer Content <sup>A</sup> , %	Grade	Description					Weight Gain <sup>B</sup>	Soluble Loss	
01	High impact strength (diethyl phthalate based)	1	37-42	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	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	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	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	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	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	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	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	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	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	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 shall be specified. Limits of  $\pm 2\%$  shall be maintained unless a closer tolerance is practical.

<sup>B</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 <b>D792</b>	Tensile Stress at Yield, Test Method <b>D638</b> , min, MPa	Flexural Modulus, Test Methods <b>D790</b> , min, MPa	Izod Impact Strength, Test Method <b>D256</b> mm, J/m	Water Absorption, Test Method <b>D570</b> , max, %		Weight Loss on Heating, Paragraph <b>11.1.11</b> , max, %			
Group	Description	Class	Plasticizer Content <sup>A</sup> , %	Grade	Description					Weight Gain <sup>B</sup>	Soluble Loss				
03	High impact strength (dimethyl phthalate based)	1	29-32	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	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	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	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	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	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	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	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	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								
						0	other								

<sup>A</sup>The test method for plasticizer content shall be specified. Limits of  $\pm 2\%$  shall be maintained unless a closer tolerance is practical.

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

## SUMMARY OF CHANGES

Committee D20 has identified the location of selected changes to this standard since the last issue (D706 - 09) that may impact the use of this standard. (May 1, 2015)

(1) Added abbreviated term CA to the title.

(2) Updated **Note 5**.

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