No.: TSM5515G

TITLE:

CLASS: C2

Established/Revised: Rev.11 (Jul.2005)

This standard has been revised in consequence of the following changes:

- (1) quality requirements have been revised as a result of introduction of new ISO molds.
- (2) standards to be referenced for test methods have been changed.
- (3) misdescription has been corrected.

Engineering Information
Planning Dept.
Engineering Administration Div.
TOYOTA MOTOR CORPORATION



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TOYOTA ENGINEERING STANDARD

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POLYACETAL RESIN MOLDING MATERIALS

Scope

material specifications in separate standards. This standard covers the general properties of polyacetal resin molding materials (hereinafter referred to as "molding materials") used for automotive plastic The molding materials shall meet the part performance criteria and

TSZ0001G. prohibitions and restrictions version of the Directive. parts made of materials provided by this standard shall Exempt uses specified by EU ELV Directive shall conform to the latest for substances of environmental concern in conform

- Classification and Designation
- Table 1. The classification and designation of the molding materials shall conform to suffixes shall be added to For a molding material requiring special performance, the following its material code.
- Chemical resistance
- High temperature light oil resistance
- ᆢ **Heat-aging resistance**
- Light resistance
- Low VOC (Volatile Organic Compound)
- Weatherability

Example: TSM5515G-Classification Suffix

Prepared and Written by: Material Engineering Div. Organic Material Dept. O TOYOTA MOTOR CORPORATION Established/ 11 Revised: Engineering Administration Div.

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• This standard and the technical Information related thereto are owned by and under sale centrel of Toyota Motor Corporation. They shall not be disclosed in whole nor in part to any third party without prior written consent of Toyota Motor Corporation.

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	Table 1
	Classification
Į	ç,
	Molding
	Materials

	етр			
condition: 105 - max. No hot-water resistance	10 t			
	ate	polyacetal resin		
requiring mechanical	per	8008		
table for	of Suitable	Bomopolymer type	TSM5515G-2C	Class 2C
expected.	exp			
grease resistance	gre	•		
hot-water resistance	hat			
condition: 80° max.	COD			
		polyacetal resin		
requiring mechanical		moderate-/low-viscosity		
table for	of Sultable	#dt remtiodough	TSH5515G-28	Class 2B
expected.	qxə			
hot-water resistance	10f			
condition: 80° max.	COR			
resistance. Temperature	res			
repeated fatigue	and			
strength, creap resistance	118			
wiring mechanical	resin req	Lyace		
table for	high-Suitable	Homopolymer type of	TSN5515G-2A	Class 2A
shall not exceed 100°C.	sha			
light oil, the temperature	119			
suffixed with D are used in	\$U£			
105 T max. When materials	105	polyacetal resin		
Temperature condition:		108-		
of Suitable for general parts.	of Sui	Copolymer type	BI-55155MST	Class 18
condition: 105 C max.	con			
resistance. Temperature	res			
and/or repeated fatigue	and	,		
wiring creep res	resin req	polyac		
table for	high-Suitable	type of		Class IA
Sajor application	_	Composition	Material code	Classification

Quality

with either one of the following, depending on the Japanese or international standard to which the associated test method shall conform. New JIS or ISO Standard \rightarrow TSM0506G The quality of the molding materials can be evaluated in principle in accordance

Former JIS or former ASTM Standard - TSM05016

meet the property requirements specified in Table 2 or 3 and Table 4, when they Regardless of the applicable standard, the quality of the molding materials shall subject to contact with strong acid. strong acid, use of the materials shall be prohibited where the materials are Note that because the molding materials covered herein are highly sensitive to specific requirements have been established, however, TSM0506G shall apply. are evaluated in accordance with the criteria specified in Section 5. are tested under the test conditions specified in Section 4 and the test results If no

iyanı alasil disguri iy sheridding or fisp, or return to Tiyyas Melar Compariston il sportsyrista, tis doquasası oğ tı tıbs sandar ilişinin ileşi ser nö losger secressey'das ol tıls spezilesinde oldına sirest casserned or the olduğunu reşinde diski spojetinin oğrusi basında santının serinde bi son ünder şeks opcuri ol Tivasa şkoter olduğunu diski sandarlı şeksinyatın çalsında basında santında parity viltasık prim virken oncenti di Tivasa şkoter olduğun diski seksilesinin seksilesinin ileşinin oğrusi taraşının santının santının oncenti di İşvası The recipient of this standard shall undertake the blewing melidentality obligations upon the recept of this Established/ | | | | Revised:

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Table 2 Requirements for General Mechanical Properties (when measurement method complying with ISO Standard is used)

Test Density Tensile test	le stren	1 1 1.	Class 18	Class 1A Class 1B Class 2B Class 2C Class 1B Class 2C Class 2B Class 2C Class 2C Class 2B Class 2C Class 2B Class 2C Class 2C Class 2B Class 2B Class 2C Cl	Class 28	Class 2C
	Strain at fracture 18 min. 9 mln. (4)	18 min.	9 min.		20 min.	
	Modulus of elasticity (MPa)	1870 min.	min.		2080 min.	
Charpy impact test	Charpy impact test With notch (kJ/m²) 4.1 min.	4.1 min.	2.7 min.	5.5 min.	3.6 min.	pin.
Deflection	(J) PdM 8.1	75 min.	80 min.		88 min	
load 0.45 KPa(C)	0.45 KPa(°C)	132 min.	min.		142 min.	
Rockwell hardness N Scale	M Scale	66 min.	dn.		73 min.	

Table 3 Requirements for General Mechanical Properties (when measurement method complying with former JIS is used)

Test item	•	3			,		
	-		1033 10 1	CIGSS IN CIGSS ID	V7 REBTA	D CEDIO	CTBSB CK CTBSS CD CTBSS CC
Specific gravity				1	1.37 to 1.44	4	
	thensile elicael	ngth	55 min.	in.	65	65 min.	59 min.
[X]	(MPa)						-
13	Elongation	at 4	at 40 min. 20 min.	20 min.	0.0	40 min.	20 min.
ffa	fracture (%)						-
tla seet teruxel?	usbuesse reseases	ngth	73 min.	in.		85 mio.	
(3)	(MPa)						
F14	Flexural mod	modulus.	1800 min.	min.		2000 min.	•
(14)	(MPa)						
[zod impact test With notch [J/m]	th notch (J/		44 min.	29 min.	59 min.	39	39 min.
(2) Fed 0281 uojizoteip 1898	20 kPa(C)				95 min.		
temperature 45:	455 kPa (°C)	_	140 min.	iin.		150 min.	
Rockwell hardness M Scale	Scale		70 min.	in.		75 min.	

Hater absorption (4) Rest aging Tensile strength result strength (5) grease resistance aging Tensile strength (5) grease resistance feasile retention rate at yield (5) grease resistance feasile retention rate at yield (5) grease resistance feasile retention rate at yield (5) grease resistance retention rate at yield (5) grease resistance retention rate at yield (6) grease resistance oil retention rate at yield (1) greating shall be better feasile strength oil retention rate at yield resistance oil retention rate at yield resistance (1) greating shall be better feasile strength oil retention rate at yield resistance (1) greating shall be better feasile strength oil retention rate at yield resistance (1) greating shall be better feasile strength (1) greating shall be better feasile with 90 greated (1) greating shall be greated (1) greating shall be greated (1) gr							
strength 70 min. on rate at yield 90 min. h 85°C yield strength 90 min. on rate at yield 90 min. on rate at yield on rate at yield on rate at yield fed [µg/g] enyde Method B [µg/m³] 140 max.	suffixed	temperate temper	Antifreeze resistance [suffixed with C] Weatherability	(suffixed with C)	resistance (suffixed with H) Grease resistance	r absorption	
Property Requirement Class 1A Class 1B 70 min. 90 min. 90 min. 90 min. 10scoloration and/or than Grade 3 in Table 1 i	1 2%	Yensile strengti retention rate at yield [t]	nile ention r ght	n nelc	retention rate at yield (4) Tensile 110°C	(4)	Table 4
0.4 max. 90 mi Shall not exhibit conspicution of proparties that langed use shall impede use of color fading shall be better of shall impede use of color fading shall be better of shall impede use of color fading shall be better of shall be			b 90 min. Discoloration and/o			0.0	r Property Requirement
			Shall not exhibit conspice degradation of properties of color fading shall be been as the color fading shall	exhibit conspic ous tion tion tion tion tion tion tion the series the series that the series that the series that the series the series that t	Shall not		1a39 2A

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- 4. Test Method
- 4.1 Testing in Accordance with ISO or New JIS
- 4.1.1 Test Specimen Preparation

determined from equation using a die conforming to TSM0506G. shall conform to ISO 9988-2. For the injection molding, in particular, muthe test specimens under the conditions best suited to MFR of the material shall conform to ISO 9988-2. compression-molding the flat plates to be used for punching the test specimens The practical conditions for injection-molding the test specimens or those for Prepare the test specimens in accordance with Section 2 of TSM0506G, as a rule. (1) given below The injection molding speed, $V_{I'}$ shall be

 $V_I = V_S/t_1 \cdot A_C \cdot n$ Ξ

molding speed (mm/s)

cross sectional area **夏**.

V_s: shot capacity (mm³)

number of cavities in die

cross sectional area of test specimen at its principal portion (mm²)

4.1.2 Test Specimen Conditioning

with Section 2.4 of TSM0506G. Prior to the test, condition the test samples and test specimens in accordance ISO 9988-2, which is 16 h or longer. For the conditioning time, however, comply with

4.1.3 Ambient Condition of Test

For the ambient condition of the test, conform to Section 2.4 of TSM0506G.

4.1.4 Collection of Test Data

test specimen molding conditions and other related data to the test results. Collect the test data in accordance with Section 2.5 of TSN0506G. Attach the

4.1.5 Number of Test Data (n)

materials shall be 10 min., unless specified specifically. The number of test data, n_r required for evaluating the properties of the molding

4.1.6 Density Measurement Test

Carry out the measurement in accordance with Section 3.1 of TSM0506G

4.1.7 Tensile Test

tensioning speed and other conditions of the test, comply with ISO 10350-1, as Comply with the The practical test conditions are shown in Table 5. test method specified in Section 3.2 of TSM0506G. for the

(MOTES) The recipient of this standard small uncomment are some the comparation if appropriate the deciments by the standard part of the control of the cont The recipient of this standard shall undertake the following combinantiality obligations upon the receipt of this Established/ 11 Revised:

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Table 5

			(MPa)
:	1 mm/min	4:	Modulus of elasticity
10% or less, use 5 mm/min.		\vdash	fracture (4)
When the elongation after tracture is		-	Elongation after
1	50 mm/min	L	Tensile test Yield stress (KPa)
Repark	Cross head speed	Cros	#ej!
		İ	

4.1.8 Charpy Impact Test

In accordance with Section 3.3 of TSM0506G

- 4.1.9 Deflection Temperature under Load Measurement Test In accordance with Section 3.4 of TSM0506G.
- 4.1.10 Hardness Test atmosphere of 23 ± In accordance with Section 3.8, TSM0506G. 2°C, and measurement shall be based on M-Scale. This test shall be conducted in the
- 4.2 Testing in Accordance with Former ASTM or Former JIS Unless otherwise specified, the test shall be conducted under the conditions specified in Section 4.2.1 to 4.2.4 inclusive.
- 4.2.1 Conditioning TSM0501G for not less than 24 h. Condition the test samples and/or specimens in accordance with Section 4,
- 4.2.2 Atmosphere In accordance with Section 5, TSM0501G
- 4.2.3 Preparation of Test Specimens
 In accordance with Section 3.1, TSM0501G
- 4.2.4 Number of Test Specimens
 In accordance with Section 6, TSM05016
- 4.2.5 Specific Gravity Test
 In accordance with Section 9.1, TSM0501G
- 4.2.6 Tensile Test In accordance with Section 9.2, TSM0501G. This test shall atmosphere of 23 \pm 2°C with 10 mm/min of crosshead speed. This test shall be conducted in the
- 4.2.7 Flexural Test The recipions of this standard shall undertake the following confidentiality obligations upon the recipt of this atmosphere of 23 ± In accordance with Section 9.3, TSM0501G. 2° with 2.0 mm/min of crosshead speed. This test shall be conducted in Established/ 11 Revised: the

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- 4.2.8 Izod Impact Test
- atmosphere of 23 ± In accordance with Section 9.4, . ე TSM0501G. This test shall be conducted in the
- .2.9 Hardness Measurement Test

atmosphere of 23 ± 2°C, and measurement shall be based on M-Scale In accordance with Section 9.9, TSM0501G. This test shall be conducted in the

- 4.2.10 Heat Distortion Temperature Measurement Test kPa and 455 kPa of flexure stress. In accordance with Section 9.6, TSM0501G. This test shall be conducted at 1820
- 4.3 Testing Other Mechanical Properties
- 4.3.1 Water Absorption Measurement Test In accordance with Section 9.16, TSN05016
- 4.3.2 Reat Aging Resistance Test (Suffixed with H) Use the tensile test specimens shaped in accordance with Section 3.1 of TSM0501G. Condition the test specimens as follows:
- Condition in accordance with Section 4 of TSM05016.
- (2) Leave for 1440 h (60 days) in a Geer oven adjusted to 110 \pm 2°C. Using the test specimens conditioned in (1) and (2), conduct the tensile test in accordance with Section 9.2 of TSM0501G. Determine the tensile strength condition in accordance with Section 4 of TSM0501G. retention rate at yield from equation (2). Then again,

Tensile strength retention rate at yield S (%) = $S_1/S_0 \times 100$ 2

where,

S₀: tensile strength after S₁: tensile strength after conditioning conditioning

- 4.3.3 Grease Resistance Test (Suffixed with C) Use the tensile test specimens shaped in accordance with Section 3.1 of TSM0501G Condition the specimens as follows:
- (1) Condition in accordance with Section 4 of TSM0501G.
- (2) Apply the same grease/oil as that for actual production use uniformly over again in accordance with Section 4 of TSM0501G. Using the test specimens conditioned in (1) and (2), test in accordance with Section 9.2 of TSM0501G. Det strength retention rate at yield from equation (3). 1440 h (60 days). the specimen surfaces, and leave the specimens at $110 \pm 2 \text{ C}$ (85 $\pm 2 \text{ C}$) for Then, wipe the grease/oil off the specimens, and condition Determine the conduct the tensile tensile

pjert titall diagraf by at redding or filte, or tream to Tayada Magor Comparation if appropriate, the decimands of all this standard plane for your do not longer increasing does to the termination of the effort concerned or the Course a region of this propriation colored thereto are compalled to the colored of the color of the colored of the colored prices.

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Tensile strength retention rate at yield 5 (%) Ħ S₁/S_c × 100 ---3

 $S_{\mathfrak{p}}$: tensile strength after conditioning $S_{\mathfrak{p}}$: tensile strength after conditioning 22

4.3.4 Antifreeze Resistance Test (Suffixed with C)

Condition the specimens as follows: Use the tensile test specimens shaped in accordance with Section 3.1 of TSM0501G.

(1) Condition in accordance with Section 4 of TSM0501G.

(2) Immerse the test specimens under the following conditions:

equation (4). 9.2 of TSN0501G. pillute the same antifreeze as that for actual production use by 50% (vol) with distilled water, and immerse the specimens in the dilution of 110 ± 2°C for 1440 h (60 days). Then, wash them with water, and again condition conditioned in (1) and (2), conduct the tensile test in accordance with Section in accordance with Section 4 of TSM0501G. Determine the tensile strength retention rate at yield from Next, using the specimens

Tensile strength retention rate at yield S(%) = $S_1/S_0 \times 100$

 S_{θ} : tensile strength after S_{I} : tensile strength after conditioning (1) conditioning (2)

4.3.5 Weatherability (Light Resistance) Test

This test (light resistance). is performed on W- or L-suffixed materials requiring weatherability

Test equipment

(a) For W molding materials:

Sunshine Weather-O-Meter (Section 9.20, TSM0501G)

(b) For L molding materials:

Fade-O-Metez (Section 9.20, TSM0501G)

(2) Weatherability test conditions

(a) Black panel temperature: 83 ± 3°C

(b) Exposure time: 800 h

After exposure, inspect the surface for cracks with an 50-power microscope. the results check test specimens visually for discoloration and/or color fading, and evaluate in accordance with the criteria given in Table 6

Remarkable change		1
Change	elds1decoeun	2
Small change	Fair	3
Slight change	Good	4
No visible change	Excellent	5
Conditions	Rating	Grade
•	o armer	

righer that desped by stratelling or ling or return to Torpta Mingr Corporation, if appropriate, the documents At the responsive depth for the no lenger necessary due to the enthication of the wint concerned or the description of this standard, in the notation of the concerned by and states often control of Torpta Moore country and the booked in branch make not to just to any third party walness prior without concern of Torpta Moore from Torpy shall not be disclosed in whate not to just to any third party walness prior without concern of Torpta Moore est of this standard whall undertake the following cordid ediality sidilgations upon the receipt of this

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(Reference)

	Table 7
Grade	Color difference
	(AB) (t)
5	0.7 or less
4	0.8 to 2.0
3	2.1 to 4.0
2	4.1 to 7.0
1	7.1 or more

Note: (1)

is specified in individual parts drawings. Acceptable color difference of interior parts after light resistance test

4.3.6 High Temperature Light Oil Resistance Test

Section 3.1 of TSM0501G. following procedures: tensile test specimens that have been configured in accordance with Condition the above specimens according to 뉹

- (1) Condition the specimens under the procedures specified in Section 4 of TSM0501G
- (2) Immerse the specimens in the high lubricity standard light oil (RF-90-A-92) the procedures specified in Section 4 of TSM0501G container, wipe the oil carefully off the specimens, and condition them under container for further 500 h at 100 \pm 2°C. Take the specimens out of the h at 100 ± 2°C. Replace the light oil with fresh quantity and store the made by Haltermann Co. With the container covered tightly, store it for 500

the tensile strength retention rate at yield from equation (5) as follows: After completion of the respective procedures (1) and (2), put the test specimens to the tensile test specified in Section 9.2 of TSM0501G. Determin Determine

Tensile strength retention rate at yield S (%) = $S_1/S_0 \times 100$ (5)

Where

 $S_{\mathfrak{p}}$: tensile strength after conditioning in accordance with procedure (1) $S_{\mathfrak{p}}$: tensile strength after conditioning in accordance with procedure (2)

4.3.7 Low VOC

Carry out the test in accordance with Method A or Method B specified below.

(1) Method A (bag method)

Calculate the quantity of formaldehyde evaporated from the test piece in accordance with TSM0508G. The test piece shall be a flat piece of $60 \times 60 \times 2 \text{ rm}$ in dimensions as shown in Fig. 4 in TSM0506G, Section 2.3. The temperature of resin during test piece molding shall be 190°C. Use a cutting knife for removing the molded test piece from the runner. Take care not to evaporated from one test piece by its mass that has been measured in advance. For the test result, record the quantity of evaporation per unit mass or μ heat the test piece. ece. Using equation (6), calculate the quantity of evaporated In the calculation, divide the quantity of formaldehyde

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evaporated from test piece (#g/test piece)]/(Mass of test piece (g)] --Quantity of evaporated formaldehyde(${}^{\mu}g/g$) = (Quantity of formaldehyde <u>(6</u>

- (2) Method B (thermal desorption method) Calculate the quantity of formaldehyde evaporated from the test piece in accordance with TSM0509G.
- Evaluation of the Test Result
- 5.1 Numerical Value of Test Result Calculate the mean value (\overline{X}) and the standard deviation (s) from the data obtained values is defined in Section 6 of TSM0501G. from the procedures given in Section 4. The method for rounding the numerical The number of test specimens is
- 5.2 Evaluation of Test Result Judge the numerical values calculated in Section 5.1 as follows:

(1) For lower limit values specified in Tables 2 through 4 Accept : $(S_1 \le X - 2.00 \times s)$ Reject : $(S_2 > X - 2.00 \times s)$

 S_{k} : lower limit value of specification (2) For upper limit values specified in Tables 2 through 4 Accept : $(S_{k} \ge X + 2.00 \times s)$ Reject : $(S_{k} < X + 2.00 \times s)$

 S_b : upper limit value of specification

where, mean value of test specimens:

standard deviation of test specimens: T = (X1 + X2 + X3 + + *

* *

$$V = S/(n-1)$$

$$S = (X_1 - \overline{X})^2 + (X_2 - \overline{X})^2 + \dots + (X_n - \overline{X})^2$$

$$= \sum Xi^2 - (\sum Xi)^2/n$$

Indication of Material Marking to Part

by this standard, Indicate the material marking to the parts which are made of the material covered as given in Table 8.

Material Polyacetal resin	Material code T3M5515G-lA T3M5515G-1B T3M5515G-2A T3M5515G-2B TSM5515G-2B TSM5515G-2C	Marking method >POM<
	Table 8	
Material	ial	king met
	TSM5515G-1A	>>01<
	TSM5515G-1B	
	1	

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	Single-Point Data Part 1	
2	Plastics Acquisition and	ISO 10350-1
₽.	Determination of Properties	
2	Materials Part 2: Preparation of Test Specimens a	
		ISO 9988-2
	Control Method for Substances of Environmental Conce	TSZ0001G
	Desorption Method	
	Test Method for Measuring Volatile Substances under He	TSM0509G
	Method	
	Volatile Substance Measurement Method under Sampling B	TSM0508G
	Compliance with ISO	
	Standard Test Methods for Plastic Molding Materials I	TSM0506G
	Standard Test Methods for Plastic Molding Materials	TSM0501G