SAE International™

SURFACE VEHICLE RECOMMENDED PRACTICE

SAE J2642

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Recommended Practice for Developing Specifications for Automotive Thermoplastic Materials

1. Scope

1.1 This SAE Recommended Practice is intended to establish uniform procedures for developing specifications for automotive thermoplastics. It is intended for use by automotive companies and their suppliers of molded and/or fabricated parts from thermoplastic materials.

1.2 This document lists those test methods and procedures that are useful for the development of specifications for automotive thermoplastic materials. Not all tests are applicable to all thermoplastic materials. Appendix A contains a cross-reference of appropriate test methods for each family of thermoplastic material. The test methods may change (be added or deleted) in future revisions.

1.3 This document categorizes the test methods and procedures for developing specifications for automotive thermoplastic materials by categories:

a. Lot release
b. Certification
c. Initial characterization

1.3.1 LOT RELEASE—Measure of lot-to-lot consistency.

1.3.2 CERTIFICATION—Periodic check inspection against a specification.

1.3.3 INITIAL CHARACTERIZATION—Define general characteristics for application development.

It is important to distinguish the usefulness of the individual test methods to assure consistent quality without expending unnecessary resources.

1.4 This document allows for use of recycled, reconstituted, and/or recycled-regrind materials provided that the thermoplastic material:

a. Has not been altered or modified to change its suitability for safe processing or the material's general characteristics,
b. Meets the requirements of its intended use and is identified as such.

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1.5 Purpose—The purpose of this document is to define the test methods used to characterize thermoplastic materials for the development of automotive specifications.

2. References

2.1 Applicable Publications—The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest version of SAE publications shall apply.

2.1.1 SAE PUBLICATIONS—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

SAE J576—Plastic Materials for Use in Optical Parts Such as Lenses and Reflectors of Motor Vehicle Lighting Devices
SAE J578—Color Specification
SAE J1344—Marking of Plastic Parts
SAE J1545—Instrumental Color Difference Measurement for Exterior Finishes, Textiles and Colored Trim
SAE J1756—Test Procedure to Determine the Fogging Characteristics of Interior Automotive Materials
SAE J1885—Accelerated Exposure of Automotive Interior Trim Components Using a Controlled Irradiance Water Cooled Xenon-Arc Apparatus
SAE J1960—Accelerated Exposure of Automotive Exterior Materials Using a Controlled Irradiance Water Cooled Xenon-Arc Apparatus
SAE J1976—Outdoor Weathering of Exterior Materials

2.1.2 ASTM STANDARDS—Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM D 1003—Standard Test Method for Haze and Luminous Transmittance of Transparent Plastics
ASTM D 1693—Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics
ASTM D 3763—Standard Test Method for High Speed Puncture Properties of Plastics using Load and Displacement Sensors
ASTM D 4349—Classification System for Polyphenylene Ether (PPE) Materials
ASTM D 4673—Standard Classification System for Acrylonitrile-butadiene-styrene (ABS) Plastics and Alloys Molding and Extrusion Materials
ASTM D 4976—Standard Specification for Polyethylene Plastics Molding and Extrusion Materials

2.1.3 ISO PUBLICATIONS—Available from ANSI, 25 West 43rd Street, New York, NY 10036-8002.

ISO 75-1—Plastics—Determination of temperature of deflection under load—Part 1: General test method
ISO 75-2—Plastics—Determination of temperature under load—Part 2: Plastics and ebonite
ISO 105/A02—Textiles—Grey scale for assessing change in color
ISO 178—Plastics—Determination of flexural properties
ISO 179-1—Plastics—Determination of Charpy impact properties—Part 1: Non-instrumented impact test
ISO 180—Plastics—Determination of Izod impact strength
ISO 188—Rubber, vulcanized or thermoplastic—Accelerated aging and heat resistance tests
ISO 293—Plastics—Compression moulding of test specimens of thermoplastic materials
ISO 294-1—Plastics—Injection moulding of test specimens of thermoplastic materials—Part 1: General principles, and moulding of multi-purpose and bar specimens
ISO 294-3—Plastics—Injection moulding of test specimens of thermoplastic materials—Part 3: Small plates
ISO 294-4—Plastics—Injection moulding of test specimens of thermoplastic materials—Part 4: Determination of moulding shrinkage
ISO 306—Plastics—Thermoplastic materials—Determination of Vicat softening temperature (VST)
ISO 489—Plastics—Determination of refractive index
ISO 527-1—Plastics—Determination of tensile properties—Part 1: General principles

ISO 527-2—Plastics—Determination of tensile properties—Part 2: Test conditions for moulding and extrusion plastics
ISO 974—Plastics—Determination of the brittleness temperature by impact
ISO 1133—Plastics—Determination of melt mass-flow rate (MFR) and melt volume-flow rate (MVR) of thermoplastics
ISO 1183-1—Plastics—Methods for determining the density and relative density of non-cellular plastics
ISO 1183-3—Plastics—Methods for determining the density and relative density of non-cellular plastics—Part 3: Gas pyknometer method
ISO 1872-2—Plastics—Polyethylene (PE) moulding and extrusion materials—Part 2: Preparation of test specimens and determination of properties
ISO 1873-2—Plastics—Polypropylene (PP) moulding and extrusion materials—Part 2: Preparation of test specimens and determination of properties
ISO 1874-2—Plastics—Polyamide (PA) moulding and extrusion materials—Part 2: Preparation of test specimens and determination of properties
ISO 3167—Plastics—Multipurpose test specimens
ISO 3451-1—Plastics—Determination of ash—Part 1: General methods
ISO 3451-2—Plastics—Determination of ash—Part 2: Poly (alkylene terephthalate) materials
ISO 3451-3—Plastics—Determination of ash—Part 3: Unplasticized cellulose acetate
ISO 3451-4—Plastics—Determination of ash—Part 4: Polyamides
ISO 3451-5—Plastics—Determination of ash—Part 5: Poly(vinyl chloride)
ISO 3795—Road vehicles, and tractors and machinery for agriculture and forestry—Determination of burning behavior of interior materials
ISO 7391-2—Plastics—Polycarbonate (PC) moulding and extrusion materials—Part:2 Preparation of test specimens and determination of properties
ISO 7792-2—Plastics—Thermoplastic polyester (TP) moulding and extrusion materials—Part 2: Preparation of test specimens and determination of properties
ISO 8257-2—Plastics—Poly(Methyl Methacrylate) (PMMA) moulding and extrusion materials—Part 2: Preparation of test specimens and determination of properties
ISO 9988-2—Plastics—Polyoxymethylene (POM) moulding and extrusion materials—Part 2: Preparation of test specimens and determination of properties
ISO 11357-1—Plastics—Differential scanning colorimetry (DSC)—Part 1: General principles
ISO 11357-3—Plastics—Differential scanning colorimetry (DSC)—Part 3: Determination of temperature of enthalpy and melting and crystallization
ISO 11358—Plastics—Thermogravimetry (TG) of polymers—General principles
ISO 11359-1—Plastics—Thermomechanical analysis (TMA)—Part 1: General principles
ISO 11359-2—Plastics—Thermomechanical analysis (TMA)—Part 2: Determination of coefficient of linear thermal expansion and glass transition temperature
ISO 11403-1—Plastics—Acquisition and presentation of comparable multipoint data—Part 1: Mechanical properties
ISO 11469—Plastics—Generic Identification and Marking of Plastic Products

3. Testing and Conditioning

3.1 Test Specimens

a. 150 min x 10 x 4.0 mm tensile test specimen

1. ISO 3167, Type 1A injection molded according to ISO 294-1 and relevant material standard.
2. ISO 3167, Type 1B machined from plaque compression molded according to ISO 293 and relevant material standard.

b. 80 x 10 x 4 mm machined from center of ISO 3167, Type 1A injection molded bar or compression molded plaque. Specimens of small length (<80mm) are also machined from ISO 3167, Type 1A injection molded bar or compression molded plaque.

c. 60 x 60 x 2.0 mm molded according to ISO 294-3 and relevant ISO material standard.
d. 100 mm diameter or 100 mm x 100 mm x 3.2 mm thick injection molded plaque.
e. 355 x 100 x 2.0 mm (max.) plaque injection molded or compression molded.
f. Specimens are to be tested as molded – no annealing is allowed.

3.2 Statistical Data—Statistical data for lot-release and certifiable properties shall be derived from test results on a minimum of 30 lots. If 30 lots of data are not available, the statistics shall be derived from a minimum of 6 lots and individual test bar data, not test results (i.e., for tensile strength, 6 lots x 5 bars/lot = 30 test bar data points). Continue lot testing until a minimum of 30 lots is reached. A lot is a definite quantity of some commodity manufactured or produced under conditions that are presumed to be uniform as commensurate with the supplier's standard practice.

3.3 Conditioning and Test Conditions—All tests shall be performed on test specimens conditioned in a controlled atmosphere of 23 °C ± 2 °C and 50% ± 5% relative humidity for a minimum of 16 hours prior to testing or as specified in the appropriate material standard and tested in the same atmosphere unless otherwise specified.

3.4 Tolerances—For tolerances of test specimens and test conditions not addressed in this document, refer to the specific test method or material document.

4. Lot-Release Properties and Test Methods—These tests as they apply are to be conducted, as applicable, on all lots of released materials:

4.1 Melt flow rate by ISO 1133 at specified conditions for the material.

4.2 Filler content, if filled, by ISO 3451.

4.3 Some materials may require more properties than MFR and/or filler content.

5. Certifiable Properties and Test Methods—Certifiable properties and test methods in Table 1 are to be conducted, as applicable, on a randomly selected single lot of material at a frequency of at least once per year to demonstrate compliance to a specification:

TABLE 1—CERTIFIABLE PROPERTIES AND TEST METHODS

Test Method	Description	Specimen	Test Conditions
ISO 75-1,-2	DTUL	80 x 10 x 4 mm	Flatwise at 1.8 MPa (ISO 75_{Af})
ISO 178	Flexural[1] Modulus	80 x 10 x 4 mm	64 mm span, 2 mm/min. Strain rate report the modulus between 0.05% and 0.25% strain
ISO 179-1	Notched Charpy[1] Impact	80 x 10 x 4 mm	Machined V notch, 0.25 mm radius, edgewise impact (ISO 179/eA)
ISO 180	Notched Izod[1] Impact	80 x 10 x 4 mm	Machined V notch, 0.25 mm radius, edgewise impact (ISO 180/1A)
ISO 306	Vicat Softening Temperature	10 x 10 x 4 mm	Method B50, silicone oil bath
ISO 527-1,-2	Tensile Strength	150 min x 10 x 4 mm	50 mm/min strain rate unless sample exhibits brittle break (no yield, strain at break <10%), then strain rate shall be 5 mm/min.
	Tensile Modulus[1]	150 min x 10 x 4 mm	1 mm/min strain rate, report the modulus between 0.05% and 0.25% strain.
ISO 1183-1 or 1183-3	Density	Chip from molded bar	Method A (immersion)

1. Notched Charpy impact and tensile modulus are the preferred properties. Notched Izod impact and flexural modulus are included for those materials which do not currently have a data base for the preferred properties and will be removed after 2005 when notched Charpy impact and tensile modulus data have been compiled.

6. *Initial Characterization Properties and Test Methods*

6.1 Table 2 contains tests for initial characterization purposes only and, after material approvals, no further test frequency is required. See Table A2 for applicability and special conditions. If not included in Table A2, the test is required.

TABLE 2—INITIAL CHARACTERIZATION PROPERTIES AND TEST METHODS

Test Method	Description	Specimen	Test Conditions
SAE J1756	Interior Fogging	100 mm diameter x 3.2 mm or 100 x 100 x 3.2 mm	As appropriate
ISO 179-1	Notched Charpy(1) at –40 °C	80 x 10 x 4 mm	Machined V notch, 0.25 mm radius, edgewise impact (ISO 179/eA)
ISO 180	Notched Izod(1) at –40 °C	80 x 10 x 4 mm	Machined V notch, 0.25 mm radius, edgewise impact (ISO 180/1A)
ISO 188	Heat aging for 1000 hours	As appropriate	Report % tensile strength and % notched bar impact retention
ISO 294-3,-4	Mold shrinkage	60 x 60 x 2 mm	Report % mold shrinkage after 16 to 24 hours at 23 °C, cavity pressure, % post molding shrinkage
ISO 489	Index of refraction	3.2 mm thick sheet	Must be clear, molded sheet
ISO 527-1,-2	Poisson's Ratio	150 (min) x 10 x 4 mm	1 mm/min. strain ratio. Report a single value to 2 decimal places at longitudinal strain of 0.25%
ISO 974	Brittleness temperature	As appropriate	Report t_{50} in °C – specimen type (notched or unnotched)
ISO 3795	Flammability	355 x 100 x 2 (or less) mm	Report burn rate
ASTM D 1003	Luminous transmittance and haze	3.2 mm thick sheet	Must be clear, molded sheet
ASTM D 1693	Environmental stress crack resistance	As appropriate	Igepal reagent (Condition B), report F_{50} average value and F_{10} value for lowest single sample.
ASTM D 3763	Multiaxial impact strength(2)	100 mm diameter x 3.2 mm or 100 x 100 x 3.2 mm	2.2 m/s for materials used in exterior/ under-the-hood applications only, 6.6 m/s for material used in interior applications only and both test speeds for materials used in all applications

1. See footnote 1 of Table 1 concerning use of notched Izod impact.
2. For multiaxial impact strength, ASTM D 3763 is to be used for unreinforced materials which fail in a ductile manner at 23 °C. Report test data for 23 °C ± 2 °C, and the lowest of the following temperatures in which a minimum of 80% ductile failures are observed: 0 °C ± 2 °C; –15 °C ± 2 °C, –30 °C ± 2 °C, or –40 °C ± 2 °C.

   Test specimens must be conditioned for minimum of 6 h at test temperature prior to impact testing. Low temperature testing shall be conducted within the same environmental chamber as the clamp mechanism of the impact device.

   Test a minimum of 10 specimens from a minimum of 3 individual lots at a single condition.

   Report should include the following:

   a) Number of samples tested per lot per temperature; b) Number of lots tested; c) Number of samples with ductile failure per each test condition; d) Force versus deflection curve which represents a typical ductile impact event at the lowest temperature that yields a minimum of 80% ductile failures; e) Speed of testing; f) Average velocity slowdown; g) Geometry of test specimens used.

   Report energy in Joules (mean value and lowest observed value) at maximum load at 23 °C ± 2 °C, and at the lowest temperature that yields a minimum of 80% ductile failures. When reporting the mean and lowest observed test values, include only ductile failure results.

   A ductile failure is defined as a puncture of the test plaque without cracks radiating more than 10 mm beyond the center of impact.

6.2 Supply the following on all materials for initial submission

6.2.1 DSC curve by ISO 11357-1 and ISO 11357-3, 2nd heating at a scan rate applicable to the material.

6.2.2 TGA curve by ISO 11358 as a function of temperature run in nitrogen from 23 °C to 700 °C at a scan rate of 20 °C/min. Continue heating from 700 °C to 900 °C in air.

6.2.3 TMA curves by ISO 11359–1 and –2 as a function of temperature over the appropriate range in both the flow and cross flow directions.

6.2.4 Tensile stress vs. strain curves by ISO 11403-1 at appropriate temperatures, 150 min x 10 x 4 mm specimen, 5 mm/min strain rate to yield point for ductile materials or break point for brittle materials.

6.2.5 INFRARED SPECTRA.

7. Special Purpose Characterization of Automotive Materials—The following requirements are to be requested for application specific information, as appropriate, in addition to the basic call-out. All test results shall be submitted with initial characterization, when specified.

7.1 UV Light Resistant, Interior

a. Xenon Arc Exposure
b. Applicable to unpainted color matched compounds only

7.1.1 TEST METHOD—SAE J1885, 601.6 kJ/m^2 minimum exposure, 60 x 60 mm minimum x 2.0 mm, smooth surface, low gloss, injection molded specimen.

NOTE—The user of this document shall specify one of the evaluation procedures listed as follows:

7.1.1.1 The color of each test specimen shall be measured per SAE J1545, CIELAB color space, 10 degree observer, illuminant D65, specular included, sphere geometry, before and after exposure. ΔE=3.0 max. No objectionable color change or surface defects allowed.

7.1.1.2 Rating 4, minimum (AATCC Evaluation Procedure 1/ISO 105/A02). No objectionable color change or surface defects allowed.

7.2 UV Light Resistant, Under glass, Interior

Florida and Arizona Exposure

7.2.1 TEST METHOD—One (1) year 5 degrees south, under automotive glass (PPG Herculite K, tempered safety glass, 3 mm thick). 60 x 60 mm minimum x 2.0 mm smooth surface low gloss injected molded specimen. Exposed specimens shall be cleaned before color evaluation according to SAE J1976.

NOTE—The user of this document shall specify one of the evaluation procedures listed below:

7.2.1.1 The color of each test specimen shall be measured per SAE J1545, CIELAB color space, 10 degree observer, illuminant D65, specular included, sphere geometry, before and after exposure. ΔE=3.0 max. No objectionable color change or surface defects allowed.

7.2.1.2 Rating 4, minimum (AATCC Evaluation Procedure 1/ISO 105/A02). No objectionable color change or surface defects allowed.

7.3 UV Light Resistant, Exterior

Applicable to color matched unpainted compounds only

7.3.1 XENON ARC EXPOSURE – TEST METHOD—SAE J1960, 2500 kJ/m^2 minimum exposure. 60 x 60 mm minimum x 2.0 mm, smooth surface, low gloss, injection molded specimen.

NOTE—The user of this document shall specify one of the evaluation procedures listed as follows:

7.3.1.1 The color of each test specimen shall be measured per SAE J1545, CIELAB color space, 10 degree observer, illuminant D65, specular included, sphere geometry, before and after exposure. ΔE=3.0 max. No objectionable color change or surface defects allowed.

7.3.1.2 Rating 3-4, minimum (AATCC Evaluation Procedure 1/ISO 105/A02). No objectionable color change or surface defects allowed.

7.3.2 FLORIDA AND ARIZONA EXPOSURE—SAE J1976, 2 years, 5 degrees south, direct exposure. 60 x 60 mm minimum 2.0 mm, smooth surface, low gloss injection molded specimen. Exposed specimens shall be cleaned before color evaluation according to SAE J1976.

NOTE—The user of this document shall specify one of the evaluation procedures listed as follows:

7.3.2.1 The color of each test specimen shall be measured per SAE J1545, CIELAB color space, 10 degree observer, illuminant D65, specular included, sphere geometry, before and after exposure. ΔE=3.0 max. No objectionable color change or surface defects allowed.

7.3.2.2 Rating 3-4, minimum (AATCC Evaluation Procedure 1/ISO 105/A02). No objectionable color change or surface defects allowed.

7.4 Fogging—Use only for interior application materials

7.4.1 TEST METHOD—SAE J1756, Photometric Procedure. Test time and temperatures as specified by the user of this document.

Report minimum Fog Number and Test conditions

7.5 Recycled—The formulation consists of a minimum of 25% recycled content (post-industrial and/or post-consumer) if the user of this document specifies recycle content as a part of the material line call-out.

7.6 Engine Coolant Resistance—Use only for hydrolysis resistant PA66.

After immersion for 1000 hours at 125 °C and 103 kPa pressure in 50/50 solution of water and approved automotive coolant concentrate, the tensile strength must retain a minimum of 20% of the original value listed in the specification.

7.7 Optical Parts such as lenses and Reflectors of Lighting Devices

7.7.1 Materials must meet the requirements of SAE J576.

7.7.2 Materials must be of an appropriate color such that the final lighting device will meet the requirements of SAE J578.

8. ***Applicable Tests—***The tests and test conditions for each material detailed in Table A1 and Table A2 of Appendix A are to be the standard for developing automotive specifications for thermoplastic materials.

9. Define the appropriate marking symbol for articles produced from the specified material using SAE J1344 and/or ISO 11469.

PREPARED BY THE SAE PLASTICS COMMITTEE

APPENDIX A

TABLES OF TESTS AND TESTING CONDITIONS BY MATERIAL.

TABLE A1—STATISTICAL REQUIREMENTS

Material	Density	Melt Flow Rate Conditions °C/load (kg)	Tensile Strength	Tensile Modulus[1]	Flexural Modulus	Notched Charpy Impact	Notched Izod Impact[1]	Heat Deflection Temperature °C at 1.8 MPa	Filler[2] Content	Vicat Softening Temp., °C
PA[3]	yes	no	yes	yes	no	yes	no	yes	yes	no
PC	yes	300/1.2	yes	yes	yes	yes	yes	yes	yes	yes
PC+ABS	no	265/5	yes	yes	yes	yes	yes	yes	yes	yes
PE	yes	190/2.16[4]	yes[5]	yes	yes	yes	no	no	yes	no
PMMA	no	230/3.8	yes	yes	yes	yes	yes	no	no	yes
POM	yes	190/2.16	yes	yes	no	yes	no	yes	yes	no
PP	no	230/2.16	yes	yes	yes	yes[6]	yes[6]	yes	yes	no
PPE	no	no	yes	yes	yes	yes	yes	no	yes	yes
SMA	no	220/10	yes	yes	yes	yes	yes	yes	yes	no
TEO	yes	230/2.16	yes	yes	yes	yes	yes	yes	yes	no
TPES	yes	[7]	yes	yes	no	yes	no	yes	yes	no

1. Notched Izod impact and flexural modulus are included only for those materials that do not have a data base on notched Charpy impact and tensile modulus. They are intended for use only until the data for notched Charpy impact and tensile modulus have been compiled and will be removed after 2005.
2. Reinforced/filled grades only.
3. Samples conditioned in a moisture proof container at 23 °C ± 2 °C for at least 24 hours.
4. A 21.6 kg weight is used for materials with a melt flow rate less than 0.1 g/10 min.
5. Test speed of 500 mm/min is used for LDPE.
6. Heterophasic copolymers only.
7. Unreinforced grades only: PBT — 250/2.16
   PET — 285/2.16

TABLE A2A—INITIAL CHARACTERIZATION OF AUTOMOTIVE MATERIALS

Material	Molding Conditions	Stress/Strain Temperature, °C	Heat Aging Temperature, °C Unreinforced	Heat Aging Temperature, °C Reinforced	Coefficient of Linear Thermal Expansion (CLTE) Range °C	Shrinkage Mold after 16 to 24 h	Shrinkage Post after 48 h at 80 °C	Shrinkage Post after 30 min at 120 °C
PA(polyamide)(1)	ISO 1874-2	–40, 23, 100, 150	110(2)	140(2)	–30 to 150	yes	yes	yes
PC(polycarbonate)	ISO 7391-2	–40, 23, 120	90	120	–30 to 100	yes	yes	yes
PC+ABS(polycarbonate) acrylonitrile/butadiene/ styrene)	ASTM D4673	–40, 23, 80, 100	85	95	–30 to 100	yes	yes	yes
PE(polyethylene)						(3)	(3)	(3)
Branched	ISO 1872-2	23, 50, 65	90	n/a	–30 to 40	yes	no	no
Linear	ISO 1872-2	23, 50, 65	100	n/a	–30 to 50(4)	yes	(5)	(6)
PMMA(polymethyl-methacrylate)								
general purpose	ISO 8257-2	–40, 23, 80	80	n/a	–30 to 100	yes	yes	no
high heat	ISO 8257-2	–40, 23, 90	90	n/a	–30 to 100	yes	yes	no
impact modified	ISO 8257-2	–40, 23, 70	70	n/a	–30 to 100	yes	yes	no
POM(polyoxymethylene)								
Homopolymer	ISO 9988-2	–40, 23, 80, 100	110	110	–30 to 100	yes	yes	yes
Copolymer	ISO 9988-2	–40, 23, 80, 100	120	120	–30 to 100	yes	yes	yes
PP(polypropylene)	ISO 1873-2	0, 23, 100	120	140	–30 to 100	yes	yes	yes
PPE(polyphenylene ether)	ASTM D 4349	–40, 23, 80, 100	TBD	TBD	–30 to 100	yes	yes	no
SMA(styrene/maleic anhydride)		–40, 23, 100	90	110	–30 to 100	yes	yes	yes
TEO(thermoplastic elastomeric olefins)								
flex mod <850MPa		–40, 23, 100	80	120	–30 to 100	yes	yes	yes
flex mod 850-1550 MPa		–40, 23, 100	100	120	–30 to 100	yes	yes	yes
flex mod >1550 MPa		–40, 23, 100	120	120	–30 to 100	yes	yes	yes
TPES(thermoplastic polyesters)	ISO 7792-2	–40, 23, 100, 150	120	140	–30 to 150	yes	yes	yes

1. Samples conditioned in a moisture proof container at 23 °C ± 2 °C for at least 24 hours.
2. Heat stabilized grades only.
3. Mold shrinkage is not appropriate for PE with MFR <0.1 or materials used for compression molding, blow molding or extrusion.
4. Temperature range of –30 to 60 °C for HDPE (high density polyethylene.)
5. Post shrinkage after 48 h at 50 °C for Class 1 (ref. ASTM D 4976) and after 48 h at 60 °C for class 2 and higher (ref. ASTM D 4976).
6. Post shrinkage after 30 min at 70 °C for Class 1 (ref. ASTM D 4976) and after 30 min at 80 °C for Class 2 and higher (ref. ASTM D 4976).

TABLE A2B—INITIAL CHARACTERIZATION OF AUTOMOTIVE MATERIALS

Material	Multiaxial Impact	Charpy Impact at –40 °C	Izod[1] Impact at –40 °C	Luminous Transmittance	Haze	Index of Refraction	Brittleness Temperature	DSC Scan Rate °C/min.
PA(polyamide)[2]	yes	yes	no	no	no	no	no	10
PC(polycarbonate)	yes	no	yes	yes	yes	no	no	20
PC+ABS(polycarbonate+ acrylonitrile/ butadiene/styrene	yes	no	yes	no	no	no	no	20
PE(polyethylene)								
branched	no	no	no	no	no	no	yes[3]	
linear	yes[4]	no	no	no	no	no	yes[3]	20
PMMA(polymethyl-methacrylate)								
general purpose	no	no	no	yes	yes	yes	no	
high heat	no	no	no	yes	yes	yes	no	
impact modified	no	no	yes	yes	yes	yes	no	20
POM(polyoxymethylene)								
homopolymer	no	yes	no	no	no	no	no	
copolymer	no	yes	no	no	no	no	no	10
PP(polypropylene)	yes	yes[5]	yes[5]	no	no	no	no	10
PPE(polyphenylene ether)	no	no	yes	no	no	no	no	10
SMA(styrene/maleic anhydride)	yes	no	yes	no	no	no	no	10
TEO(thermoplastic elastomeric olefins)								
flex mod <850 MPa	yes	no	no	no	no	no	no	
flex mod 850-1550 MPa	yes	no	no	no	no	no	no	
flex mod >1550MPa	yes	no	no	no	no	no	no	20
TPES(thermoplastic polyester)	yes	yes	no	no	no	no	no	10

1. Notched Izod impact is included only for those materials that do not have a data base on notched Charpy impact. It is intended for use only until the data for notched Charpy impact have been compiled and will be removed after 2005.
2. Samples conditioned in a moisture proof container at 23 °C ± 2 °C for at least 24 hours.
3. Only materials with a melt flow rate less than 0.4 g/10 min.
4. Only materials using a 21.6 kg load for melt flow rate determination.
5. Notched impact at –20 °C for heterophasic copolymers only.