Contents of CAMPUS â

Content

Contents of CAMPUS â

Contents of CAMPUS â

1 General Principles

1 General Principles

1.1 Basis of CAMPUS

The basis of CAMPUS are the following three International Standards:

ISO 10350-1, Plastics - Acquisition and presentation of comparable single-point data – Part 1: Moulding materials.

ISO 11403-1, Plastics - Acquisition and presentation of comparable multipoint data - Part 1: Mechanical properties.

ISO 11403-2, Plastics - Acquisition and presentation of comparable multipoint data - Part 2: Thermal and processing properties.

These standards where developed by the Technical Committee ISO/TC 61 “Plastics”, Sub-Committee SC 2 “Mechanical Properties”, Working Group WG 8 “Forms of Data Presentation”. CAMPUS represents an application of these standards in the sense that, as far as possible,

- the data tables in CAMPUS are taken from the above International Standards only,
- the lowest status of development for their application generally being „Draft International Standard, DIS“. This relates to the above indicated standards and to the relevant material and test standards as well.

1.2 Scope of this Document

The status of ISO 10350-1, ISO 11403-1 and ISO 11403-2 and of the many standards involved, combined with the rules of CAMPUS given above, are difficult to handle for all that are less familiar with the standardization system. The present document therefore lists the single-point and multipoint properties included in CAMPUS 5.2 and summarizes the test conditions and supplementary instructions that are given in the standards and often are asked for.

1.3 Specimen Conditioning

1.3.1 Humidity Insensitive Materials

For materials that have properties that are not significantly sensitive to any absorbed water, test specimens are conditioned according to the International Standard appropriate to the material. If the materials standard is not available, condition test specimens at (23 ± 2) °C and (50 ± 10)% r.h. for a minimum length of time of 88 h (see ISO 291, Class 2).

1.3.2 Humidity Sensitive Materials

1.3.2.1 Dry and Humid State

For those materials having properties that are significantly dependent upon the concentration of any absorbed water, consult the relevant materials standard for procedures for conditioning specimens to achieve material that has one of the following two states:

- Dry: For thermoplastics the dry state is that as molded.
- Humid: In equilibrium with an atmosphere of 50% r.h. at 23 °C.

Following such conditioning, all test specimens are stored at (23 ± 2) °C for a minimum of 16 h before testing. The storage atmosphere is either dry (sealed) or at 50% r.h. depending upon the condition of the specimen.

Ensure that humid test specimens do not markedly lose water and dry test specimens do not markedly take up water up to the end of the individual test.

The different states are handled like one material, presenting singlepoint-data in two columns and multipoint data as separate graphics . But with the following exceptions:

1.3.2.2 Exceptions for Single-Point Data

Property		Symbol	Status
Melt volume-flow rate		*MVR*	Dry only
Molding shrinkage for thermoplastics	parallel	S_{Mp}	
	normal	S_{Mn}	
Tensile creep modulus (at room temperature)	1h	$E_{tc}1$	Humid only
	1000h	$E_{tc}10^3$	
Melting temperature		T_m	Dry only
Glass transition temperature		T_g	
Flexural softening temperature		$T_f1,8$	
		$T_f0,45$	
		$T_f8,0$	
Vicat softening temperature		$T_V50/50$	
Coefficient of linear thermal expansion	parallel	a_p	
	normal	a_n	
Burning behavior	1,5 mm thick	*B50/1.5*	Humid only
		B500/1.5	
	–,– mm thick	*B50/-,-*	
		B500/-,-	
Flammability by oxygen index		*OI23*	
Surface resistivity		s_e	
Comparative tracking index		*CTI*	

Table 1: Exceptions for single-point data

1.3.2.3 Exceptions for Multipoint Data

<table>
<tr><th>Property
Variable
Parameter</th><th>Symbol</th><th>Status</th></tr>
<tr><td>Shear modulus (real part)
Temperature</td><td>$G'(T)$</td><td rowspan="4">Dry only</td></tr>
<tr><td>Specific enthalpy difference
Temperature</td><td>$DH(T)/m$</td></tr>
<tr><td>Shear stress (viscosity)
Shear rate
Temperature</td><td>$t(\dot{\gamma},T)$</td></tr>
<tr><td>Specific volume
Temperature
Pressure</td><td>$v(T, p)$</td></tr>
</table>

Table 2: Exceptions for multipoint data

1.3.2.4 Exceptions for Creep Data

Creep tests are carried out in a laboratory with the atmosphere 23 °C / 50 % r.h.. For testing at an elevated temperature this results in test atmospheres of the same absolute but markedly lower relative humidity, that can be calculated according to the following equation.

$$U_T = U_{23} \exp [- T^* (T_{23}^{-1} - T^{-1})] \quad (1.1)$$

where

U_T is the relative humidity at the test temperature T, in % r.h.;

U_{23} is the relative humidity of the laboratory atmosphere, i.e. at 23 °C, in % r.h.;

T_{23} = 296 K is the temperature of the laboratory atmosphere in K;

T is the test temperature in K;

T* = 5213 K.

E.g. starting at the laboratory atmosphere 23 °C / 50 % r.h. and raising the test temperature to T = (60 + 273) K leads to a the test humidity of U_T = 7 % r.h. only. Ensure that for a humidity sensitive material the test specimen is in equilibrium with the relevant test atmosphere before starting the test.

Resulting from the conditions described above the humidity of the test specimens differs between different test temperatures: Creep data of humidity sensitive materials, taken at different temperatures, do not refer to comparable material states.

1.3.3 Ageing of Test Specimens

(Physical) ageing is the change of a property versus time without any chemical change (e.g. decomposition). It takes place after the processing of the test specimen, i.e. after cooling from elevated temperatures to a lower temperature, at which structural relaxation times are long in comparison with the ageing time. Ageing may be generated by volume retardation, relaxation of internal stresses and recrystallization. Its type, amount and rate depends on the ageing temperature.

In case of room-temperature testing the ageing time is the period between cooling down from processing temperatures and reading the property, the minimum of this period being the minimum conditioning time, given in clause 1.3.1 and 1.3.2, i.e. 88 h, and all properties that require testing times up to some hours maximum, conventionally are carried out soon after. Therefore the ageing time and the conditioning time generally are in the same order of magnitude, resulting in extensively comparable ageing states and thus room-temperature properties. This holds too for the testing at low temperatures, which retard further ageing.

The ageing process is more complicated when measurements are made at elevated temperatures: The room-temperature ageing of the conditioning period may at least partly be reversed, followed by a modified ageing type at the higher temperature. For testing the thermal properties melting (T_m), glass (T_g) and softening temperatures (T_f and T_V) as well as the coefficients of thermal expansion (α_p and α_n) the temperature run is fixed in the relevant testing standard. Thus the measured properties are based on states of ageing, which are comparable between different laboratories. In order to ensure this, no conditioning at elevated temperatures is provided beyond the procedures described in the relevant standard for the material. For testing stress-strain diagrams at elevated temperatures a warm-up time as short as possible is used that suffices for attaining homogeneous temperatures. e.g. 20 min to 30 min.

An insufficient state of standardization is present for the testing of creep data: The wide range of testing times between 1 h and 10^3 h or even 10^4 h is not accompanied by suitably fixed conditioning i.e. ageing times. For room-temperature testing the conditioning time of $\leq$ 88 h results in floating ageing states for a large range of the testing-time „window“. For the testing at elevated temperatures even no conditioning procedure is given, though the action of ageing is well described in ISO 899-1, annex A. The only reasonable definition would be: „Condition the test specimen prior to loading at the relevant test temperature, for at least the planned testing time.“ This however will double the amount of time for testing creep data.

1.4 Test Atmosphere

1.4.1 Principles

The test is conducted in the same atmosphere as used for conditioning, or the residence time between conditioning and including testing is short enough to prevent the specimens from undergoing any changes in their material state and hence behavior.

1.4.2 Change of Humidity

The testing of room-temperature properties commonly is carried out at the laboratory atmosphere of 23 °C and 50% r.h.. For testing initially dry plastics, the maximum residence time that avoids unacceptable changes of properties depends on the thickness of the test specimen and the sensitivity of the test method. Up to now the following examples are known.

The tensile modulus versus temperature of PA66 can be described by the following equation:

$$E_t(t) / E_{t0} = 1- 0,028\ t^{1/2}/h \qquad (1.2)$$

where

$E_t(t)$ is the tensile modulus after the residence time t;

E_{t0} is the tensile modulus of the initially dry material;

t is the residence time in hour, h;

h is the specimen thickness in millimeter, mm.

At h = 4 mm thickness e.g., the tensile modulus decreases by 1% within two hours.

The impact strength of initially dry plastics tested at the humid laboratory atmosphere, generally increases with the residence time. For Charpy notched impact strength e.g. the maximum residence time of the test specimens is 8,2 h for PA66 and 3,2 h for PA6 to avoid an increase of more than 5%.

The action of the uncontrolled humidity uptake on the softening temperatures T_f and T_V of initially dry materials has not yet been studied.

1.4.3 Change of Temperature

Differences in temperature between the test specimen and the testing atmosphere can be handled only for short-time tests, i.e. impact tests, and often are advantageous in developing automatic equipment. ISO 179-2 (instrumented Charpy test) gives the recommendation to use resident times less than 10 s for low-temperature-conditioned specimens tested at room temperature.

1.5 Special Symbols [1)]

dry: Dry state of a humidity sensitive material, see clause 1.3.2.

cond: Humid state of a humidity sensitive material, see clause 1.3.2.

\+ „Applicable“ or „used“: For a not-numerical data field, e.g. for functions, manufacturing process methods and additives.

– „Missing“ or „not used“: Instead of a value for a numerical data field and for a not-numerical data field, e.g. functions, manufacturing process methods and additives.

∗ „Not applicable“ or „not relevant“: Instead of a value for a numerical data field, see e.g. table 5 (tensile properties).

> „Greater than“: The relevant property is beyond a limit provided in CAMPUS for recording, e.g. (nominal) strain to break: (ε_{tB}) $\varepsilon_t > 50\%$, or volume and surface resistivity: $\rho_e > 10^{13}\ \Omega$ cm and $\sigma_e > 10^{15}\ \Omega$.

N	„Non break“
P	„Partial break“
H	„Hinge break“
C	„Complete break“

N	„No class satisfied“	Classes of burning behavior, see 2.2.3.5, properties B50 and B500.
HB, V-2, V-1, V-0	See IEC 60695-11-10	
5VA, 5VB	See IEC 60695-11-20	

UL	„UL- Recognized”

B	„Break point”	Designation of an ultimate point of a stress/strain diagram.
Y	„Yield point”	
↑	„Ascending order”	Marks a property, the values of which are sorted
↓	„Descending order”	
⊗	„Polar diagram”	Marks the properties selected for

1) When defining search requirements, CAMPUS will automatically convert lower-case letters or insert missing hyphens.

Contents of CAMPUSâ

2 Single-Point Data

2 Single-Point Data

According to clause 1, the acquisition of the single-point data generally shall be in accordance with ISO 10350-1. With respect to the high number of properties and thus of test methods and test standards involved, it was split up into the following two parts.

Part 1: Moulding materials

Part 2: Long-fibre-reinforced plastics

The indicated symbols were introduced into CAMPUS from version 4.1 onwards. This paper therefore gives the symbols according to ISO 10350-1 commonly for all languages.

In ISO 10350-1 the properties additionally are numbered. These numbers however depend on the exclusion or inclusion of properties and thus differ between the versions of ISO 10350, whereas the symbols represent a permanent designation system. The numbers therefore have not been introduced into CAMPUS.

For the injection or compression molding of test specimens see clause 2.2.7.

For machining specimens from compression molded plates see ISO 2818.

For the conditioning of the test specimens see clause 1.3.

2.1 Summary of Test Conditions

2.1.1 Thermoplastic Materials

Rheological Properties

Property		Symbol	Standard	Specimen (Dimensions in mm)	Unit	Supplementary Instructions	Test conditions
Melt volume-flow rate		MVR	ISO 1133	Material	cm³/10 min	Test conditions according to the relevant material standard	
Molding shrinkage	parallel (p)	S_{MP}	ISO 294-4 (Th.-plast) ISO 2577 (Th.-sets)	60 * 60 * 2	%		parallel to flow direction
	normal (n)	S_{MN}					normal to flow direction

Mechanical Properties

Property		Symbol	Standard	Specimen (Dimensions in mm)	Unit	Supplementary Instructions	Test conditions
Tensile modulus		E_t	ISO 527-1 and -2	ISO 3167 injection molded: type A, machined: type B.	MPa	Determined in the range 0,05- 0,25% strain	1mm/min
Yield stress		σ_Y					50mm/min
Yield strain		ε_Y			%		
Nominal strain at break		ε_{tB}				If Yield stress exists.	
Stress at 50% strain		σ_{50}			MPa	If Yield stress does not exist.	
Stress at break		σ_B				If Yield stress and Stress at 50 % strain don't exist.	If Strain break <= 10%, then 5mm/min If 10% < Strain at break <= 50%, then 50mm/min
Strain at break		ε_B			%	If Yield stress and Stress at 50 % strain don't exist	
Tensile creep modulus	1h	$E_{tc}1$	ISO 899-1		MPa	All strains <= 0.5%.	1h
	1000h	$E_{tc}10^3$				All strains <= 0.5%.	1000h
Charpy impact strength	unnotched	$a_{cU}+23$	ISO 179/1eU	80 * 10 * 4	kJ/m^2	Using conventional impact pendulums and respecting their individual application ranges, that with the largest value of its potential energy possible shall be selec-ted, see ISO 179 (Charpy), 8256 (tensile impact) and 13802 (pendulums). For instrumented Charpy tests see ISO 179-2 Notched: Reliable if Charpy impact strength shows "NB".	+23°C
		$a_{cU}-30$					-30°C
	notched	$a_{cA}+23$	ISO 179/1eA				+23°C
		$a_{cA}-30$					-30°C
Tensile impact strength		a_{t1}	ISO 8256-1			Recommended if Charpy- notched impact strength shows "NB".	+23°C
Puncture impact properties	Max. Force	F_M+23	ISO 6603-2	60 * 60 * 2	N		4,4m/s± 0,2m/s (***)
		F_M-30					
	Punct. Energy	W_P+23			J	Up to the deflection at which the force has dropped down to half the maximum force.	
		W_P-30					
	Transition temperature	T_{db}			°C		

Footnotes:
(*) e: Edge wise blow according to ISO 179: 1993
(**) u: unnotched
(***) This bar may be taken from the central region of the multi- purpose- test specimen according to ISO 3167

Electrical Properties

Property		Symbol	Standard	Specimen (Dimensions in mm)	Unit	Supplementary Instructions	Test conditions
Relative permittivity	100 Hz	ε_r100	ISO 60250	60 * 60 * 2	-		100 Hz
	1 MHz	ε_r1M					1 MHz
Dissipation factor	100 Hz	tanδ100			E-4		100 Hz
	1 MHz	tanδ1M					1 MHz
Volume resistivity		ρ_e	IEC 60093	60 * 60 * 2	Ω m	Use contact electrodes voltage 500V.	
Surface resistivity		σ_e		Plaque with thickness: 1.0mm +/- 0.1mm(*)	Ω	Use contact electrodes voltage 500V. Use contacting line electrodes, 50 mm long and with a gap of 5 mm, and a grounded contacting electrode at the back side of the plate.	
Electric strength		E_B1	IEC 60243-1		kV/mm	Short- time test, voltagerate 2kV/s Immersion in transformer oil according to IEC 60296.	
Comparative tracking index		CTI	IEC 60112	≥15 * ≥15 * 4	-	Test liquid A	

Thermal Properties

Property		Symbol	Standard	Specimen (Dimensions in mm)	Unit	Supplementary Instructions	Test conditions
Melting temperature		T_m	ISO 11357-1 and -3	Material	°C	C 1 b)(DSC or DTA)	10°C/min
Glass transition temperature		T_g	ISO 11357-1 and -2			Method A (DSC or DTA) Only for amorphous, single-phase thermoplastics.	
Temperature of deflection under load (flexural softening temperature)		T_f1,8	ISO 75-1 and -2	80 * 10 * 4 or 110*10*4 (*)		For both rigid and less rigid materials	
		T_f0,45					
		T_f8,0				For rigid materials only	
Vicat softening		T_V50/50	ISO 306	≥ 10 * 10 * 4 (**)			50°C/h; 50N
Coefficient of linear thermal expansion	Parallel (p)	α_p	ISO 11359-1 and -2	(**)	10^{-6}. K^{-1}		23 °C - 55 °C, Normal to the flow direction
		α_p-40					-40 °C - 100 °C, Normal to the flow direction
	Normal (n)	α_n					23 °C - 55 °C, Parallel to the flow direction
		α_n-40					-40 °C - 100 °C, Parallel to the flow direction
Burning behavior	1.5 mm thick	B50/1.5	UL 94 IEC 60695-11-10 IEC 60695-11-20	125 * 13 * 1.5	Class	Indicate class from the following sequence B50:HB, V-2, V-1, V-0 B500: N, 5VA or 5VB	
		B500/1.5		≥150 * ≥150 * 1.5			
	-.- mm thick	B50/-.-		125 * 13 * -.-			
		B500/-.-		≥150 * ≥150 * -.-			
Flammability by oxygen index		OI23	ISO 4589-1 and-2	80 * 10 * 4	%	Method A	
Burning Rate (automotive)		FMVSS	ISO 3795	356 * 102 * 1	mm/min		
Thermal stability in air (Charpy, 50% property retention at 3000 h)		TS_{3000}	IEC 60216-1	80 * 10 * 4	°C	unnotched / notched: state described with symbol *T*stSp	

Footnotes:
(*) This bar may be taken from the central region of the multi- purpose- test specimen according to ISO 3167.

Test specimen	Loading direction	Span
80 mm x10 mm x 4 mm	flatwise	64 mm
110 mm x 10mm x 4 mm	edgewise	100mm

(**) can be taken from the central region of the multipurpose - test specimen according to ISO 3167

Electrical Properties

Property		Symbol	Standard	Specimen (Dimensions in mm)	Unit	Supplementary Instructions	Test conditions
Relative permittivity	100 Hz	ε_r100	IEC 60250	60 * 60 * 2			-
	1 MHz	ε_r1M					
Dissipation factor	100 Hz	tanδ100			10^{-4}		
	1 MHz	tanδ1M			10^{-4}		
Volume resistivity		ρ_e	IEC 60093		Ω m	Use contact electrodes voltage 500V	
Surface resistivity		σ_e			Ω	Use contact electrodes voltage 500V. Use contacting line electrodes, 50 mm long and with a gap of 5 mm, and a grounded contacting electrode at the back side of the plate	
Electric strength		E_B1	IEC 60243-1	≥60 * ≥60 * 1	kV/mm	Short- time test, voltagerate 2kV/s Immersion in transformer oil according to IEC 60296.	
Comparative tracking index		CTI	IEC 60112	≥15 * ≥15 * 4	-	Test liquid A	

Other Properties

Property	Symbol	Standard	Specimen (Dimensions in mm)	Unit	Supplementary Instructions	Test conditions
Water absorption	W_W	ISO 62 and ISO 15512	Thickness ≥ 1	%	Saturation values	23°C immersion in water
Humidity absorption	W_H					
Density	ρ	ISO 1183	≥10 * ≥10 * 4 (*)	kg/m^3		

(*) can be taken from the central region of the multipurpose - test specimen according to ISO 3167

Material Specific Properties

Property	Symbol	Standard	Specimen (Dimensions in mm)	Unit	Supplementary Instructions	Test conditions
Viscosity number	VN	depending on material	material	cm³/g	Test conditions according to the relevant material standard	
Indicative density	ρ_I	ISO 1872-1		kg/m³	Applicable to PE only	
Luminous transmittance	τ_t	ISO 13468-1, -2	60 * 60 *2	%	it is a matter of total transmission, the registration of non-diffuse and possibly diffuse parts of transmission from colorless transparent material	calculation for illuminant D65, CIE standard observer, alternatively C2°

2.1.2 Film Grades

Mechanical Properties

Property		Symbol	Standard	Specimen (Dimensions in mm)	Unit	Supplementary Instructions	Test conditions
Stress at yield	parallel	s_{Yp}	ISO 527-1, -3	strip, 15 mm wide, clamping distance 100 mm	MPa	nominal strains only, relative to clamping distance	
	normal	s_{Yn}					
Strain at yield	parallel	e_{Yp}			%		
	normal	e_{Yn}					
Maximum stress	parallel	s_{Mp}			MPa		
	normal	s_{Mn}					
Maximum strain	parallel	e_{tBp}			%		
	normal	e_{tBn}					
Elmendorf tear resistance	parallel	F_{tp}	ISO 3167	rectangular (63,5 ± 0,5)mm x (75 ± 0,5)mm, cut perpendicular to longer edge, length of cut (20 ± 0,5)			work spent in tearing the specimen shall be between 20% and 80% of the pendulum energy
	normal						
Trouser tear resistance	parallel			rectangular, 50mmx150 mm, cut perpendicular to shorter edge, length of cut (75 ± 1)mm, thickness d <=1 mm			v=200 mm/min
	normal						

Optical Properties

Property		Symbol	Standard	Specimen (Dimensions in mm)	Unit
Gloss	20°	Gloss20	ISO 2813		-
	45°	Gloss45			
	60°	Gloss60			
Haze		Haze	ISO 14782	~ 50 * 50	%

Barrier Properties

Property		Symbol	Standard	Specimen (Dimensions in mm)	Unit
Water vapor transmission rate	23°C; 85% r.h.	WVTR2385	ISO 15106-1 and -2		g/(m²*d)
Oxygen transmission rate	23°C, 0% r.h.	OTR23/0	ISO 15105-1 and -2		cm³/(m²*d*bar)
	23°C, 85% r.h.	OTR23/85			
Carbon Dioxide transmission rate	23°C, 0% r.h.	CDTR23/0			
	23°C, 85% r.h.	CDTR23/85			

2.1.3 Thermoplastic Elastomers (TPE)

Mechanical Properties

Property	Symbol	Standard	Specimen (Dimensions in mm)	Unit	Supplementary Instructions	Test conditions
Stress at 10% strain	s_{10}	ISO 527-1 and -2	ISO 527-1/1BA	MPa	If yield stress does not exist	200 mm/min
Stress at 100% strain	s_{100}					
Stress at 300% strain	s_{300}					
Nominal strain at break	e_{tB}			%	If strain at break is greater than 300%: indicate'>300'	
Stress at break	s_B			MPa		
Compression set under constant strain, 23°C	CS23	ISO 815	type B: plate Ø = 13 mm, d = 6.3 mm	%	Specimens may be stacked if initial thickness is smaller than 6.3 mm. Time of measurement after relief of compression 30 min ISO 815 refers to IRHD in order to define the strain to be applied. IRHD — strain (%) 10 - 95 — 25 80 - 89 — 15 90 - 95 — 10 >95 — not covered -> indicate: '*' Determination of IRHD acc. ISO 48	23°C, 25% strain, 22 -24 h
70°C	CS70					70°C, 25% strain, 22 -24 h
100°C	CS100					100°C, 25% strain, 22 -24 h
Tear strength	TearS	ISO 34-1	angle test specimen with nick	kN/m	Method B, prcedure b. Loading in parallel direction, the cut (nick) is in the normal direction	500 mm/min
Abrasion resistance	AbrRes	ISO 4649		mm³		
Shore A hardness (3s)	ShrA/3	ISO 868	≥ 6 * 25 * 25	-		Indenter Typ A, reading after 3s
Shore D hardness (15s)	ShrD/15					Indenter Typ D, reading after 15s

2.2 Thermoplastic Materials

2.2.1 Rheological Properties

2.2.1.1 Melt Volume-Flow Rate

ISO 1133

Specimen: Material

Property	Symbol	Unit
Melt volume-flow rate	*MVR*	cm^3/10 min

Number values for the test conditions temperature and load are given in the International Standard for the relevant material, see table 6.

Material		Standard	Temperature in °C	Load in kg
PS		ISO 1622-2	200	5
PE		ISO 1872-1	1)	
PP		ISO 1873-1	230	2,16
PA		ISO 1874-2	2)	
ABS		ISO 2580-2	220	10
PS-I		ISO 2897-2	200	5
EVAC		ISO 4613-1	3)	
SAN		ISO 4894-2	220	10
ASA, AEPDS, ACS		ISO 6402-1	220	10
PC		ISO 7391-2	300	1,2
PET, PBT, PCT, PEN		ISO 7792-2	2)	
PMMA		ISO 8257-1	230	3,8
PB		ISO 8986-1	4)	
POM		ISO 9988-2	190	2,16
MABS		ISO 10366-2	220	10
TPC		ISO 14910-2	5)	
PPE	PPE+PS, unfilled	ISO 15103-2	250	10
	(PPE+PS)-Mineralf.		350	5
	PPE+PA		280	5
PK		ISO 15526-1		
LCP				
PES				
PPS				
PPSU				
PSU				
TEEE				

Table 3: Conditions for testing melt volume-flow rate, MVR

[1] A temperature of 190 °C and four loads are indicated in the standard. Please refer to ISO 1872-1, which load shall be used.

[2] This material standard does not provide MVR in the standard property table. Record ∗ (not relevant) for these materials and property.

[3] Three temperatures and two loads are indicated in the standard. Please refer to ISO 4613-2, which combination shall be used.

[4] A temperature of 190 °C and two loads are indicated in the standard. Please refer to ISO 8986-1, which load shall be used.

[5] Three temperatures and load of 2,16 kg are indicated in the standard. Please refer to ISO 14910-2, which temperature shall be used.

2.2.1.2 Molding Shrinkage

ISO 294-4 for Thermoplastics

ISO 2577 for Thermosets

Specimen: 60 * 60 * 2 mm^3

Property	**Symbol**	**Unit**
Molding shrinkage		
parallel (p)	S_{Mp}	%
normal (n)	S_{Mn}	%

For **specimens** prepared by injection molding use mold type D1 for 1 mm thickness and type D2 for 2 mm thickness, respectively, see ISO 294-3 for thermoplastics and ISO 10724-2 for thermosets.

Where specimens are prepared by injection molding, record property values both parallel (p) and normal (n) to the flow direction into the mold. For compression molded specimens record ∗ (not applicable) for the normal direction.

Round robin tests have provided recommended molding parameters for the preparation of test specimens to be used in the determination of shrinkage. These are given in table 7.

Material	**Cavity pressure p_{CH} / MPa**
ABS	50
LCP-GF30	50
PC, PC-GF20	50
PEBA	50
PES, PSU	50
PPE	50
PPS-GF40	50
PS, PS-HI	50
PVDF	50
SAN	50
PA11	60
PA12	60
PA46	60
PA6, PA6-GF15, -GF30, -GF50, -BM230	60
PA612	60
PA63T	60
PBT, PBT-GF10, -GF15, -GF20, -GF30, -GF50, -GK30	60
PET-GF30	60
PP	60
PMMA	70
PA6/6T	90
POM	90

Table 4: Conditions for determination of molding shrinkage

2.2.2 Mechanical Properties

The tests are generally carried out at the standard laboratory conditions 23 °C / 50 % r.h.. For testing the properties of moisture sensitive materials in the dry state (as molded) see clause 1.4.2. For testing low-temperature-conditioned specimens at room temperature see clause 1.4.3.

ISO 3167 describes two types of **specimens** for tensile tests. The type A specimen has a lower value for the radius of the shoulders of 20 mm to 25 mm (recommended: 24 mm ± 1 mm), which thereby enables a central region to be obtained of length at least 80 mm. The standard ISO bar having dimensions 80 mm x 10 mm x 4 mm can thus be cut from the central region of this type of test specimen which is therefore demanded for directly molded specimens. The type B specimen has a larger shoulder radius of >60 mm (recommended: 60 mm ± 0,5 mm) and is provided only for specimens machined from compression molded plates.

2.2.2.1 Tensile Test

ISO 527-1 and -2

Specimen: ISO 3167 A, see 2.2.2

Property	Symbol	Unit
Tensile modulus	E_t	MPa
Yield stress	s_Y	MPa
Yield strain	e_Y	%
Nominal strain at break	e_{tB}	%
Stress at 50% strain	s_{50}	MPa
Stress at break	s_B	MPa
Strain at break	e_B	%

ISO 527-1 demands, that the **prestress** at the start of the tensile test shall be less than the stress at 0,05 % strain, which corresponds to the lower limit of the modulus-testing interval. The clamping procedure, however, generally generates higher values of prestress, positive or negative. These shall be equilibrated to the above given limit before starting the test.

The **tensile modulus** is defined as the secant modulus taken between the strains of 0,05 % and 0,25 %, using the test speed of 1 mm/min.

Instead of using the two distinct stress/strain points the tensile modulus can be determined also by a linear regression procedure applied on the part of the curve between these mentioned points.

Record value of **nominal strain at break** only for specimens that show yielding or a breaking **strain beyond 10 %** when tested at a speed of 50 mm/min. The test speed shall be 50 mm/min, see Figure 1 and Table 5.

After the measurement of the tensile modulus at the test speed of 1 mm/min, the **same test specimen** can be used for testing the other relevant tensile properties. It can be deloaded however intermediately, i.e. starting a second test with the speed of 5 mm/min or 50 mm/min, respectively, at zero point load. Using the one test specimen at both 5 mm/min and 50 mm/min are not allowed.

The **nominal strain** shall be used beyond yielding, see Table 5. Its determination is based upon the relative change of the grip separation L, see Figure 1, upper abscissa, instead of the change of the gauge length L_0, see Figure 1, lower abscissa.

Note that the nominal strain at break can be only half the strain at break formerly used.

The nominal strain at break is additively composed by the strain at yield and the part of nominal strain between yield and break.

If break occurs **above 50 % nominal strain**, record it as >50.

Record s_{50} value for specimens only that show no **yielding up to 50 % strain**, see Table 5.

Record s_B and e_B-values for specimens only that show **break without yielding**. For a strain at break of less than or equal to 10 % when tested at a speed of 50 mm/min the test speed shall be 5 mm/min, see Figure 1. For a strain at break greater than 10 % and up to 50 % when tested at a speed of 50 mm/min the test speed shall be 50 mm/min. See Table 5.

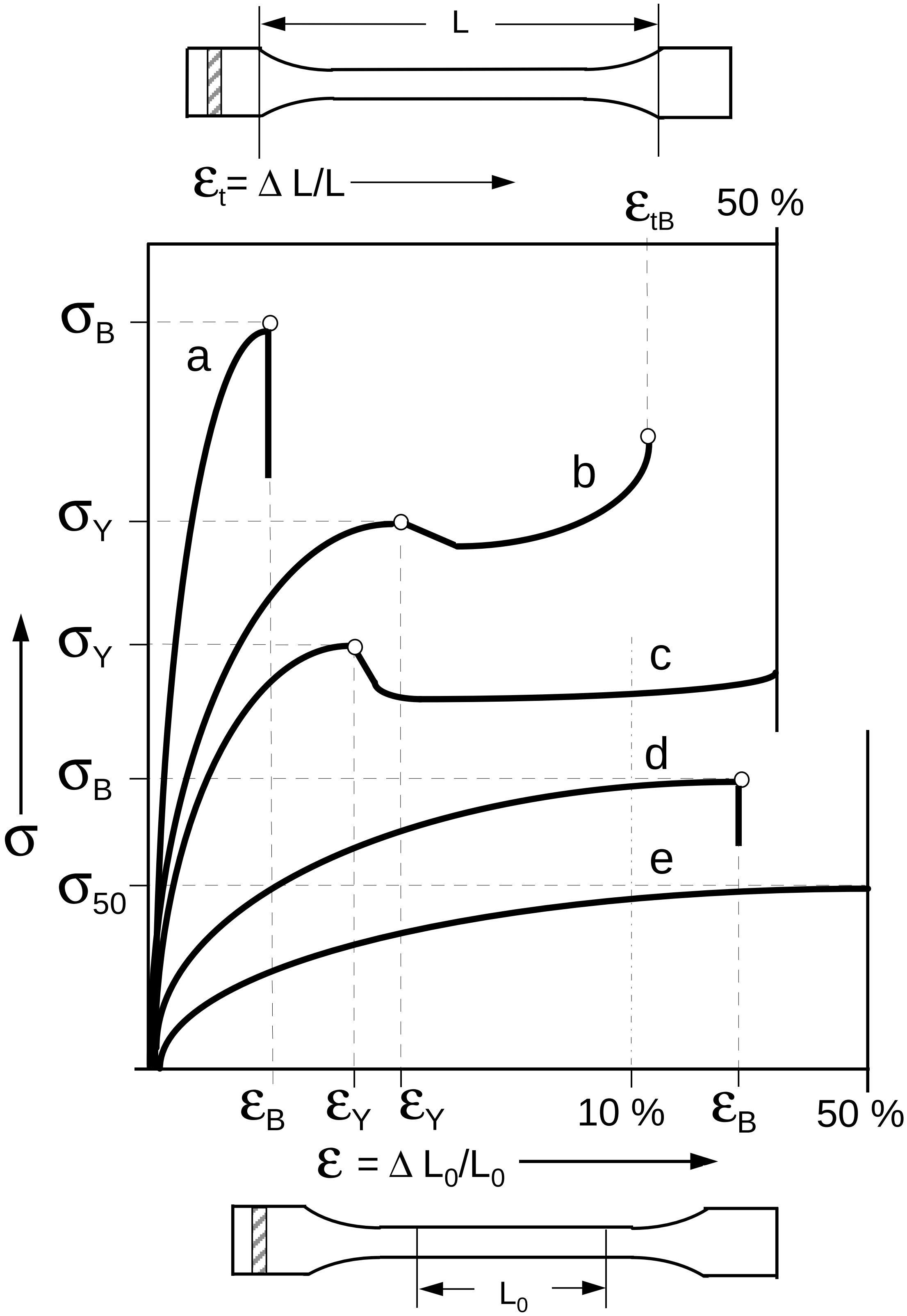
Stress-strain characteristic [1)]	Property						Test speed in mm min^{-1}
	s_Y	e_Y	e_{tB}	s_{50}	s_B	e_B	
a	*	*	*	*	n	n	5
b	n	n	n	*	*	*	50
c	n	n	> 50	*	*	*	50
d	*	*	*	*	n	n	50
e	*	*	*	n	*	> 50	50
f	n	n	-	*	*	*	50

1) Type of stress/strain curve according to Figure 1, if tested at the testing speed of 50 mm min^{-1}.

* Property not relevant

n Number value of the mean property to be recorded

Table 5: Scheme for recording tensile properties and the testing speed to be used



σ_Y	yield stress
ε_Y	yield strain
σ_B	breaking stress
ε_B	breaking strain
ε_{tB}	nominal strain at break
σ_{50}	stress at 50 % strain

Figure 1: Tensile stress/strain curves

2.2.2.2 Tensile Creep Test

ISO 899-1

Specimen: ISO 3167 A, see 2.2.2

Property	Symbol	Unit
Tensile creep modulus		
1h	$E_{tc}1$	MPa
1000h	$E_{tc}10^3$	MPa

All strains shall be below 0,5 %. For the effects of ageing see ISO 899-1, annex A, and clause 1.3.3. of this document.

2.2.2.3 Charpy Impact Test

ISO 179-1 and –2

ISO 179 is split up into two parts, covering non-instrumented (Part 1) and instrumented (Part 2) tests. These test methods are regarded as equivalent.

Specimen: 80 * 10 * 4 mm³ cut from the middle of the multipurpose test specimen ISO 3167 A, see 2.2.2

Property		Symbol	Unit
Unnotched Charpy impact strength	23°C	$a_{cU}+23$	kJ/m²
	-30°C	a_{cU} -30	kJ/m²
Notched Charpy impact strength	23°C	$a_{cA}+23$	kJ/m²
	-30°C	a_{cA} -30	kJ/m²

Symbols *are as follows.*

a	*Impact strength*
c	*Charpy*
1	*Specimen type 80 * 10 * 4*
e	*Edgewise impact, see below*
U	*Unnotched*
A	*V notch, r = 0,25 mm, 8 mm remaining width at notch base*
+23	*Temperature in °C*
-30	*Temperature in °C*

The direction of blow shall be edgewise.

For details of impact **pendulums** see ISO 13802.

Using conventional impact pendulum machines and respecting their individual application ranges of 10%-80% of their potential energy, that with the highest potential energy possible shall be used, see ISO 179-1.

Machine **notches** in accordance with ISO 2818. Use a single cutter tool and select values of the feed speed and of the chip thickness, the window of ranges for which is given in the standard.

2.2.2.4 Tensile Impact Test

ISO 8256

Specimen: 80 * 10 * 4 mm³, Double-V notch r = 1 mm, 6 mm remaining width at notch base, see also 2.2.2

Property	Symbol	Unit
Tensile impact strength	$a_t 1$	kJ/m²

***Symbols** are as follows.*

a	*Impact strength*
t	*tensile*
1	*Specimen type 80 x 10 x 4*
+23	*Temperature in °C*

For details of conventional **impact pendulums** see ISO 13802.

Using conventional impact pendulum machines and respecting their individual application ranges, that with the highest potential energy possible shall be used, see ISO 8256.

Machine **notches** in accordance with ISO 2818. Use a single cutter tool and select values of the feed speed and of the chip thickness, the window of ranges for which is given in the standard.

2.2.2.5 Puncture Impact Test

ISO 6603-2

Specimen: 60 * 60 * 2 mm³

Property		Symbol	Unit
Maximum force	23°C	$F_M 23$	N
	-30°C	F_M-30	N
Puncture energy	23°C	$W_p 23$	J
	-30°C	$W_{p\text{-}}30$	J
Transition temperature		T_{ab}	°C

For **specimens** prepared by injection molding use mold type D2 for 2 mm thickness, see ISO 294-3 for thermoplastics and ISO 10724-2 for thermosets.

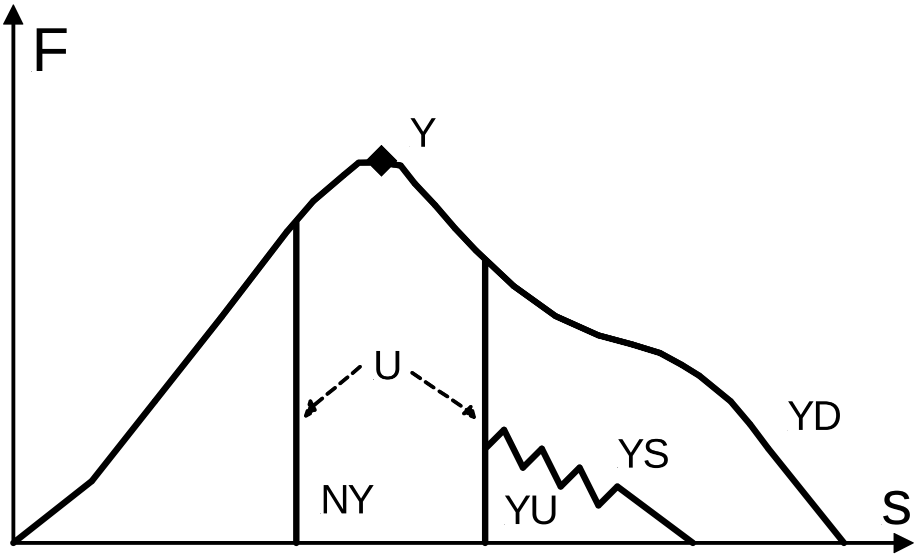
Use a **striker velocity** of 4,4 m/s ± 0.2 m/s (falling height 1 m), which shall not decrease by more than 20% during impact. In case of a falling mass system, its minimum potential energy therefore shall by 3 times the puncture energy.

Use a striker with a **diameter** of 20 mm, lubricated at its top by oil or grease in the viscosity range of 10^{-2} Pa·s ≤ η ≤ 10^{1} Pa·s, equipped by a force detector near its top resulting in a minimum natural frequency of the device of 6 kHz.

Clamp the test specimen by a force that is sufficiently high to prevent the test specimen from any out-of-plane movement of its outer regions. The diameter of the unclamped central area of the test specimen shall be 40 mm.

The **puncture energy** is taken at 50% decrease in force after the maximum.

Record data only for material with sufficiently high toughness at 23°C is. For materials that show failure type NY, see *Figure 2*, record ∗ (inapplicable)



YD **Y**ielding (zero slope at maximum force) followed by **D**eep drawing

YS **Y**ielding (zero slope at maximum force) followed by (partially) **S**table crack growth

YU **Y**ielding (zero slope at maximum force) followed by **U**nstable crack growth

NY **N**o **Y**ielding

Figure 2: Curves of Force F versus displacement s for puncture testing and failure

For the ductile-brittle transition temperature a series of puncture tests is conducted at various test temperatures. It's value is taken as the temperature where the maximum change in puncture energy occurs when plotted as a function of test temperature.

2.2.3 Thermal Properties

2.2.3.1 Differential Scanning Calorimetry

ISO 11357-1, -2 and -3

Specimen: Material

Property	Symbol	Unit
Melting temperature	T_m	°C
Glass transition temperature	T_g	°C

For **melting temperature** use 10 °C/min. Record melting peak temperature.

For **glass transition temperature** use 10 °C/min. Record midpoint temperature.

2.2.3.2 Temperature of Deflection under Load

ISO 75-1 and -2

Specimen: 80 * 10 * 4 mm³, see also 2.2.2

Property	Symbol	Unit
Temperature of deflection under load		
A	*T_f1.8*	°C
B	*T_f0.45*	°C
C	*T_f8.0*	°C

The **designations and abbreviations** that have been used for the property are somewhat confusing: On the one hand the long-term type of the „Temperature of Deflection Under Load, DTUL“ will not find common usage, on the other hand the commonly used abbreviation „HDT“ has no standardized wording. The designation therefore is: „Flexural softening temperature, T_f“, similar to the „Vicat softening temperature, T_V“.

The Numbers of symbols indicate flexural stress (i.e. maximum surface stress) in MPa:

Use 1,8 MPa and one other value.

The 80 * 10 * 4 mm³ bars are loaded **flatwise** with a support span of 64 mm, as in flexural testing (ISO 178). Beyond the procedures described in the relevant standard for the material no conditioning at elevated temperatures is allowed, see clause 1.3.3.

2.2.3.3 Vicat Softening Temperature

ISO 306

Specimen: ≥10 * 10 * 4 mm³

Property	Symbol	Unit
Vicat softening temperature	*T_V50/50*	°C

The numbers of the symbol indicate the heat rate in °C/h and the load in N.

For **injection molded test specimens** carry out the test at the central region of the multipurpose test specimen where possible.

Use a **heating rate** of 50 °C/h and a load of 50 N.

Beyond the procedures described in the relevant standard for the material **no conditioning** at elevated temperatures is allowed, see clause 1.3.3.

This property is less suitable for thermosets and semi crystalline materials.

2.2.3.4 Linear Thermal Expansion

ISO 11359-1 and -2

Specimen: For injection molded test specimens carry out the test at the central region of the multipurpose test specimen where possible.

Property	Symbol	Unit
Coefficient of linear thermal expansion		
parallel (p)	a_p, α_p-40	10^{-6}/K
normal (n)	a_n, α_n-40	10^{-6}/K

Where specimens are prepared by **injection molding**, record property values both parallel (p) and normal (n) to the flow direction into the mold. For **compression molded** specimens record ∗ (not applicable) for the normal direction.

Record the **secant slope** of the specimen relative length change over the temperature range 23 °C to 55 °C or -40 °C to 100 °C (VDA datasheet).

$$a = \frac{L_1 - L_0}{L_0 (T_1 - T_0)}$$

2.2.3.5 Burning Behavior

IEC 60695-11-10 and –11-20

Specimen: 50 W flame: 125 * 13 * thickness mm^3

500 W flame: ≥150 * ≥150 * thickness mm^3

Property	Symbol	Unit
Burning behavior		
1,5 mm thickness	*B50/1.5*	Class
-.- mm thickness	*B50/–.–*	Class
Burning behavior 5V		
-.- mm thickness	*B500/–.–*	Class

***Symbols** are as follows.*

B *Burning behavior*
50 *Small flame (50 W)*
500 *500 W Flame*
1.5 *Thickness in mm*
-.- *Thickness in mm to be recorded*

Record one of the following **classifications**:

- 50 W flame: V-0, V-1, V-2, HB or N, where N indicates, that the material does not satisfy the criteria of any of the other classes.
- 500 W flame: 5VA, 5VB or N, where N indicates, that the material does not satisfy the criteria of any of the other classes.

2.2.3.6 Flammability

ISO 4589-1 and -2

Specimen: 80 * 10 * 4 mm³

Property	Symbol	Unit
Flammability by Oxygen index	*OI23*	%

Test at ambient **temperature**, Use **procedure** A: top surface ignition.

2.2.3.7 Burning Rate

ISO 3795 (Federal Motor Vehicle Safety Standard §572.302)

Specimen: 356 * 102 * 1 mm³

Property	Symbol	Unit
Burning rate (Thickness 1 mm)	*FMVSS*	mm/min

2.2.4 Electrical Properties

The tests are generally carried out at the standard laboratory conditions 23 °C / 50 % r.h.. For testing the properties of moisture sensitive materials in the dry state (as molded) see clause 1.4.2. For testing low-temperature-conditioned specimens at room temperature see clause 1.4.3.

2.2.4.1 Dielectric Properties

IEC 60250

Specimen: 60 * 60 * 2 mm³

Property	Symbol	Unit
Relative permittivity		
100 Hz	$e_r 100$	
1 MHz	$e_r 1M$	
Dissipation factor		
100 Hz	$\tan d 100$	10^{-4}
1 MHz	$\tan d 1M$	10^{-4}

For **specimens** prepared by injection molding use mold type D2 for 2 mm thickness, see ISO 294-3 for thermoplastics and ISO 10724-2 for thermosets.

Compensate for **electrode edge effects**.

2.2.4.2 Resistivity

IEC 60093

Specimen: 60 * 60 * 2 mm³

Property	Symbol	Unit
Volume resistivity	r_e	Ωm
Surface resistivity	s_e	Ω

For **specimens** prepared by injection molding use mold and type D2 for 2 mm thickness, see ISO 294-3 for thermoplastics and ISO 10724-2 for thermosets.

To gain reproducible values it is necessary to be aware of **polarization effects** by shortening the electrodes and measuring discharge current until it is constant, before starting the test.

For Volume resistivity values larger than 10^{13} Ωm record $>\mathbf{10^{13}}$.
For Surface resistivity values larger than 10^{15} Ω record $>\mathbf{10^{15}}$.

For the volume-resistivity record 1-minute value after electrification.

Use contacting line **electrodes** 1 mm to 2 mm width, 50 mm long and 5 mm apart, a grounded contacting electrode at the back side of the plate and the test voltage of 500V.

2.2.4.3 Electric Strength

IEC 60243

Specimen: ≥60 * ≥60 * 1 mm³

Property	Symbol	Unit
Electric strength	E_B1	kV/mm

For **specimens** prepared by injection molding use mold type D1 for 1 mm thickness, see ISO 294-3 for thermoplastics and ISO 10724-2 for thermosets.

For testing electric strength use 1 mm **thickness** and the small tolerance of ± 0,1 mm.

If the specimen type 60 mm x 60 mm x 1 mm shows **discharge** along the surface, use larger compression molded test specimens with 1 mm thickness.

Use 20 mm diameter spherical **electrodes**. Immerse in transformer oil in accordance with IEC 60296. Use the short-time test with a voltage application rate of 2 kV/s.

2.2.4.4 Comparative Tracking Index

IEC 60112

Specimen: ≥15 * ≥15 * 4 mm³

Property	Symbol	Unit
Comparative tracking index	*CTI*	

For injection molded **specimens** use test specimens from the shoulder of the multipurpose test specimen.

Use **solution A**.

2.2.5 Other Properties

2.2.5.1 Water and Humidity Absorption

ISO 62 and ISO 15512

Specimen: Thickness ≥1 mm

Property	Symbol	Unit
Water absorption	W_W	%
Humidity absorption	W_H	%

For **specimens** prepared by injection molding use mold type D1 for 1 mm thickness and type D2 for 2 mm thickness, respectively, see ISO 294-3 for thermoplastics and ISO 10724-2 for thermosets.

For **water absorption** record saturation value in water at 23 °C.

For **humidity absorption** record saturation value at 23 °C/ 50% r.h..

2.2.5.2 Density

ISO 1183

Specimen: For injection molded test specimens carry out the test at the central region of the multipurpose test specimen where possible.

Property	Symbol	Unit
Density	r	kg/m³

The four methods specified in ISO 1183 are regarded as equivalent.

2.2.6 Material Specific Properties

These material specific properties are not included in ISO 10350-1.

2.2.6.1 Viscosity Number

ISO: see Table 6

Specimen: Material

Property	Symbol	Unit
Viscosity number	VN	cm³/g

Material		Standard	Solvent (Temp. in °C, if different from 25 °C) [1]	Concentration in g/l
PA6, 66, 66, 69, 610, 612 and 6/6T		ISO 307	Sulphuric acid	5
PA11, 12, 11/12 and all PA reinforced by chalk			m-Cresol	
PVC		ISO 1628-2	Cyclohexanone	5
PE and PP	$40 < VN < 200$	ISO 1628-3 and Techn. Corrigend. 1	Decahydronaphthaline (135)	5
	$200 < VN < 1000$			1
	$1000 < VN < 5000$			0,2
PC		ISO 1628-4	Dichloromethane	5
PET		ISO 1628-5, ISO 7792-1	Phenol / 1.2-dichlorobenzene	
PBT and ET/BT				
PMMA		ISO 1628-6	Chloroform	2,6
PS		ISO 1622-2	[2]	
ABS		ISO 2580-2		
PS-I (SB)		ISO 2897-2		
SAN		ISO 4894-2		
ASA, AEDPS, ACS		ISO 6402-2		
POM		ISO 9988-2		
MABS		ISO 10366-2		
EVAC		ISO 4613-2	See ISO 1628-3	
PB		ISO 8986-2		
TPR		ISO 14910-2		
PK		Item 686A		
LCP, PES, PES, PPS, PPSU, PSU and TEEE		unknown		

[1] For the purpose of comparable data only a unique set of test parameters have been selected for each type of polymer. For some polymer types the testing or the material standard give several sets of test conditions, i.e. solvents/temperatures. In case where suitable equations are given, the data may be measured using test conditions differing from Table 6 and converted to those indicated in Table 6.

[2] This material standard does not provide VN in the standard property table. Record ∗ (not relevant) for these materials and property.

Table 6: Conditions for testing viscosity number, VN

2.2.6.2 Indicative Density

ISO 1872-1

Specimen: Material

Property	Symbol	Unit
Indicative density (for PE only)	r_I	kg/m³

2.2.6.3 Luminous Transmittance

ISO 13468-1, -2

Specimen: 60 * 60 * 2 mm³

Property	Symbol	Unit
Luminous transmittance	t_t	%

Calculation for illuminant D65 with CIE standard observer, alternatively C2°.

The total transmission shall be recorded. That is the non-diffuse and possibly diffuse parts of transmission from colorless transparent material.

2.2.7 Processing Conditions for Test Specimens

For injection or compression molding, the **procedures** described in ISO 293, ISO 294-1 and -3, ISO 295 or ISO 10724-1 and -2 shall be used. The molding method and the conditions are specified in the relevant International Standard for the material. If molding conditions have not yet been standardized, they shall represent the centre of the recommended processing ranges. In each case and for each of the processing methods they shall be the same for every specimen.

If only **compression molding** conditions are indicated, all test specimens shall be compression molded. If both compression and injection molding conditions are indicated, only the plates larger than 60 mm x 60 mm shall be compression molded.

Material standards, Part 2: ISO ...-2

2.2.7.1 Injection Molding (I) of Thermoplastics (P)

ISO 294-1 and –3 and Table 7, Table 8 and Table 9

Property	Symbol	Unit
Melt temperature	$T_M IP$	°C
Mold temperature	$T_C P$	°C
Injection velocity	$v_I P$	mm/s
Pressure at hold	p_H	MPa

The values for the **injection velocity** v_I to be recorded shall be taken for processing multipurpose-test specimens and bars, using the ISO molds type A or B, see ISO 294-1. For the other specimen types, i.e. small plates (ISO molds D1 or D2, see ISO 294-3), it is recommended that the relevant injection velocity v_I be chosen such that the injection time t_I is comparable to that used for the ISO mold type A.

The values for the **pressure at hold** p_H to be recorded are suitable for processing 4 mm thick test specimens, i.e. multipurpose-test specimens and bars, using the ISO molds type A or B, see ISO 294-1. For the other specimen types, i.e. small plates (ISO molds D1 or D2, see ISO 294-3), markedly lower values may be sufficient to prevent the test specimen from sink marks.

Material	Standard	Group[2)		T_{MI}[3)	T_C[4)	v_I[5)	p_H[6) 7)	w_W[7) 8)
PE	ISO 1872-2	1 < MVR		210	40	100*	70	≤ 0,2
PP	ISO 1873-2	MVR < 2^{C}		255		200*		
		2^{C} ≤ MVR ≤ 10^{C}		230				
		10^{C} < MVR		200				
PS	ISO 1622-2			220	45	200**	100	
PS-I	ISO 2897-2	General purpose		220				
		Flame retarded		210				
ABS	ISO 2580-2	All grades		250	60			
		Flame retarded		220				
MABS	ISO 10366-2			245				
ASA, AES and ACS	ISO 6402-2			250				≤ 0,1
SAN	ISO 4894-2			240				
PMMA	ISO 8257-2	MVR ≤ 1		270	T_V50/50 - 40 °C [9)	250**	70	
		1 < MVR ≤ 2		260				
		2 < MVR ≤ 4		250				
		4 < MVR ≤ 8		240				
		8 < MVR ≤16		230				
		16 < MVR		220				
PC	ISO 7391-2	MVR ≤ 5		310	90	200**		≤ 0,02
		5 < MVR ≤ 10		300	80			
		10 < MVR ≤ 15		290				
		15 < MVR		280				
		Filled / reinforced		300	110			
PBT	ISO 7792-2	Unfilled		260	80			
		Imp. mod. / flame r.		250				
		Filled		260				
		Filled, imp.m.a.fl.r.		250				
PET		Unfilled	Amorph.	285	20			
			Crystall.	275	135			
		Filled, crystall.	Unnucl.	285				
			Nucleat.		110			
		Flame ret	Unnucl.	275	135			
			Nucleat		110			
PCT		Unfilled	Amorph.	300	20			
			Crystall.		120			
		Filled, semicrystall.						
PEN		Unfilled, amorph.			20			
TEEE	[7)	Shore D	70	240	45			≤ 0,1
			55	230				
			40	190				

Table 7: Processing conditions for injection molding thermoplastic materials[1).
(For polyamides see Table 8, for polyphenylene ether see Table 9.)

Material	Standard	Group[2]		T_MI[3]	T_C[4]	v_I[5]	p_H[6) 7)]	w_W[7) 8)]
POM Homopol.	ISO 9988-2	Unmodified	MFR ≤ 7	215	90	140**	100	≤ 0,15
			MFR > 7			300**		
		Impact modified	MFR ≤ 7		60	140**		
			MFR > 7			300**		
POM Copol.		Unmodified		205	90	200**		
		Impact modified			80			
PPS	7)			330	145	400***		
LCP	7)			295	100	300**		
EVOH	ISO 14663-2	F = 0	15< EC≤ 30	220	5	150		
			30< EC≤ 45	200	50			
			45< EC≤ 60	180				
		F≤ 30	15< EC≤ 30	230	60			
		F≤ 30	15< EC≤ 30	250				
EVAC	ISO 4631-2							
TPC	ISO 14910-2							
PK-EP	ISO 15526-2	$205 < T_m \leq 215$		235	80	200**	70	
		$215 < T_m \leq 225$		245				
		$225 < T_m \leq 235$		255				
		$235 < T_m \leq 245$		265				
		$245 < T_m \leq 255$		275				
PK-E	ISO 15526-2	$255 < T_m$		275				
LCP								
PES								
PPSU								
PSU								

1) Except for the maximum water content w_W only those parameters have been included that are indicated in ISO 10350-1 and ISO 11403-1. Some material standards give numbers for additional data, e.g. cooling time or cycle time, which however cannot be used commonly for all types of molds. For these data therefore see the general regulations given in ISO 294-1.

2) MVR: Melt volume-flow rate in ccm/10 min, tested at a load, of 2,16 kg. For the test temperatures see table 6. The sign ^{C} indicates, that the values are converted from MFR data.

T_m: Melting temperature.
F: Filling
EC: Ethylene content

3) T_MI: Melt temperature of injection molding (I) in °C.

4) T_C: Mold cavity temperature in °C.

5) v_I: Injection velocity in mm/s. For the use of data see 2.2.7.1.
Tolerances are: * ± 20 mm/s; ** ± 100 mm/s and *** ± 200 mm/s.

6) p_H: Hold pressure in front of the screw, in MPa, tolerance: ± 10 MPa. For testing molding shrinkage, S_M, see clause 2.2.1.2.

7) Values recommended by CAMPUS.

8) w_W: Water content in % m/m.

9) $T_V50/50$: Vicat softening temperature, see clause 2.2.3.3.

Polymer	**VN[2)]-Group**	**w_G[3)]**	**w_P[4)]**	**T_MI[5)]**	**T_C[6)]**	**v_I[7)]**	**p_H[8) 9)]**	**w_W[9) 10)]**
	VN ≤ 160			250				
PA6	160 < VN ≤ 200	0		260				
	200 < VN ≤ 240			270				
	240 ≤ VN	$w_G \le 50$			80			
	VN ≤ 200	0		290				
PA66	VN ≤ 160	$10 \le w_G \le 50$						
		$50 \le w_G \le 70$		300	100			
PA46	VN ≤ 260	$w_G \le 50$		315	120			
PA69, PA610	VN ≤ 200	0		270				
	VN ≤ 150			240				
	150 < VN ≤ 200	$w_G \le 10$		250				
	200 < VN ≤ 250		0	270				
PA612	VN ≤ 140	$10 \le w_G \le 30$		250				≤ 0,2
		$30 \le w_G \le 50$		260				if
	140 < VN ≤ 180	$10 \le w_G \le 30$						VN
		$30 \le w_G \le 50$		270				≤ 200
				210	80			
	150 < VN ≤ 200	0		230				≤ 0.1
	200 < VN ≤ 240			250		200	70	if
PA11	VN ≤ 130	$30 \le w_G \le 50$		230				VN
	130 < VN ≤ 240	$10 \le w_G \le 20$		250				> 200
		$20 \le w_G \le 50$						and
PA12	VN ≤ 130			200				for
	120 < VN ≤ 150			210				PA46
	150 < VN ≤ 200	$w_G \le 10$	≤ 5	220				
	200 < VN ≤ 240			240				
	VN ≤ 150			200				
	150 < VN ≤ 200	0	> 5	210	70			
	200 < VN ≤ 250			220				
	VN ≤ 130	$10 \le w_G \le 30$		230				
		$30 \le w_G \le 50$		240	80			
	130 < VN ≤ 180	$10 \le w_G \le 30$						
		$30 \le w_G \le 50$		250				
PAMXD6	VN ≤ 130	0	0	260	130			
	VN ≤ 130	$20 \le w_G \le 50$		270				
	130 < VN ≤ 160			280				
PANDT/INDT	VN ≤ 160	0			80			≤ 0,1
	VN ≤ 120	$20 \le w_G \le 50$		300				

Table 8: Processing conditions for injection molding polyamides (ISO 1874-2)[1)]

[1)] Except for the maximum water content w_W only those parameters have been included that are indicated in ISO 10350-1 and ISO 11403-1. Some material standards give numbers for additional data, e.g. cooling time or cycle time, which however cannot be used commonly for all types of molds. For these data therefore see the general regulations given in ISO 294-1.

2) VN: Viscosity number, see clause 2.2.6.1.

3) w_G: Glass content in %(m/m).

4) w_P: Plasticizer content in % (m/m).

5) T_MI: Melt temperature of injection molding (I) in °C.

6) T_C: Mold cavity temperature in °C.

7) v_I: Injection velocity in mm/s, ± 100 mm/s. For the use of data see clause 2.2.7.

8) p_H: Hold pressure in front of the screw, in MPa, tolerance: ± 10 MPa. For testing molding shrinkage, S_M, see clause 2.2.1.2.

9) Values recommended by CAMPUS.

10) w_W: Water content in % m/m.

Polymer	T_f1,8[2] -Group	w_F[3]	T_MI[4]	T_C[5]	v_I[6]	p_H[7) 8)]	w_W[8) 9)]
PPE	210 < T_f1,8	0	340	120	200 ± 100	70 ± 10	< 0,05
PPE+PS	T_f1,8 ≤ 90	0	260	60			
	90 < T_f1,8 ≤ 110	≤ 50	240				
	110 < T_f1,8 ≤ 130		280	80			
	130 < T_f1,8 ≤ 150		290				
	150 < T_f1,8 ≤ 160		310	120			
	160 < T_f1,8 ≤ 170		320				
	170 < T_f1,8 ≤ 200		340				
	200 < T_f1,8	0					
PPE+PA	160 < T_f1,8 ≤ 180	≤ 50	290	190			
	180 < T_f1,8		300	100			
PPE+ +other		≤ 30	280	80			
		30 < w_F ≤ 50	300	100			
	180 < T_f1,8 ≤ 190	0	290	90			
		≤ 50	300	100			
	190 < T_f1,8 ≤ 200	0	310	120			
	200 < T_f1,8	≤ 50	320	120			
PPE+PS+ +other	190 < T_f1,8 ≤ 200						

Table 9: Processing conditions for injection molding polyphenylene ether (ISO 15103-2)[1]

1) Except for the maximum water content w_W only those parameters have been included that are indicated in ISO 10350-1 and ISO 11403-1. Some material standards give numbers for additional data, e.g. cooling time or cycle time, which however cannot be used commonly for all types of molds. For these data therefore see the general regulations given in ISO 294-1.

2) T_f1,8: Flexural softening temperature at the flexural stress of 1,8 MPa.

3) w_F: Filler content in %(m/m).

4) T_MI: Melt temperature of injection molding (I) in °C.

5) T_C: Mold cavity temperature in °C.

6) v_I: Injection velocity in mm/s. For the use of data see clause 2.2.7.

7) p_H: Hold pressure in front of the screw, in MPa, tolerance: ± 10 MPa. For testing molding shrinkage, S_M, see clause 2.2.1.2.

8) Values recommended by CAMPUS.

2.2.7.2 Injection Molding (I) of Thermosets (S)

ISO 10724-1, -2

Property	**Symbol**	**Unit**
Injection temperature	$T_M IS$	°C
Mold temperature	$T_C S$	°C
Injection velocity	$v_I S$	mm/s
Cure time	$t_C I$	s

The values for the **injection velocity** v_I to be recorded shall be taken for processing multipurpose-test specimens and bars, using the ISO molds type A or B, see ISO 10724-1. For the other specimen types, i.e. small plates (ISO molds D1 or D2, see ISO 10724-1), it is recommended that the relevant injection velocity v_I be chosen such that the injection time t_I is comparable to that used for the ISO mold type A.

2.2.7.3 Compression Molding (C) of Thermoplastics (P)

ISO 293 and table 13

Property	**Symbol**	**Unit**
Molding temperature	$T_M CP$	°C
Mold time	t_M	min
Cooling rate	R_C	K/min
Demolding temperature	T_D	°C

<table>
<tr><th>Material</th><th>Standard</th><th>Group</th><th>$T_M C$ 1)</th><th>R_C 2)</th><th>T_D 3)</th></tr>
<tr><td rowspan="3">PE</td><td rowspan="2">ISO 1872-2</td><td>LD</td><td rowspan="2">180</td><td rowspan="10">15</td><td rowspan="3">≤ 40</td></tr>
<tr><td>HD</td></tr>
<tr><td>ISO 11542-2</td><td>UHM</td><td>210</td></tr>
<tr><td rowspan="3">PVC-U</td><td rowspan="3">ISO 1163-2</td><td></td><td>T_V50/50 + 100 °C</td><td rowspan="3">40 ± 2</td></tr>
<tr><td>VC/VAC</td><td>T_V50/50 + 90 °C</td></tr>
<tr><td>Acryl-modified</td><td>T_V50/50 + 105 °C</td></tr>
<tr><td rowspan="3">PVC-P</td><td rowspan="3">ISO 2898-2</td><td>Shore < 35</td><td>135 to 160</td><td rowspan="3">≈ 40</td></tr>
<tr><td>35 ≤ Shore ≤ 50</td><td>145 to 170</td></tr>
<tr><td>50 < Shore</td><td>170 to 180</td></tr>
<tr><td rowspan="2">EVAC</td><td rowspan="2">ISO 4613-2</td><td>≤ 10 % VAC</td><td>155</td><td rowspan="2">≤ 40</td></tr>
<tr><td>> 10 % VAC</td><td>125</td></tr>
<tr><td>PB</td><td>ISO 8986-2</td><td></td><td>200</td><td>30</td><td>30 ± 5</td></tr>
<tr><td>TPR</td><td>ISO 14910-2</td><td></td><td></td><td></td><td></td></tr>
</table>

PK	ISO 15526-2				
LCP					
PES					
PPS					
PPSU					
PSU					
TEEE					

Table 10: Processing conditions for compression molding thermoplastic materials

1) $T_M C$: Molding temperature of compression molding (C) in °C.

2) R_C: Cooling rate in °C / min.

3) T_D: Demolding temperature in °C

2.2.7.4 Compression Molding (C) of Thermosets (S)

ISO 295

Property	**Symbol**	**Unit**
Mold temperature	$T_M CS$	°C
Cure time	$t_C C$	min

2.2.8 Other stability properties

The following properties are not described in ISO 10350 but instead in VDA 232-201.

The weather stability properties are determined after exposure according to ISO 4892-2A for 750 h, the light stability properties after exposure according to ISO 4892-2B for 250 h.

Property	**Symbol**	**Unit**	**Standard**
Weather stability delta l	WS Δl	-	ISO 11664-4
Weather stability delta a	WS Δa	-	ISO 11664-4
Weather stability delta b	WS Δb	-	ISO 11664-4
Weather stability delta E	WS ΔE	-	ISO 11664-4
Weather stability grey scale	WS Grey	-	ISO 105-A02
Light stability delta l	LS Δl	-	ISO 11664-4
Light stability delta a	LS Δa	-	ISO 11664-4
Light stability delta b	LS Δb	-	ISO 11664-4
Light stability delta E	LS ΔE	-	ISO 11664-4
Light stability grey scale	LS Grey	-	ISO 105-A02
Emission of organic compounds	EOC	µg C/g	VDA 277
Thermal desorption analysis of organic emissions	TDS_{oc}	µg/g	VDA 278
Odor test*	Odor	-	VDA 270 B 3

Footnotes:
(*) Evaluation after storage of 3 plates 60 x 60 x 2 (mm)³ for 2 h ± 10 min at 80 °C.

2.3 Film Grades

2.3.1 Mechanical Properties

The tests are generally carried out at the standard laboratory conditions 23 °C / 50 % r.h.. For testing the properties of moisture sensitive materials in the dry state (as molded) see clause 1.4.2. For testing low-temperature-conditioned specimens at room temperature see clause 1.4.3.

2.3.1.1 Tensile Test

ISO 527-1 and -3

Specimen: strip, 15 mm wide

Property		Symbol	Unit
Yield stress	parallel	s_{Yp}	MPa
	normal	s_{Yn}	MPa
Yield strain	parallel	e_{Yp}	%
	normal	e_{Yn}	%
Maximum stress	parallel	s_{Mp}	MPa
	normal	s_{Mn}	MPa
Maximum nominal strain	parallel	e_{tBp}	MPa
	normal	e_{tBn}	MPa

Use a **clamping distance** of 100 mm.

Record nominal strains only, relative to clamping distance.

2.3.1.2 Tear Resistance

ISO 6383-2

Specimen:

Elmendorf: rectangular (63,5 ± 0,5) *(75 ± 0,5) mm², cut perpendicular to longer edge, length of cut (20 ± 0,5) mm

Trouser: rectangular, 50 *150 mm², cut perpendicular to shorter edge, length of cut (75 ± 1) mm, thickness d ≤ 1 mm

Property		Symbol	Unit
Elmendorf tear resistance	parallel	F_{tp}	N
	normal	F_{tn}	N
Trouser tear resistance	parallel	r_{tp}	N/mm
	normal	r_{tn}	N/mm

For the Elmendorf tear resistance the **work spent in tearing** the specimen shall be between 20% and 80% of the pendulum energy.

For trouser tear resistance use a test speed of v=200 mm/min.

2.3.1.3 Dart Drop Test

ISO 7765-1
Specimen: 230 * 230 mm^2

Property	Symbol	Unit
Dart drop A	*DartA*	g
Dart drop B	*DartB*	g

2.3.1.4 Friction

ISO 8295
Specimen: Strip (80 * 200) mm^2

Property	Symbol	Unit
Dynamic coefficient of friction	μ_D	

Use a **test speed** of v =(100 ± 10) mm/min, a **mass** of m=(200 ± 2) g and a **loaded area** of 40 cm^2

2.3.2 Optical Properties

2.3.2.1 Gloss

ISO 2813
Specimen: ISO

Property		Symbol	Unit
Gloss	20°	*Gloss20*	
	45°	*Gloss45*	
	60°	*Gloss60*	

2.3.2.2 Haze

ISO 14782
Specimen: sufficient size, e.g. 50 * 50mm^2

Property	Symbol	Unit
Haze	*Haze*	%

2.3.3 Barrier Properties

2.3.3.1 Water Vapor Transmission Rate

ISO 15106-1 and -2
Specimen: ISO

Property	Symbol	Unit
Water vapor transmission rate at 23°C; 85% r.h.	*WVTR2385*	g/(m^2*d)

2.3.3.2 Transmission Rate

ISO 15105-1 and -2

Specimen: ISO

Property		Symbol	Unit
Oxygen transmission rate	23°C; 0% r.h.	*OTR23/0*	$cm^3/(m^2*d*bar)$
	23°C; 85% r.h.	*OTR23/85*	$cm^3/(m^2*d*bar)$
Carbon Dioxide transmission rate	23°C; 0% r.h.	*CDTR23/0*	$cm^3/(m^2*d*bar)$
	23°C; 85% r.h.	*CDTR23/85*	$cm^3/(m^2*d*bar)$

2.3.4 Processing Conditions for Test Specimens

Property	Symbol	Unit
Type of extrusion	*ExtTy*	blown cast
Minimum achievable thickness	*MinThick*	mm
Thickness	*SThick*	mm

For the type of extrusion indicate Blown or Cast

2.4 Thermoplastic Elastomers (TPE)

2.4.1 Mechanical Properties

The tests are generally carried out at the standard laboratory conditions 23 °C / 50 % r.h.. For testing the properties of moisture sensitive materials in the dry state (as molded) see clause 1.4.2. For testing low-temperature-conditioned specimens at room temperature see clause 1.4.3.

2.4.1.1 Tensile Test

ISO 527-1 and -2

Specimen: ISO 527-1/1BA

Property	**Symbol**	**Unit**
Stress at 10% strain	s_{10}	MPa
Stress at 100% strain	s_{100}	MPa
Stress at 300% strain	s_{300}	MPa
Nominal strain at break	e_{tB}	%
Stress at break	s_B	MPa

The **test speed** is 200 mm/min.

If break occurs **above 300 % nominal strain**, record it as >300.

2.4.1.2 Compression Set under Constant Strain

ISO 815

Specimen: Type B: Plate with 13 mm diameter and thickness 6.3 mm

Property		**Symbol**	**Unit**
Compression set under constant strain	23°C	*CS23*	%
	70°C	*CS70*	%
	100°C	*CS100*	%

Apply a constant strain of 25% for at least 22-24 h

Specimens may be stacked if initial **thickness is smaller than 6.3 mm**.

Time of measurement after relief of compression 30 min.

ISO 815 refers to IRHD in order to define the strain to be applied.

IRHD	strain (%)
10 - 95	25
80 - 89	15
90 - 95	10
>95	not covered -> indicate: '*'

Determination of IRHD acc. ISO 48 “Rubber, vulcanized or thermoplastic - Determination of hardness”.

2.4.1.3 Tear Test

ISO 34-1

Specimen: angle test specimen with nick

Property	Symbol	Unit
Tear strength	*TearS*	kN/m

The test speed is 500 mm/min

For the test take Method B, procedure b of ISO 34-1. Loading shall be in parallel direction, the cut (nick) is in the normal direction

2.4.1.4 Abrasion Resistance

ISO 4649

Specimen: …

Property	Symbol	Unit
Abrasion resistance	*AbrRes*	mm^3

2.4.1.5 Shore Hardness

ISO 868

Specimen: $\geq 6 * 25 * 25\ mm^3$

Property	Symbol	Unit
Shore A hardness (3s)	*ShrA/3*	
Shore D hardness (15s)	*ShrD/15*	

Contents of CAMPUS â

3 Multi-Point Data

3 Multi-Point Data

The multipoint data included in CAMPUS are based on the International Standards for comparable multipoint data ISO 11403, Part 1 and Part 2, and on the ISO test Standards indicated in table 14.

Instead of recording data for the relevant material, reference may be given to a similar grade that shows comparable behavior.

Properties data may be interpolated but not extrapolated out of the relevant tested ranges of variables and parameters.

Select temperatures from the series of integral multiplies of 10 °C replacing 20 °C by 23°C if relevant.

For the injection or compression molding of test specimens see „Processing conditions for test specimen“ and tables 10, 11 and 12.

For machining specimens from compression molded plates see ISO 2818.

For the conditioning of the test specimens see clause 1.3.

3.1 Summary of Test Conditions

Property Variable Parameter(s)	Symbol	ISO 11403: Part, clause	ISO testing standard	Specimen	Unit
Dyn. shear storage modulus Temperature	G'(T)				MPa °C
Dyn. shear loss modulus Temperature	G''(T)	1, 6.2	6721-1, 2 and 7	d > 1	MPa °C
Shear loss factor (tan . Temperature	tan d (T)				- °C
Dyn. tensile storage modulus Temperature	E'(T)				MPa °C
Dyn. tensile loss modulus Temperature	E''(T)	1, 6.2	6721-1, 4	d > 1	MPa °C
Tensile loss factor (tan . Temperature	tan d (T)				- °C
Tensile modulus Temperature	E_t(T)				MPa °C
Stress Strain Temperature	σ(ε,T)	1, 6.3	527-1, -2 and -3		MPa % °C
Secant modulus Strain Temperature	E_{tS}(ε,T)	-	-	ISO 3167	MPa % °C
Creep stress Strain Time, Temperature	σ_c(ε,t,T)	1, 6.4	899-1		MPa % h, °C
Creep secant modulus Strain Time, Temperature	E_{tcS}(ε,t,T)	-	-		MPa % h, °C
Specific enthalpy difference Temperature	ΔH(T)/m	2, 6.2	11357-1 and 4		kJ / kg °C
Viscosity Shear rate Temperature	$\eta(\dot{g}, T)$		11443		Pa s s^{-1} °C
Shear stress Shear rate Temperature	$\tau(\dot{g}, T)$	2, 6.4		Material	Pa s^{-1} °C
Specific volume Temperature Pressure	v(T, p)	-	17744		m^3 / kg °C MPa

Table 11: Test conditions for multipoint data

3.2 Dynamic Shear Test

ISO 6721-1, -2

Specimen: Use a specimen of 1 mm thickness prepared by compression molding if feasible. Alternatively use a test specimen machined from an injection molded plate 60 mm x 60 mm x 1 mm according to ISO 294-3 for thermoplastics and ISO 10724-2 for thermosets.

Property	**Symbol**	**ISO 11403: Part, clause**	**Unit**
Dyn. shear storage modulus Temperature	*G'(T)*	1, 6.2	MPa °C
Dyn. shear loss modulus Temperature	*G''(T)*		MPa °C
Shear loss factor (tan . Temperature	*tan d (T)*		- °C

Shear modulus is the real part G' of the dynamic (complex) shear modulus G* = G' + G'', measured at a frequency of 1 Hz ± 0,5 Hz. Begin the measurement at the lowest temperature and proceed to higher values.

Record data between -40 °C and the maximum working temperature.

3.3 Dynamic Tensile Test

ISO 6721-1, -4

Specimen: Use a specimen of 1 mm thickness prepared by compression molding if feasible. Alternatively use a test specimen machined from an injection molded plate 60 mm x 60 mm x 1 mm according to ISO 294-3 for thermoplastics and ISO 10724-2 for thermosets.

Property	**Symbol**	**ISO 11403: Part, clause**	**Unit**
Dyn. tensile storage modulus Temperature	*E'(T)*	1, 6.2	MPa °C
Dyn. tensile loss modulus Temperature	*E''(T)*		MPa °C
Tensile loss factor (tan . Temperature	*tan d (T)*		- °C

Tensile modulus is the real part E' of the dynamic (complex) shear modulus E* = E' + E'', measured at a frequency of 1 Hz ± 0,5 Hz. Begin the measurement at the lowest temperature and proceed to higher values.

Record data between -40 °C and the maximum working temperature.

3.4 Tensile Test

ISO 527-1 and -2

Specimen: ISO 3167.

Property	**Symbol**	**ISO 11403: Part, clause**	**Unit**
Tensile modulus Temperature	$E_t(T)$	1, 6.3	MPa °C
Stress Strain Temperature	$s(e,T)$		MPa % °C

ISO 527-1 demands, that the prestress at the start of the tensile test shall be less than the stress at 0,05 % strain, which corresponds to the lower limit of the modulus-testing interval. The clamping procedure, however, generally generates higher values of prestress, positive or negative. These shall be equilibrated to the above given limit before starting the test.

Record data between -40 °C and the maximum working temperature. Data can be recorded for 10 temperatures maximum

For testing single-point (room-temperature) data the test speed depends on the mode of failure of the material, see table 8. In order to avoid changing the test speed at different temperatures for a given material, multipoint data are measured using the common test speed of 5 mm min^{-1}.

The test is carried out up to an ultimate point that may be the yield point Y or, if no yielding is observed, the breaking point B or 50% strain maximum. If relevant, the ultimate point of the diagrams are designated by B (Break) or Y (Yield).Resulting from the difference in test speed, the stress and strain at yield or the stress at 50% strain, may differ from the corresponding single-point data.

The stresses at 10 equidistant intervals of strain up to the relevant ultimate point are recorded.

Secant Modulus

Specimen: 3167 A, see 2.2.2

Property	**Symbol**	**ISO 11403: Part, clause**	**Unit**
Secant modulus Strain Temperature	$E_{tS}(e,T)$	-	MPa % °C

The secant modulus E_{tS} and the creep secant modulus E_{tcS} are not given in the standards. They are the ratio between the relevant stress and strain, calculated by the CAMPUS program, and do not require additional data input.

3.5 Creep Test

ISO 899-1

Specimen: ISO 3167.

Property	**Symbol**	**ISO 11403: Part, clause**	**Unit**
Creep stress Strain Time, Temperature	$s_c(e, t, T)$	1, 6.4	MPa % h, °C

For a given temperature, strains are recorded for the times of 1 h, 10^1 h, 10^2 h, 10^3 h and 10^4 h, for 5 stress levels, which are equidistantly distributed between zero and a maximum stress that the polymer could experience for prolonged periods of time at the relevant temperature. CAMPUS provides the optional inclusion of up to five additional, equidistant higher stress levels. These may be suitable for describing the behavior at short loading times, where the test specimen can carry higher stresses.

Data can be recorded for 6 temperatures maximum that cover the range between -40 °C and the maximum working temperature.

3.6 Specific Enthalpy Difference - Temperature

ISO 11357-1 and -4

Specimen: Material

Property	**Symbol**	**ISO 11403: Part, clause**	**Unit**
Specific enthalpy difference Temperature	$\Delta H(T)/m$	2, 6.2	kJ / kg °C

The specific enthalpy difference is referred to room temperature [ΔH(23°C) = 0]: It is the integral of the specific heat c_P (at constant pressure), starting at room temperature to higher and lower temperatures.

The specific heat is measured in a cooling run, using the temperature rate of –10 K min^{-1}, starting at the maximum recommended processing temperature and down to -40 °C.

The resulting temperature at the onset of crystallization T_c, respectively the glass transition temperature T_g may be indicated in the diagram. The difference between the melting temperature T_m (see table 2.1) and the crystallization temperature T_c gives an impression of the hysteresis in the melting range.

3.7 Shear Stress (Viscosity) –Shear Rate

ISO 11443

Specimen: Material

Property	**Symbol**	**ISO 11403: Part, clause**	**Unit**
Shear stress (viscosity) Shear rate Temperature	$t(\dot{\gamma},T)$	2, 6.4	Pa s s^{-1} °C

Based on a capillary or slit-die rheometer, the basic properties are the shear stress , corrected according to the Bagley method, and the shear rate , corrected according to Weissenberg- Rabinowitsch. For each temperature the shear stress τ (the shear viscosity, i.e. the ratio $\eta = \tau /$) is recorded between the shear rates 3 s^{-1} and 30.000 s^{-1} at nine values equidistant on a logarithmic scale: Δlg = 0,5.

Data are recorded for 3 temperatures that cover the range of the recommended processing temperatures.

Corresponding to the secant moduli (see 3.3), the viscosity is the secant slope of the shear-stress versus shear-rate diagram, the latter however being much easier to understand and to interpret compared to the viscosity diagram.

3.8 Specific Volume - Temperature

ISO/CD 17744:2001

Specimen: Material

Property	Symbol	ISO 11403: Part, clause	Unit
Specific volume Temperature Pressure	$v(T, p)$	-	m^3 / kg °C MPa

The specific volume is measured at constant pressures of (20; 40; 80; 120; 160 and 200) MPa, starting at the maximum recommended processing temperature and cooling with 2,5 K min^{-1} down to room temperature. The isobar for 0,1 MPa (≈ 1 bar) is extrapolated.

For the data below the relevant freezing temperatures, crystallization or glass transition temperatures, record if they are measured, using a direct piston-displacement method, i.e. under uniaxial -strain condition, or indirectly with the test specimen immersed in a hydraulic fluid, e.g. mercurium.

Below the relevant freezing temperatures, data from different isobars should not be used for the calculation of isothermal properties, e.g. the compressibility of the solid state, as each isobar in this region reflects the properties of a different frozen-in state of the material.

25 generic grades of thermoplastics have been tested, commissioned by CAMPUS. These pvT data are included in CAMPUS and can be linked to commercial grades where relevant. pvT data mainly depend on the chemical composition of the plastic only and are nearly independent of features between different commercial grades, including average molecular mass, except extreme cases like PE-UHM. The contribution of inorganic fillers and reinforcement can be taken into account by assuming that their volume does not change with temperature nor pressure.

3.9 LTHA Test

ISO 2578, IEC 60216

Specimen: see Section 2. For the property “Stress at Break” it is acceptable to use the same sample geometry like for “Tensile Impact Strength”.

Property *P*	Symbol	ISO 11403: Part, clause	Unit
Stress at Break	$s_B(t, T)$	3, 6.5	%
Strain at Break	$\varepsilon_B(t, T)$		
Charpy Impact Strength (23°C)	$a_{cU}+23(t, T)$		
Puncture Maximum Force (23°C)	$F_M+23(t, T)$		
Tensile Impact Strength	$a_{t1}(t, T)$		
Electric Strength	$E_B1(t, T)$		

Long Term Heat Aging (LTHA) data is recorded after oven ageing of samples of a given thickness at a set of selected temperatures and cooling to room-temperature as described in section 1.3.3. Tests on elevated temperatures are only accepted on special request.

The preferred method for thermoplastic materials is the Fixed temperature method (IEC 60216-1). At least five but typically ten equidistantly distributed ageing periods are necessary for one LTHA curve. After each period a series of five specimens is returned to room temperature and subjected to the property measurement indicating the degree of aging. The periods have to be chosen such to allow for at least two data points before the end-of-life point (e.g. 50% retention) and one after the end-of-life point.

It is also acceptable to use the Fixed time frame method (IEC 60216-6) instead with a time frame of >552 h.

The initial property is the property of the material after 48 h at the lowest of the selected aging temperatures. All data is normalized to this initial value according to the following equation:

$$P\ [\%] = P\ (t, T)\ /\ P\ (48\ h, T_{min}) * 100. \qquad (3.1)$$

3.9.1 LTHA absolute

ISO 2578, IEC 60216

Specimen: see Section 2.

Property *P*	**Symbol**	**ISO 11403: Part, clause**	**Unit**
Charpy Impact Strength (23°C)	a_{cA}+*23* (LTHA)	3, 6.5	kJ/m²

Absolute Long Term Heat Aging (LTHA) is recorded for the VDA CAMPUS datasheet. The temperature of 50% retention after 3000 h of thermal aging is additionally recorded as a single point value TS_{3000}.

Contents of CAMPUS â

4 Properties not Covered by ISO 10350 and ISO 11403

4 Properties not Covered by ISO 10350 and ISO 11403

4.1 Chemical Resistance

The chemical resistance data are not presented in the single-point datasheets, because the International Standard for the Acquisition and Presentation of comparable multipoint data, ISO 11403-3, has not been widely used up to now and no truly comparable data are available. Thus information about the chemical resistance, based on existing data, is displayed in the text window of CAMPUS.

The list of chemicals (see table 15) for which the chemical resistance can be described is following ISO 175.

Because the description of the chemical resistance of a polymer is generally more complicated than is possible in a simple ranking of yes or no CAMPUS gives the possibility to add more information in internal or external links. The ranking follows the following system:

	Symbol	Description	Comments
a)		possible	Defined as: Supplier has sufficient indication that contact with chemical can be potentially accepted under the intended use conditions and expected service life. Criteria for assessment have to be indicated (e.g. surface aspect, volume change, property change).
b)		not recommended	Defined as: Not recommended for use under any condition.
c)		not recommended – see explanation	Defined as: Not recommended for general use. But short-term exposure under certain restricted conditions could be acceptable – examples to be provided (e.g. fast cleaning with thorough rinsing, spills, wiping, vapor exposure).

Searchable classifications are a) and c) only

Further information can be given for a) and c) in internal or external links.

Media Name	short name
Acids	
Acetic Acid (5% by mass) at 23°C	$5\%C_2H_4O_2$
Citric Acid solution (10% by mass) at 23°C	10%citr
Lactic Acid (10% by mass) at 23°C	10%lact
Hydrochloric Acid (36% by mass) at 23°C	36%HCl
Nitric Acid (40% by mass) at 23°C	$40\%HNO_3$
Sulfuric Acid (38% by mass) at 23°C	$38\%H_2SO_4$
Sulfuric Acid (5% by mass) at 23°C	$5\%H_2SO_4$
Chromic Acid solution (40% by mass) at 23°C	$40\%CrO_3$
Bases	
Sodium Hydroxide solution (35% by mass) at 23°C	35%NaOH
Sodium Hydroxide solution (1% by mass) at 23°C	1%NaOH
Ammonium Hydroxide solution (10% by mass) at 23°C	$10\%NH_4OH$
Alcohols	
Isopropyl alcohol at 23°C	C_3H_7OH
Methanol at 23°C	CH_3OH
Ethanol at 23°C	C_2H_5OH
Hydrocarbons	
n-Hexane at 23°C	C_6H_{14}
Toluene at 23°C	$C_6H_5CH_3$
iso-Octane at 23°C	iC_8H_{18}
Ketones	
Acetone at 23°C	CH_3COCH_3
Ethers	
Diethyl ether at 23°C	$(C_2H_5)_2O$
Mineral oils	
SAE 10W40 multigrade motor oil at 23°C	m.oil
SAE 10W40 multigrade motor oil at 130°C	130°moil
SAE 80/90 hypoid-gear oil at 130°C	130°gear
Insulating Oil at 23°C	ins.oil
Standard Fuels [1)]	
ISO 1817 Liquid 1 at 60°C	60°fuel1
ISO 1817 Liquid 2 at 60°C	60°fuel2
ISO 1817 Liquid 3 at 60°C	60°fuel3
ISO 1817 Liquid 4 at 60°C	60°fuel4
Standard fuel without alcohol (preferably ISO 1817 Liquid C) at 23°C	fuelC
Standard fuel with alcohol (preferably ISO 1817 Liquid 4) at 23°C	fuel+alc
Diesel fuel (preferably ISO 1817 Liquid F) at 23°C	Disl
Diesel fuel (preferably ISO 1817 Liquid F) at 90°C	90°Disl
Diesel fuel (preferably ISO 1817 Liquid F) above 90°C	90+°Disl

Media Name	**short name**
Salt solutions	
Sodium Chloride solution (10% by mass) at 23°C	10%NaCl
Sodium Hypochlorite solution (10% by mass) at 23°C	10%NaClO
Sodium Carbonate solution (20% by mass) at 23°C	20%$NaCO_3$
Sodium Carbonate solution (2% by mass) at 23°C	2%$NaCO_3$
Zinc Chloride solution (50% by mass) at 23°C	50%$ZnCl_2$
Other	
Ethyl Acetate at 23°C	$C_4H_8O_2$
Hydrogen peroxide at 23°C	H_2O_2
DOT No. 4 Brake fluid at 130°C	130°br.f
Ethylene Glycol (50% by mass) in water at 108°C	108°Cool
1% solution of nonylphenoxy-polyethyleneoxy ethanol in distilled water at 23°C	1%deterg
50% Oleic acid + 50% Olive Oil at 23°C	Oil
Water at 23°C	H_2O
Deionized water at 90°C	90°H_2O
Phenol solution (5% by mass) at 23°C	5%C_6H_5OH

Table 12: List of chemicals

[1]: See table 16

Liquid	Constituents	Content / % (V/V)	
1	2,2,4-trimethylpentane	30	
	toluene	50	
	di-isobutylene	15	
	ethanol	5	
2	2,2,4-trimethylpentane	25.35	equivalent to 84.5% (V/V) of liquid 1
	toluene	42.25	
	di-isobutylene	12.68	
	ethanol	4.22	
	methanol	15.00	
	water	0.50	
3	2,2,4-trimethylpentane	45	
	toluene	45	
	ethanol	7	
	methanol	3	
4	2,2,4-trimethylpentane	42.5	
	toluene	42.5	
	methanol	15	

Table 13: Standard fuels according ISO 1817

4.1.1 VDA Chemical Resistance

The following additional properties are described in VDA 232-201. The Chemical Resistance is recorded at temperatures typical for automotive applications as given in the following table:

Media Name	Abbreviation	Temperature	Group
Motor fuel FAM-B	fuelFAMB	85	Standard Fuels
Diesel EN 590	DislEN590	85	Standard Fuels
Coolant Glysantin G48, 1:1 in water	130°Cool	130	Other
DOT No. 4 Brake fluid	120°DOT4	120	Other
Motor oil OS206 304 Ref.Eng.Oil, ISP	OS206304	140	Mineral oils
Automatic hypoid-gear oil Shell Donax TX	140°gear	140	Mineral oils
Hydraulic oil Pentosin CHF 202	CHF202	125	Mineral oils

4.2 Properties for Rheological Calculations

The properties for rheological calculation are not defined in ISO 10350. The conditions for testing are not standardized thus the data are not comparable and displayed in the text window of CAMPUS.

Property	Unit
Density of melt	kg/m^3
Thermal conductivity of melt	W/(m K)
Specific heat capacity of melt	J/(kg K)
Effective thermal diffusivity	m^2/s
Ejection temperature	°C

4.3 Linear Thermal Expansion - Temperature

The following properties are not described in ISO 10350 or ISO 11403 but instead in VDA 232-201. The data shall be recorded in the temperature range -40 .. 100 °C.

Property	Symbol	Unit
Coefficient of linear thermal expansion		
parallel (p)	α_p-40	10^{-6}/K
normal (n)	α_n-40	10^{-6}/K

Contents of CAMPUS â

5 Abbreviated Terms

5 Abbreviated Terms

This guide for fixing abbreviated descriptions mainly is relevant for licensees only and shall be the only source of searchable abbreviations used in CAMPUS.

5.1 General

ISO 1043-1 includes abbreviated terms, that have come into established use (like ABS), symbols for components of these terms (i.e. AN, B and S) and symbols for special characteristics (like -HI). The latter two types of symbols enable to compile additional descriptions of the one plastic, different from the abbreviated term (e.g. SAN-HI or S/AN+B/S/AN instead of ABS). The aim however of this guide (as of ISO 1043) is „to prevent the occurrence of more than one abbreviated term for a given plastics terms“. Only in this case the designation system described in ISO 1043 becomes suitable for searching purposes. The following principles, therefore, shall be used for CAMPUS.

All polymers shall be presented according to the following system:

(P1+P2+P3)-(F1+F2)X...

where:

P1: polymer 1

P2: polymer 2

P3: polymer 3

F1: filler 1

F2: filler 2

X: total weight percentage of fillers (= % F1 + % F2)

... : indicates more ingredients which are not specified

- The polymers P1,P2 and P3 shall be taken from the list of base polymers, separate document “Base Polymers”.
- Copolymers are handled as base polymers, separate document http://www.campusplastics.com/docs/basepoly.htm.
- For mixtures and blends start with the polymer that forms the continuous phase.
- The fillers F1 and F2 shall be taken from the list of fillers, starting with the filler having the highest amount of addition, see table 17.

Each licensee can request to add more base polymers and fillers via M-Base

Examples:

ABS

ABS+PC

(ABS+PC)-GF20

PC-(GF+GB)10

PC-GF

(ABS+PC)-(GF+CF)30...

5.2 Base Polymers

For the table of allowed base polymers, see separate document http://www.campusplastics.com/docs/basepoly.htm

5.3 Fillers

CF	carbon fiber
CD	carbon fines, powder
GF	glass fiber
GB	glass beads, spheres, balls
GD	glass fines, powder
GX	glass not specified
K	calcium carbonate
MF(x)	metal fibre
MD(x)	metal fines, powder
MF	mineral fibre
MX	mineral not specified
MD	mineral fines, powder
NF	natural organic fiber
P	mica
Q	silica
RF	aramid fiber
T	talcum
X	not specified
Z	others not included in this list

Table 14: Fillers

5.4 Flame Retardants

HALOGONATED COMPOUNDS	
10	aliphatic/alicyclic chlorinated compounds
11	aliphatic/alicyclic chlorinated compounds in combination with antimony compounds
12	aromatic chlorinated compounds
13	aromatic chlorinated compounds in combination with antimony compounds
14	aliphatic/alicyclic brominated compounds
15	aliphatic/alicyclic brominated compounds in combination with antimony compounds
16	aromatic brominated compounds (excluding brominated diphenyl ether and biphenyls)
17	aromatic brominated compounds (excluding brominated diphenyl ether and biphenyls) in combination with antimony compounds
18	polybrominated diphenyl ether
19	polybrominated diphenyl ether in combination with antimony compounds

20	polybrominated biphenyls
21	polybrominated biphenyls in combination with antimony compounds
22	aliphatic/alicyclic chlorinated and brominated compounds
25	aliphatic fluorinated compounds
NITROGEN COMPOUNDS	
30	nitrogen compounds (confined to melamine, melamine cyanurate, urea)
ORGANIC PHOSPHORUS COMPOUNDS	
40	Halogen-free organic phosphorus compounds
41	Chlorinated organic phosphorus compounds
42	Brominated organic phosphorus compounds
INORGANIC PHOSPHORUS COMPOUNDS	
50	ammonium orthophosphates
51	ammonium polyphosphates
52	red phosphorus
METAL OXIDES, METAL HYDROXIDES, METAL SALTS	
60	aluminum hydroxide
61	magnesium hydroxide
62	antimony (III) oxide
63	alkali-metal antimonate
64	magnesium/calcium carbonate hydrate
BORON AND ZINC COMPOUNDS	
70	inorganic boron compounds
71	organic boron compounds
72	zinc borate
73	organic zinc borate
SILICA COMPOUNDS	
75	inorganic silica compounds
76	organic silica compounds
OTHERS	
80	graphite

Contents of CAMPUS â

6 Normative References

6 Normative References

6.1 Standards for Comparable Data, Molding and Testing

ISO 34-1:2004, Rubber, vulcanized or thermoplastic – Determination of tear strength – Part 1: Trouser, angle and crescent test pieces

ISO 62:2008, Plastics – Determination of water absorption

ISO/DIS 75-1:2004, Plastics – Determination of temperature of deflection under load – Part 1: General test method

ISO/DIS 75-2:2004, Plastics – Determination of temperature of deflection under load – Part 2: Plastics and ebonite

ISO 179-1:2000, Plastics – Determination of Charpy impact properties – Part 1: Non-instrumented impact test

ISO 179-1 DAM 1:2004

ISO 179-2:1997, Plastics – Determination of Charpy impact properties – Part 2: Instrumented test

ISO 179-2 Technical Corrigendum 1:1998

ISO/DIS 291:2008, Plastics – Standard atmospheres for conditioning and testing

ISO 293:2004, Plastics – Compression moulding of test specimens of thermoplastic materials

ISO 294-1:1996, Plastics – Injection moulding of test specimens of thermoplastic materials – Part 1: General principles, multipurpose and bar test specimens

ISO 294-1 AMD 1:2001

ISO 294-1 DAM 2:2003

ISO 294-3:2002, Plastics – Injection moulding of test specimens of thermoplastic materials – Part 3: Small plates

ISO 294-3 DAM 1:2002

ISO 294-4:2001, Plastics – Injection moulding of test specimens of thermoplastic materials – Part 4: Determination of moulding shrinkage

ISO 295:2004, Plastics – Compression moulding test specimens of thermosetting materials

ISO 306:2004, Plastics – Thermoplastics materials - Determination of Vicat softening temperature

ISO 307:2007, Plastics – Polyamides – Determination of viscosity number

ISO 527-1:1993, Plastics – Determination of tensile properties – Part 1: General principles
ISO 527-1 Technical Corrigendum 1:1994
ISO 527-1 DAM 1:2004

ISO 527-2:1993, Plastics – Determination of tensile properties – Part 2: Test conditions for moulding and extrusion plastics

ISO 527-3:1995, Plastics - Determination of tensile properties – Part 3: Test conditions for films and sheets
ISO 527-3 Technical Corrigendum 1: 2001

ISO 815:2008, Rubber, vulcanized or thermoplastic . Determination of compression set at ambient elevated or low temperatures

ISO/DIS 868:2001, Plastics and ebonite – Determination of indentation hardness by means of a durometer (Shore hardness)

ISO 899-1:2003, Plastics – Determination of creep behaviour – Part 1: Tensile creep

ISO/DIS 1133:2005, Plastics – Determination of the melt mass-flow rate (MFR) and the melt volume-flow rate (MVR) of thermoplastics

ISO 1183-1:2004, Plastics – Methods for determining the density and relative density of non-cellular plastics – Part 1: Immersion method, pyknometer method and titration method

ISO/FDIS 1183-2:2004, Plastics – Methods for determining the density and relative density of non-cellular plastics – Part 2: Density gradient column method

ISO 1183-3:1999, Plastics – Methods for determining the density and relative density of non-cellular plastics – Part 3: Gas pyknometer method

ISO 1628-1:2009, Plastics - Determination of the viscosity of polymers in dilute solution using capillary viscosimeters– Part 1: General principles

ISO 1628-2:1998, Plastics - Determination of the viscosity of polymers in dilute solution using capillary viscosimeters– Part 2: Poly(vinylchloride) resins

ISO 1628-3:2001, Plastics - Determination of the viscosity of polymers in dilute solution using capillary viscosimeters– Part 3: Polyethylenes and polypropylenes

ISO 1628-4:1999, Plastics - Determination of the viscosity of polymers in dilute solution using capillary viscosimeters– Part 4: Polycarbonate (PC) moulding and extrusion materials

ISO 1628-5:1998, Plastics - Determination of the viscosity of polymers in dilute solution using capillary viscosimeters– Part 5: Thermoplastic polyester (TP) homopolymers and copolymers

ISO 1628-6:1990, Plastics - Determination of the viscosity of polymers in dilute solution using capillary viscosimeters– Part 6: Methylmethacrylate polymers

ISO 2577:2007, Plastics – Thermosetting moulding materials – Determination of shrinkage

ISO 2813:1994, Paints and varnishes – Determination of the specular gloss of non-metallic paint films at 20°, 60° and 85°

ISO 2813 Technical Corrigendum 1:1997

ISO 2818:1994, Plastics – Preparation of test specimens by machining

ISO 2818 Technical Corrigendum 1:2007

ISO 3167:2002, Plastics – Multipurpose-test specimens

ISO 3795:1989, Road vehicles, and tractors and machinery for agriculture and forestry -- Determination of burning behaviour of interior materials

ISO 4589-1:1996, Plastics – Determination of flammability by oxygen index – Part 1: Guidance

ISO 4589-2:1996, Plastics – Determination of burning behaviour by oxygen index – Part 2: Ambient-temperature test

ISO 4589-2 DAM 1:2005

ISO 4649:2002, Rubber, vulcanized or thermoplastic – Determination of abrasion resistance using a rotating cylindrical drum device

ISO 4892-2:2006, Plastics -- Methods of exposure to laboratory light sources -- Part 2: Xenon-arc lamps

ISO 4892-2 DAM 1:2009

ISO 6383-2:1983, Plastics – Film and sheeting – Determination of tear resistance – Part 2: Elmendorf method

ISO 6603-2:2000, Plastics – Determination of puncture impact behaviour of rigid plastics – Part 2: Instrumented puncture test

ISO 6721-1:2001, Plastics – Determination of dynamic mechanical properties – Part 1: General principles

ISO 6721-2:2008, Plastics – Determination of dynamic mechanical properties – Part 2: Torsion pendulum

ISO 6721-2 Technical Corrigendum 1:1995

ISO 6721-7:1996, Plastics – Determination of dynamic mechanical properties – Part 7: Torsional vibration – Non-resonance method

ISO 6721-7 DAM1:2007

ISO 7765-1:1988, Plastics film and sheeting – Determination of impact resistance by the free-falling dart method – Part 1: Staircase methods

ISO 8256:2004, Plastics – Determination of tensile-impact strength

ISO 8295:1995, Plastics – Film and sheeting – Determination of the coefficients of friction

ISO 10350-1:2007, Plastics – Acquisition and presentation of comparable single-point data – Part 1: Moulding materials

ISO 10724-1:1998, Plastics – Injection moulding of test specimens of thermosetting powder and moulding compounds (PMCs) – Part 1: General principles and multipurpose-test specimens

ISO 10724-2:1998, Plastics – Injection moulding of test specimens of thermosetting powder and moulding compounds (PMCs) – Part 2: Small plates

ISO 11357-1:2009, Plastics – Differential scanning calorimetry (DSC) – Part 1: General principles

ISO 11357-2:1999, Plastics – Differential scanning calorimetry (DSC) – Part 2: Determination of glass transition temperature

ISO 11357-3:1999, Plastics – Differential scanning calorimetry (DSC) – Part 3: Determination of temperature and enthalpy of melting and crystallisation
ISO 11357-3 DAM 1:2005

ISO 11357-4:2005, Plastics – Differential scanning calorimetry (DSC) – Part 4: Determination of specific heat capacity

ISO 11359-1:1999, Plastics – Thermomechanical analysis (TMA) – Part 1: General principles

ISO 11359-2:1999, Plastics – Thermomechanical analysis (TMA) – Part 2: Determination of coefficient of linear thermal expansion and glass transition temperature

ISO 11403-1:2001, Plastics – Acquisition and presentation of comparable multipoint data – Part 1: Mechanical properties

ISO 11403-2:2004, Plastics – Acquisition and presentation of comparable multipoint data – Part 2: Thermal and processing properties

ISO 11443:2005, Plastics – Determination of the fluidity of plastics using capillary and slit die rheometers

ISO 13468-1:1996, Plastics - Determination of the total luminous transmittance of transparent materials - Part 1: Single-beam instrument

ISO 13468-2:1999, Plastics - Determination of the total luminous transmittance of transparent materials - Part 2: Double-beam instrument

ISO 13802:1999, Plastics – Verification of pendulum impact-testing machines – Charpy, Izod and tensile impact testing
ISO 13802 Technical Corrigendum 1:2000

ISO 14782:1999, Plastics – Determination of haze for transparent materials

ISO 15105-1:2007, Plastics – Film and sheeting – Determination of gas transmission rate – Part 1: Differential-pressure method

ISO 15105-2:2003, Plastics – Film and sheeting – Determination of gas transmission rate – Part 2: Equal-pressure method

ISO 15106-1:2003, Plastics – Film and sheeting – Determination of water vapour transmission rate – Part 1: Humidity detection sensor method

ISO 15106-2:2003, Plastics – Film and sheeting – Determination of water vapour transmission rate – Part 2: Infrared detection sensor method

ISO 15512:2008, Plastics – Determination of water content

ISO 17744:2004, Plastics and elastomers – Determination of specific volume as a function of temperature and pressure (pvT diagram) – Piston apparatus method

IEC 60093:1980, Methods of test for volume resistivity and surface resistivity of solid electrical insulating materials

IEC 60112:2003, Method for determining comparative and the proof tracking indices of solid insulating materials under moist conditions

IEC 60216-1:2001, Electrical insulating materials - Properties of thermal endurance - Part 1: Ageing procedures and evaluation of test results Maintenance

IEC 60216-6:2006, Electrical insulating materials - Thermal endurance properties - Part 6: Determination of thermal endurance indices (TI and RTE) of an insulating material using the fixed time frame method

IEC 60243-1:1998, Methods of test for electric strength of solid insulating materials – Part 1: Tests at power frequencies

IEC 60250:1969, Recommended methods for the determination of the permittivity and dielectric dissipation factor of electrical insulating materials at power, audio and radio frequencies including meter wave lengths

IEC 60296:2003, Specification for unused mineral insulating oils for transformers and switchgears.

IEC 60695-11-10:2003, Fire hazard testing-Part 11-10: Test flames – 50W horizontal and vertical flame test methods

IEC 60695-11-20:2003, Fire hazard testing-Part 11-20: Test flames – 500W flame test methods

VDA 270:1992, Determination of the odour characteristics of trim materials in motor vehicles

VDA 277:1995, Non-metallic materials for automotive interior - determination of emission of organic compounds

VDA 278:2002, Thermodesorption analysis of organic emissions for characterisation of non-metallic materials for automobiles

UL 94:2009, Tests for flammability of plastic materials for parts in devices and appliances, Underwriters Laboratories Inc., USA

6.2 Standards for Thermoplastic Materials

ISO 1060-1:1998, Plastics – Homopolymer and copolymer resins of vinyl chloride – Part 1: Designation system and basis for specification

ISO 1060-2:1998, Plastics – Homopolymer and copolymer resins of vinyl chloride – Part 2: Preparation of test samples and determination of properties

ISO 1163-1:1995, Plastics – Unplasticised poly(vinyl chloride) (PVC-U) moulding and extrusion materials – Part 1: Designation system and basis for specification

ISO 1163-2:1995, Plastics – Unplasticised poly(vinyl chloride) (PVC-U) moulding and extrusion materials – Part 1: Determination of properties

ISO 1622-1:1994, Plastics – Polystyrene (PS) moulding and extrusion materials – Part 1: Designation system and basis for specification

ISO 1622-2:1995, Plastics – Polystyrene (PS) moulding and extrusion materials – Part 2: Preparation of test specimens and determination of properties

ISO 1872-1:1993, Plastics – Polyethylene (PE) moulding and extrusion materials – Part 1: Designation system and basis for specification

ISO 1872-2:2007, Plastics – Polyethylene (PE) moulding and extrusion materials – Part 2: Preparation of test specimens and determination of properties

ISO 1873-1:1995, Plastics – Polypropylene (PP) moulding and extrusion materials – Part 1: Designation system and basis for specification

ISO 1873-2:2007, Plastics – Polypropylene (PP) moulding and extrusion materials – Part 2: Preparation of test specimens and determination of properties

ISO 1874-1:1992, Plastics – Polyamide (PA) moulding and extrusion materials – Part1: Designation

ISO 1874-2:1995, Plastics – Polyamide (PA) moulding and extrusion materials – Part 2: Preparation of test specimens and determination of properties

ISO 2580-1:2002, Plastics – Acrylonitrile/butadiene/styrene (ABS) moulding and extrusion materials – Part 1: Designation system and basis for specification

ISO 2580-2:2003, Plastics – Acrylonitrile/butadiene/styrene (ABS) moulding and extrusion materials – Part 2: Preparation of test specimens and determination of properties

ISO 2897-1:1997, Plastics – Impact-resistant polystyrene (PS-I) moulding and extrusion materials – Part 1: Designation system and basis for specification

ISO 2897-2:2003, Plastics – Impact-resistant polystyrene (PS-I) moulding and extrusion materials – Part 2: Preparation of test specimens and determination of properties

ISO 2898-1:1996, Plastics – Plasticised compounds of homopolymers and copolymers of vinyl chloride (PVC-P) – Part1: Designation

ISO 2898-2:2008, Plastics – Plasticised compounds of homopolymers and copolymers of vinyl chloride (PVC-P) – Part 2: Preparation of test specimens and determination of properties

ISO 4613-1:1993, Plastics – Ethylene/vinyl acetate (EVAC) moulding and extrusion materials – Part 1: Designation and specification

ISO 4613-2:1995, Plastics – Ethylene/vinyl acetate (EVAC) moulding and extrusion materials – Part 2: Preparation of test specimens and determination of properties

ISO 4613-2 DAM 1 Draft:2001

ISO 4894-1:1997, Plastics – Styrene/acrylonitrile (SAN) moulding and extrusion materials – Part 1: Designation system and basis for specification

ISO 4894-2:1995, Plastics – Styrene/acrylonitrile (SAN) moulding and extrusion materials – Part 2: Preparation of test specimens and determination of properties

ISO 6402-1:2002, Plastics - Acrylonitrile/styrene/acrylate (ASA), acrylonitrile/ethylene-propylene-diene/styrene (AEPDS) and acrylonitrile/chlorinated polyethylene/styrene (ACS) moulding and extrusion materials – Part 1: Designation system and basis for specification

ISO 6402-2:2003, Plastics - Acrylonitrile/styrene/acrylate (ASA), acrylonitrile/ethylene-propylene-diene/styrene (AEPDS) and acrylonitrile/chlorinated polyethylene/styrene (ACS) moulding and extrusion materials – Part 2: Preparation of test specimens and determination of properties

ISO 7391-1:2006, Plastics – Polycarbonate (PC) moulding and extrusion materials – Part 1: Designation

ISO 7391-2:2006, Plastics – Polycarbonate (PC) moulding and extrusion materials – Part 2: Preparation of test specimens and determination of properties

ISO 7792-1:1997, Plastics – Thermoplastic polyester (TP) moulding and extrusion materials -- Part 1: Designation system and basis for specifications

ISO 7792-2:1997, Plastics – Thermoplastic polyester (TP) moulding and extrusion materials -- Part 2: Preparation of test specimens and determination of properties

ISO 8257-1:1998, Plastics – Poly(methylmethacrylate) (PMMA) moulding and extrusion materials – Part 1: Designation

ISO 8257-2:2001, Plastics – Poly(methylmethacrylate) (PMMA) moulding and extrusion materials – Part 2: Preparation of test specimens and determination of properties

ISO 8986-1:2009, Plastics – Polybutene (PB) moulding and extrusion materials – Part 1: Designation system and basis for specification

ISO 8986-2:2009, Plastics – Polybutene (PB) moulding and extrusion materials – Part 2: Preparation of test specimens and determination of properties

ISO 8986-2 DAM1:2000

ISO 9988-1:2004, Plastics – Polyoxymethylene (POM) moulding and extrusion materials – Part 1: Designation system and basis for specification

ISO 9988-2:2006, Plastics – Polyoxymethylene (POM) moulding and extrusion materials – Part 2: Preparation of test specimens and determination of properties

ISO 10366-1:2002, Plastics – Methylmethacrylate/acrylonitrile/butadiene/styrene (MABS) moulding and extrusion materials – Part 1: Designation system and basis for specification

ISO 10366-2:2003, Plastics – Methylmethacrylate/acrylonitrile/butadiene/styrene (MABS) moulding and extrusion materials – Part 2: Preparation of test specimens and determination of properties

ISO 11542-1:2001, Plastics – Ultra-high-molecular weight polyethylene (PE-UHMW) moulding and extrusion materials – Part 1: Designation system and basis for specification

ISO 11542-2:1998, Plastics – Ultra-high-molecular weight polyethylene (PE-UHMW) moulding and extrusion materials – Part 2: Preparation of test specimens and determination of properties

ISO 11542-2 Technical Corrigendum 1:2007

ISO 12086-1:2006, Plastics – Fluorpolymer dispersions and moulding and extrusion materials – Part 1: Designation system and basis for specification

ISO 12086-2 Technical Corrigendum 1:2006

ISO 12086-2:1995, Plastics – Fluorpolymer dispersions and moulding and extrusion materials – Part 2: Preparation of test specimens and determination of properties

ISO 14663-1:1999, Plastics – Ethylene/vinyl alcohol (EVOH) copolymer moulding and extrusion materials – Part 1: Designation system and basis for specification

ISO 14663-2:1999, Plastics – Ethylene/vinyl alcohol (EVOH) copolymer moulding and extrusion materials – Part 2: Preparation of test specimens and determination of properties

ISO 14910-1:1997, Plastics – Thermoplastic polyester/ester and polyether/ester elastomers for moulding and extrusion – Part 1: Designation system and basis for specification

ISO 14910-2:1997, Thermoplastic polyester/ester and polyether/ester elastomers for moulding and extrusion – Part 2: Preparation of test specimens and determination of properties

ISO 15103-1:2000, Polyphenylene ether (PPE) moulding and extrusion materials – Part 1: Designation system and basis for specification

ISO 15103-2:2007, Polyphenylene ether (PPE) moulding and extrusion materials – Part 2: Preparation of test specimens and determination of properties

ISO 15526-1:2000, Polyketone (PK) moulding and extrusion materials – Part 1: Designation system and basis for specification

ISO 15526-2:2000, Polyketone (PK) moulding and extrusion materials – Part 2: Preparation of test specimens and determination of properties

Missing International Standards for the materials LCP, PES, PPS, PPSU, PSU and TEEE.

6.3 Standards for Abbreviated Description of Plastic

ISO 1043-1:2001, Plastics - Symbols and abbreviated terms - Part 1: Basic Polymers and their special characteristics

ISO 1043-2:2000, Plastics - Symbols and abbreviated terms - Part 2: Fillers and reinforcing materials

ISO 1043-3:1996, Plastics - Symbols and abbreviated terms - Part 3: Plasticisers

ISO 1043-4:1998, Plastics - Symbols and abbreviated terms - Part 4: Flame retardants

ISO 11469:2000, Plastics - Generic identification and marking of plastics products

ISO 18064:2003, Thermoplastic elastomers - Nomenclature and abbreviated terms

Contents of CAMPUS â

7 Tables and Figures

7 Tables and Figures