covestro

Apec®

Product range

Typical values

Apec®

Apec® is the brand name for copolycarbonates that constitute a further development of Makrolon® polycarbonate. Its unique combination of high heat resistance, toughness, transparency, light stability and flowability, its high heat resistance, which can be as high as 203°C (VST/B 120), makes Apec® ideal for molded parts that are subject to such pronounced thermal stressing that general-purpose polycarbonate is no longer adequate.

Characterization

The Apec® grades are linear, amorphous copolycarbonates (PC-HT), made of BPA, the building block for Makrolon®, and BPTMC, a special polymer constitutional unit. Depending on the ratio in which the two bisphenol components are mixed, products are obtained whose heat resistance increases in proportion to the BPTMC content.

Apec® belongs to the polycarbonate family and is a further development of the standard (BPA) polycarbonate, Makrolon®, with a higher heat resistance.

Apec® is noted for its particularly favorable combination of the following properties:

- High heat resistance
- High toughness
- High transparency
- Good flowability
- High dimension stability

Together with a low-temperature impact strength that is sufficient for many applications, this allows Apec® to be used over a broad range of temperatures from approximately –30°C to approximately +180°C.

Apec® product range[8]

Grade	Vicat softening temperature (°C)	MVR[1] (cm³/10 min)	UV-stabilized	Easy release
Standard grades				
1603	159	25	X	
1703	171	17	X	
1800	185	10		
1803	184	10	X	
Easy-flow grades				
1695	158	45		X
1697	157	45	X	X
1795	173	30		X
1797	172	30	X	X
1895	183	18		X
1897	182	18	X	X
2095[2]	203	8		X
2097	202	8	X	X
High-flow grade				
2095 HF	203	14		X
Medical grade				
1745[3, 7]	170	17		X
Flame-retardant grades				
FR1892[4]	183	18		X
FR1897[5]	182	18	X	X
DP1-9354[6]	185	12		
Reflective White grades				
RW1695	158	45		X
RW1697[7]	157	45	X	X

1) 330°C/2.16 kg
2) Not available in clear transparent color 551022, use alternatively Apec® 2097 551022.
3) Suitable for hot steam sterilization, representative sample met the requirements of USP Class VI at the time of testing, only available in color 551022 (clear transparent).
4) Listed V-0/3.0 mm according to UL 94, transparent colors possible.
5) V-0/3.0 mm according to internal measurement, transparent colors possible.
6) Listed V-0/1.5 mm; V-0/3.0 mm; 5VA/3.0 mm according to UL 94. Only opaque available.
7) Light reflection up to 95%.
8) Disclaimer of Warranty (see warranty on page 23).

Delivery form

Granules, packed in 25-kg PE bags, Big-Bags, large cartons with a PE inliner or delivered in silo trucks. Apec® is available in a large number of transparent and opaque colors.

The production plants for Apec® are certified to ISO 9001.

Designation of sales products

The designation of Apec® sales products is based on a four-digit, self-explanatory nomenclature.

The first two digits denote the heat resistance.

16.. Vicat approx. 160°C
17.. Vicat approx. 170°C
18.. Vicat approx. 185°C
20.. Vicat approx. 203°C

Digits 3 and 4 describe the grade.

..00 Standard

..03 Standard, UV-stabilized

..45 Medical, easy release

..92 Easy-flow, flame retardant, transparent

..95 Easy-flow, easy release

..97 Easy-flow, easy release, UV-stabilized

Prefixes

FR.. Flame retardant

RW.. Reflective White

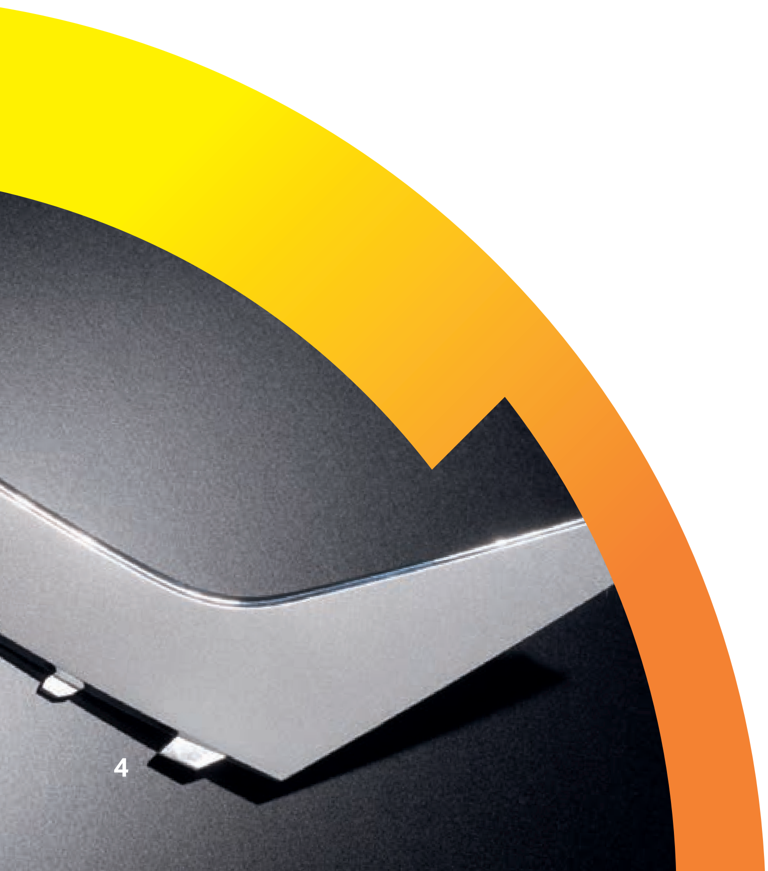
Suffix

HF.. High flow

Color designations

These are based on a six-digit code. The first two digits indicate the main color while the four remaining digits are used to distinguish between the different shades.

	Opaque color shades	Transparent color shades	Translucent color shades
White	01	–	02 (milky)
Yellow	10	15	12
Orange	20	25	22
Red	30	35	32
Violet	40	45	42
Blue	50	55	52
Green	60	65	62
Gray	70	75	72
Brown	80	85	82
Black	90	–	–
Natural	00	00	–



Applications

Thanks to its unique combination of properties (excellent transparency, heat resistance and toughness), Apec® yields moldings with a broad spectrum of applications.

Automotive:

- Automotive headlamp reflectors/bezels
- Headlamp lenses
- Reflectors for indicator and rear lights
- Housings for license plate lights
- Automotive brake and indicator bulb caps
- High-mounted stop lights
- Interior light covers and housings
- Flat fuses

Electronics / electrical engineering; domestic appliances:

- Domestic appliances/measurement transformer components
- Lamp covers (for tumble dryers, cooker hoods, bus bar supports, insulators)
- Fuse housings
- Front panels for electric cookers
- Covers for food appliances
- Socket housings
- Illuminated rotary switches
- Chip trays

Lighting:

- Signal lamp systems
- Lights/recessed lights
- Covers for industrial lamps
- Dentists' operating lamps
- Housings for halogen lights
- Housings for spotlights
- Fittings for halogen systems
- Lenses for ships' lights

Medical technology:

- Syringe tops
- Contact lens holders
- Hot steam sterilization safety valves for respiratory aids
- Medical vessels
- Medical packaging film

Safety:

- Visors of firefighter helmets
- Goggles of gas masks

Heat resistance / aging behavior

The outstanding property of Apec® is its graded, high-level heat resistance in conjunction with excellent transparency, only slight inherent color, good flowability, and high impact strength. At present, products produced on an industrial scale are available with a Vicat softening temperature of up to 203°C.

With short-term thermal loading and parts subject to only a low level of mechanical stress, the service temperatures possible for the Apec® grades are approximately 15°C below the Vicat softening temperature.

The long-term service temperature of Apec® parts depends on the demands placed on the part.

As with all thermoplastics, long-term high-temperature loading can cause changes in the property level (e.g., mechanical properties and color). The extent of the changes also depends on the duration of the loading. With excessive thermal loading, part failure can result in extreme cases as a result of brittle fracture or incipient melting.

The temperature indices to UL 746B constitute guidelines for the temperature stressing and service life of parts in Apec® (see reference data table). These are the temperatures at which the tested material property displays at least 50% of its starting level for a defined exposure time.

Optical properties

Apec® is available with a crystal clear bluish tinted color (551022). With this color, Apec® is reaching a light transmittance of 89% at 1 mm wall thickness. The refractive index is affected by the ratio of the two monomer components and falls as the heat resistance increases. Typical Apec® properties are its high surface gloss and excellent surface quality.

Toughness

Apec® shows a high impact strength over a broad temperature range. The material's high energy absorption capacity is also apparent under biaxial stress in the penetration test.

Apec® 1695

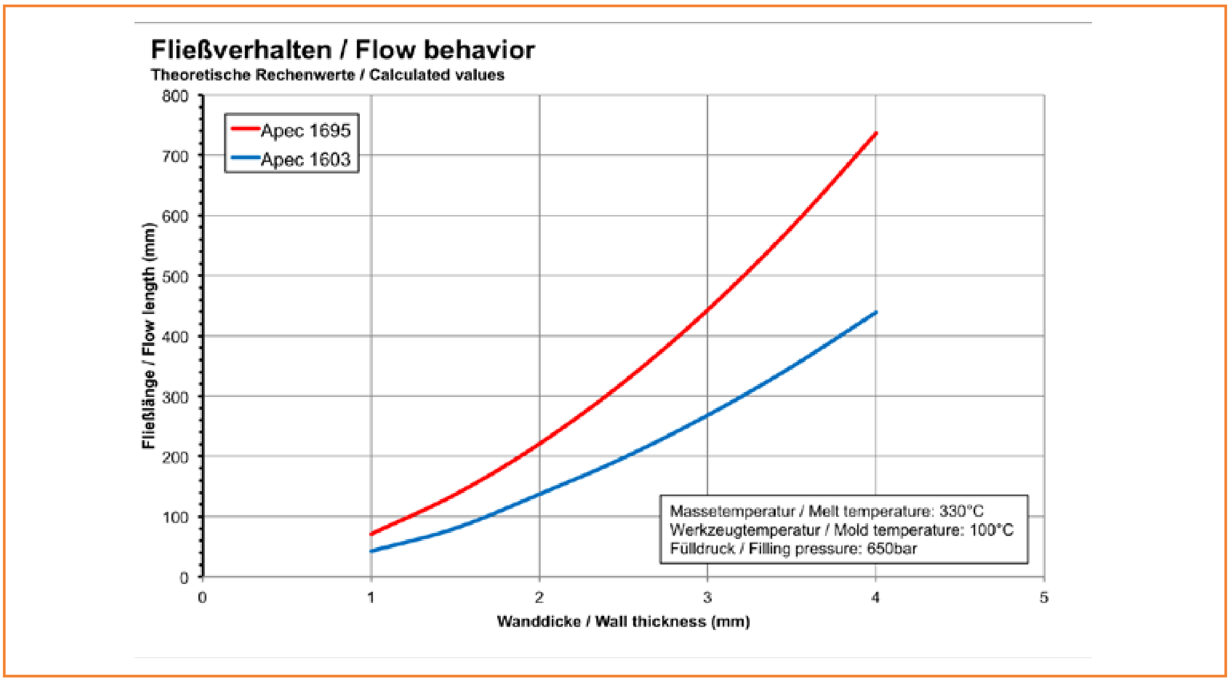


Fig. 1: A. 1695 (A. 1697)

Melt viscosity; flow properties

Like most resins, the increased heat resistance of Apec® also means higher viscosity. Compared with other amorphous thermoplastics with comparable heat resistance such as polyarylates, however, Apec® exhibits a markedly lower melt viscosity and hence better flow properties. (See the following flow length/wall thickness diagrams.)

Apec® 1795

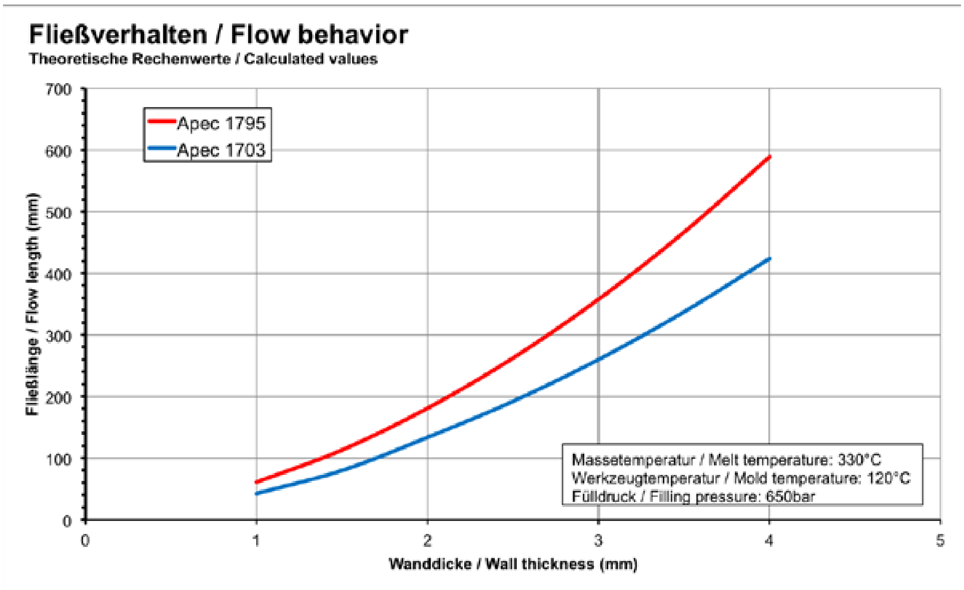


Fig. 2: A. 1795 (A. 1797)

Apec® 1895

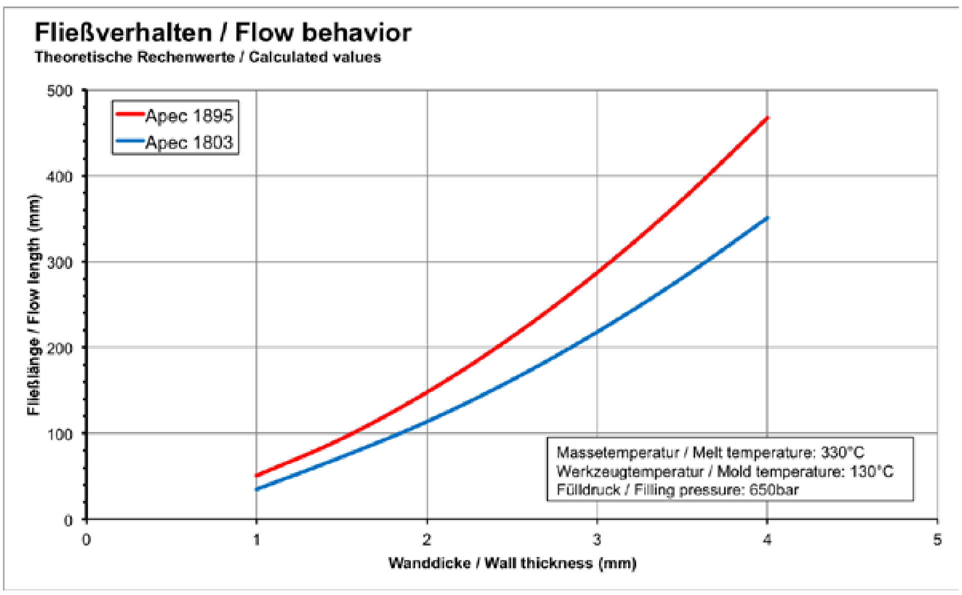


Fig. 3: A. 1895 (A. 1897)

Apec® 2095

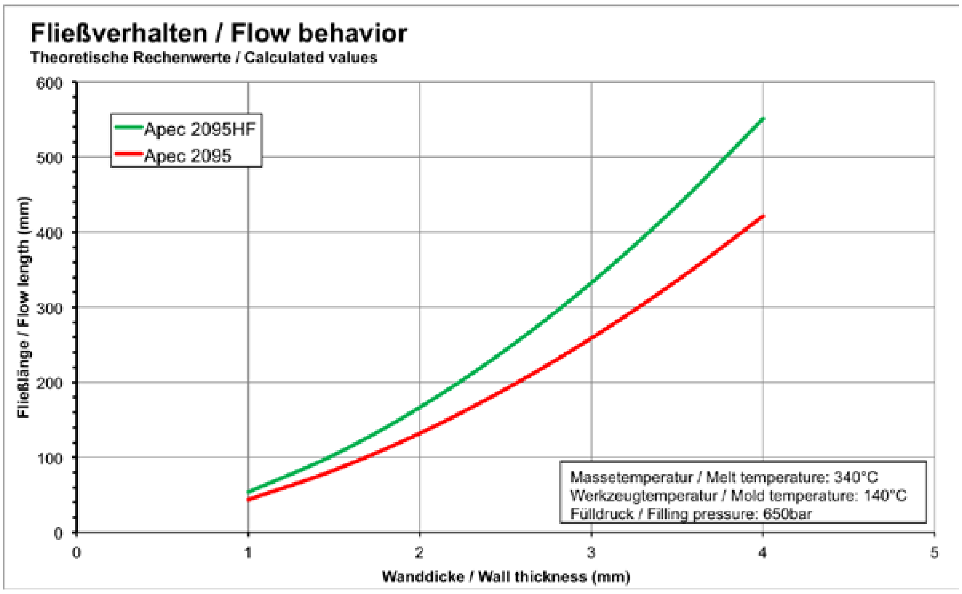


Fig. 4: A. 2095 (A. 2097)

Electrical properties

The electrical properties of Apec® and polycarbonate parts are also broadly similar. This applies particularly to surface resistivity, volume resistivity and the dielectric constant. The grades with the highest softening temperature (A. 2095 and A. 2097) are reaching a remarkable high CTI (comparative tracking index).

Flame retardance

Apec® without flame retardant additives is classified HB in accordance with UL 94. The FR grades Apec® FR1892 and Apec® FR1897 (available in transparent colors) and Apec® DP1-9354 (only available in opaque colors) are listed V-0/3.0 mm, respectively V-0/1.5 mm according to UL 94.

UV resistance

Apec® is absorbing UV light which leads to discoloration/yellowing when exposed to sunlight over a period of time. UV-stabilized Apec® grades show a markedly reduced tendency to yellowing of transparent colors. For applications requiring an exceptionally high level of UV stability, an additional UV protective coating is recommended.

Light reflectance

The new Apec® grades RW1695 and RW1697[1] allow high diffuse reflectance applications on a higher temperature level than known from the corresponding Makrolon® RW grades. Grades with even higher temperature resistance are in preparation. Apec® RW1695 and Apec® RW1697 also show a high opacity/light blocking behavior.

[1] RW = Reflective White
Due to variable content of filler, diffuse light reflection of up to 95% is possible. The mechanical behavior is something more brittle compared with A.1695 resp. A.1697.

Chemical resistance, stress crack resistance

Apec® parts show good resistance to saturated aliphatic hydrocarbons, alcohols, dilute mineral acids, and both neutral and acid salt solutions. Apec® is not resistant to aromatic hydrocarbons, ammonia, amines and aqueous alkaline solutions.

The behavior of Apec® in contact with chemicals is similar to that of standard polycarbonate.

The chemical resistance and stress crack resistance are also largely dependent on the stress level of the parts, the temperature of the objects, and the concentration of the chemicals. A practical test should therefore always be conducted in cases of doubt. If this is not possible, the bent strip test (DIN 53 449/3) at least provides a rough guide. In order to avoid stress cracking, care must always be taken to ensure that the residual outer fiber strain does not exceed 0.3%.

Resistance to hydrolysis

Hot water leads to gradual chemical degradation, coupled with a reduction in the impact strength and elongation at break. Permanent service in water at temperatures of above 60°C is therefore not recommended.

Solubility

As their heat resistance or TMC bisphenol content increases, the solubility of Apec® grades in nonhalogenated solvents, such as toluene, acetic acid ethyl ester, methyl ethyl ketone, and tetrahydrofurane also increases.

Processing
Material preparation / drying

To achieve optimum molded part properties, it is essential for Apec® granules to be dried prior to processing. Insufficiently dried granules will lead to a molecular weight reduction during processing, which can affect the properties of the finished part in the following ways:

- "Silver streaks" and bubbles on the surface
- Embrittlement (deterioration in mechanical properties, e.g., impact strength, tensile strain at break, flexural strength)
- Impairment of flammability properties
- Increased susceptibility to stress cracking

Apec® will absorb up to 0.12% water from the air (23°C/50% relative humidity) and up to 0.3% when in direct contact with water. In order to avoid the property deteriorations referred to above, it is vital for the water content to be reduced to ≤0.02% prior to processing, for critical applications ≤0.01%. We recommend the following drying conditions as a function of the moisture content of the granules and the efficiency of the dryer:

Summer temperatures, especially when coupled with a high relative humidity, create the need for longer drying times in circulating air and fresh-air dryers, which can exceed the number of hours specified in the table. In extreme cases, it may not even be possible for the requisite ≤0.02%, respective ≤0.01% to be achieved with dryers of this type. In order to ensure independence from external climatic conditions, dry-air dryers should be generally used.

To prevent the granules from becoming moist once again, particularly when they are subject to prolonged residence times in the injection molding machine, a heated hopper should be used.

The moisture content of the granules should be measured by the Karl Fischer test method or another appropriate method.
If the permitted moisture content is exceeded, the finished part may still have suffered material degradation, even if it looks perfect on the surface.

	Drying temperature (granule temperature)	Drying time		
		Circulating air dryer (50% fresh air)	Fresh-air dryer	Dry-air dryer
All grades	130°C	4 to 12 h	2 to 4 h	2 to 4 h

Recommended drying conditions for Apec®

Processing temperatures / processing advice

Injection molding is the chief process employed for the production of parts in Apec®. The advice set out below thus relates exclusively to this form of processing.

Present-day injection molding machines are suitable for the injection molding of Apec®. Open nozzles of the free-flow type with a relatively large cross section have proved successful. If there is a slight leakage of melt, this can generally be prevented by retracting the screw somewhat (removing the pressure from the melt).

Grade	Melt temperature in °C	Mold temperature in °C
16xx	320–340	100–120
17xx	320–340	110–130
18xx	330–340	120–140
20xx	330–340	130–150
FR1892/97	330–340	120–140
DP1-9354	330–340	120–140
RW1695/97	320–340	100–120

Recommended mold and melt temperatures for Apec®

In order to obtain parts with the lowest possible level of inherent stress (and particularly in the case of parts that have to be suitable for superheated steam sterilization), we recommend that the mold temperature be set as high as possible. The injection velocity, holding pressure level, and holding pressure time are a function not only of the thermoplastic being processed but also, and more especially, of the geometry of the part and the layout of the gating system. Apec® can be injected at high speeds as a matter of principle, and graded injection has also proved successful. The holding pressure should not be set higher than is absolutely necessary or allowed to act for longer than strictly required.

It is important to bear the following in mind in the event of interruptions to production:

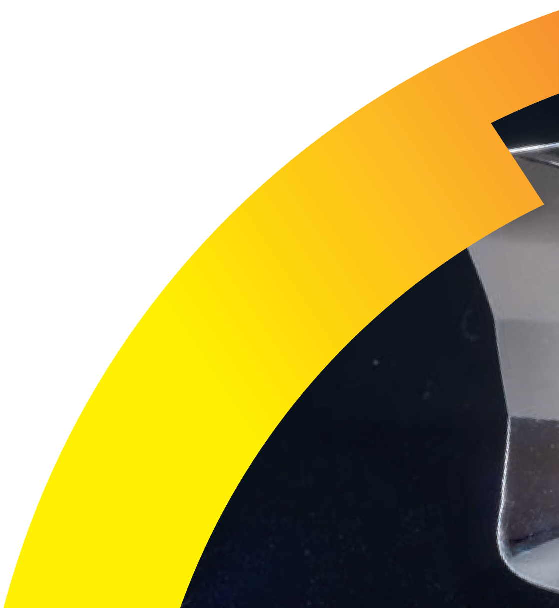
Nitrided steel injection molding machines are generally no more recommended.

If a wear- and corrosion-proof screw is being used (centrifuged cylinder with a chromium steel screw), this can be allowed to cool to room temperature.

As a rule, no problems will be encountered when parts made of Apec® are demolded (recommended demolding drafts ≥1%). When demolding cores, experience has shown a high mold temperature to have a positive influence. If demolding problems are still encountered, it may be possible to switch to a grade that contains release agent. We do not recommend the use of mold lubricants, however, since these can damage the injection molded part. Further advice on processing can be obtained from our general information brochure “Processing data for the injection molder”.

Apec® can similarly be processed by the following methods:

- Sheet extrusion
- Film extrusion
- Profile extrusion
- Extrusion blow molding
- Injection blow molding
- Film casting



Recycling, material disposal

Rejects and processing waste can be reground and processed into new moldings while observing the same drying and processing advice as for virgin product. It is essential to check the property level and color of molding compounds containing recyclate in order to ensure their suitability for the intended application. The permitted content of recyclate must be established in each individual case.

When using regrind, it must be borne in mind that the different grain geometry of regrind compared with extrusion granules affects the feed and plasticating behavior. For this same reason, physical mixtures of regrind and granules tend to separate when moved during transport, conveying, and metering.

When re using Apec®, it is important to ensure that no foreign materials or dirt are introduced. Apec® displays good compatibility with additive-free non-blended BPA-PC, which means that the two can essentially be recycled together. It should be borne in mind that, with homogeneous mixtures of the two molding compounds, the properties obtained will be a function of the mixing ratio.

Apec® can be disposed of in an environmentally friendly manner, either on a landfill or through correctly performed incineration.

The identification for the different Apec® grades is as follows:

Standard grades: >PC-HT<
Easy-flow grades: >PC-HT<
High-flow grade: >PC-HT<
FR grades: >PC-HT FR<

Designing with Apec®

Apec® is an amorphous thermoplastic with a high heat deflection temperature which belongs to the family of polycarbonates. Apec® displays good flowability in comparison with other amorphous thermoplastics with a high heat deflection temperature. This gives the design engineer a high level of freedom in design and means that the processor can benefit from a broad processing range.

Shrinkage, tolerances

Apec® displays identical shrinkage properties both parallel to and across the direction of flow. This is essential for the production of molded parts with a high dimensional stability. With optimum processing conditions, it is possible to achieve tolerances of ±0.1% for a nominal dimension of 100 mm.

Apec® grades	With flow/across flow
1695/1697	0.70/0.70
1795/1797	0.75/0.75
1895/1897	0.80/0.80
2095/2097	0.90/0.90
1603	0.75/0.75
1703/1745	0.80/0.80
1800/1803	0.85/0.85
2095HF	0.85/0.85
FR1892/FR1897	0.80/0.80
DP1-9354	0.85/0.85
RW1695/RW1697	0.70/0.70

Molding shrinkage[1)]

Mechanical properties, permitted stresses and strains

If Apec® is subject to prolonged mechanical stressing, it can suffer stress cracking in the same way as other amorphous thermoplastics. This process will be accelerated under the action of media that trigger stress cracking. It is not possible for all the factors that influence stress cracking to be recorded or taken into account at the design stage. If mechanical stressing is specified, then the design should be such that irreversible elongation does not exceed 0.3%. Under short-time loading, considerably higher strain values are possible. Up to 50% of the tensile strain at yield is permissible for once-only short-time loading, and up to 25% of the tensile strain at yield for repeated short-time loading. If there is any uncertainty regarding the mathematical determination of the stress, the appropriate safety factors should be applied.

The chemical resistance and stress cracking behavior of Apec® are largely conditioned by the temperature of the object, the nature and composition of the chemicals involved and the internal and external stresses acting on the molded parts. Both compressive stresses and tensile stresses occur as a function of the geometry of the molded part.

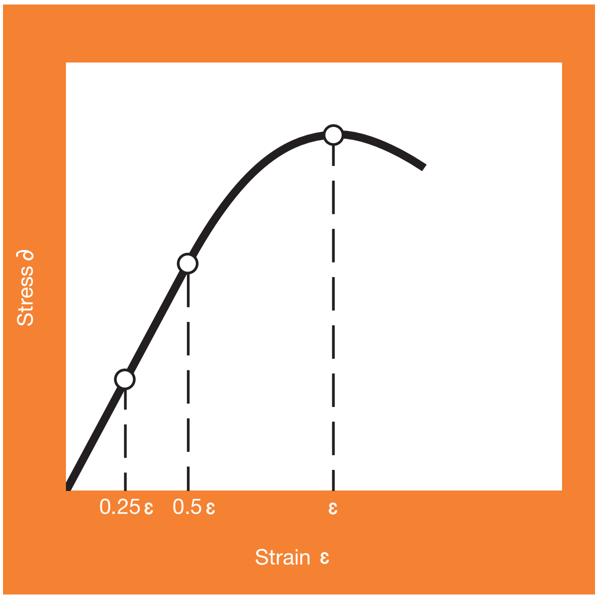


Fig. 5: Permitted stresses and strains for Apec®

Apec®	Short-time once-only MPa/%	Short-time repeated MPa/%	Long-therm MPa/%
All grades	56/3.4	35/1.7	7/0.3

If excessive tensile stresses prevail, this can lead to local deformation zones in the surface and in the regions close to the surface (microcracks, crazes) and hence to weak points.

In order to produce parts with a high serviceability, it is in the manufacturer's interest to avoid weak points of this type by ensuring that the stresses are properly under control.

As with standard polycarbonate, there is also a quick method for estimating the frozen-in tensile stresses in molded parts made of Apec®: The molded part to be tested, which has cooled to room temperature (22 ± 3°C), is fully immersed in a test medium. After 15 minutes' immersion, it is taken out of the medium and visually examined for any cracks that may have developed, together with their dimensions. If cracks are present, this indicates an unfavorable design or mold layout, or processing errors. The response threshold, i.e., tensile stresses that exceed this value are re-vleased in the form of stress cracks.

[1)] The shrinkage values were measured on a rectangular test plate 150 x 105 x 3 mm with a film gate at the 105 mm side. Melt temperature: 330 to 340°C (as a function of grade), mold temperature: 120 to 150°C (as a function of grade). Injection time: 1 s. Max. cavity pressure: 600 bar (pressure sensor close to film gate). NB: The shrinkage values given are reference values and thus only suitable for mold layout to a limited extent.

Test medium*	Treshold (after 15 min immersion)
n-Propanol	14 MPa
Toluol/n-Propanol 1:10	9 MPa
Toluol/n-Propanol 1:3	5 MPa

* The test should be conducted under a ventilation hood or in well ventilated surroundings. Protective eyewear and gloves should be worn!

A molded part in Apec® must at least pass the test in n-Propanol – even if no mechanical stressing is to be expected when it is in service. Sometimes, it is difficult to recognize stress cracks on colored plastics. In such cases, it is recommended that sample parts be made of transparent material and checked.

Radii, transitions in cross section

Sharp edges and corners lead to excessive stresses (notch effect) in corner and edge regions under loading. In the case of molded parts in Apec® which are subject to mechanical stressing, all edges and corners should be designed with a radius of at least 0.5 mm. In the same way, it is essential to avoid abrupt changes in cross section (sudden changes in stiffness). Changes in cross section should be gradual, wherever possible.

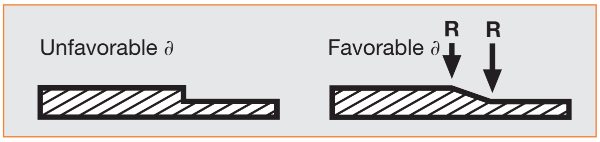


Fig. 6: Design of transitions in cross section

Screw connections and snap-fit joints

Screw bosses and snap-fitting hooks are elements of a plastics component that are subject to mechanical load. Screw bosses for self-tapping screws or self-forming screws expand when the screw is inserted, giving rise to long-term stressing.

The degree of expansion and hence the level of stress in the screw boss is determined by the type of screw used and its geometry. In the case of self-forming screws, the degree of expansion is greater than for self-tapping screws. Small thread angles reduce the level of stress in the screw boss. Any grease should be removed from the screws prior to insertion. Brass screws are not recommended for this application, since it is more difficult to remove grease from these than from nickel-plated screws, for instance. Determining the level of stress by mathematical means is difficult and always involves a high level of uncertainty (screw tolerances). In practical tests, favorable results have been obtained by observing the design guidelines given below (see also our brochure "Self-Tapping screws for thermoplastics").

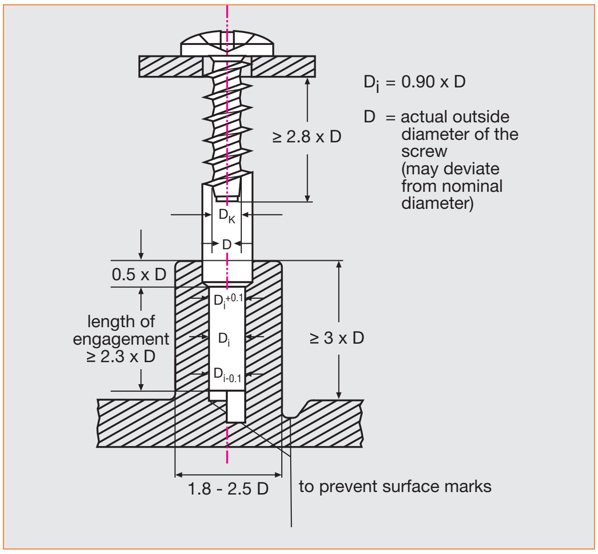


Fig. 7: Dimensioning of screw bosses for Apec®

Core diameter DK (mm)	< 0,65 x D
Pitch P (mm)	0.35 x D to 0.55 x D
Thread angle α	< 40°

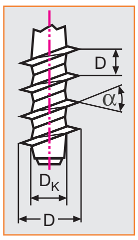


Fig. 8: Screw coupling with Apec® (recommended screw geometry)

Snap-fit joints are a simple and inexpensive type of connection. A snap-fit joint is subject to short-time mechanical load during the assembly operation. Once it has been assembled, the joint is then generally only subject to a low level of mechanical stressing. In most cases, stresses and strains can be determined mathematically (for calculation formulae and sample applications for a wide range of different snap-fit joints please see our brochure "Snap-fit Joints for Plastic – A Design Guide"). High stresses can be avoided through skilful dimensioning, as shown in the diagram below.

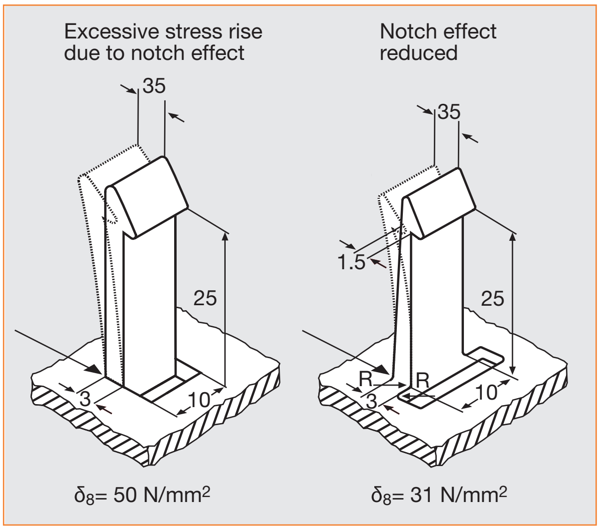


Fig. 9: Designing of snap-fit joints for Apec®

Gate layout

All the standard gating techniques can be employed for Apec®. Apart from the customary cold runner molds, molds with hot runner systems can also be used. If a hot runner system is employed, however, this should satisfy the requirements set out in the diagram below:

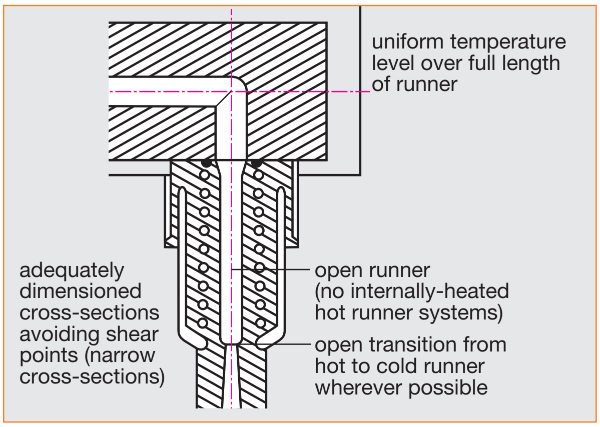


Fig. 10: Requirements for the hot runner system

Molded parts made of Apec® should be produced with a low level of stress. In the case of pinpoint gates, the point of injection is the area where the highest stress level prevails within the mold. These frozen-in stresses are caused by the very high flow velocity close to the gate.

The level of stress can be reduced not only by employing large gate cross sections but also by partially increasing the wall thickness in the region of the mold. If tunnel gates are used, a version with an accumulator base is recommended. This variant permits a clear reduction in melt stressing (Fig. 11).

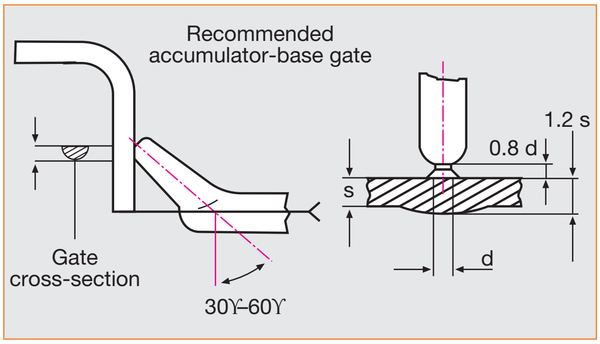


Fig. 11: Gate dimensioning – minimum gate diameter (d = 60%) of wall thickness (s)

The cross sections of the feed channels must be dimensioned as a function of the grade of Apec® employed, the weight of the molded part, and the length of the gate. It is not possible to give general recommendations on account of the many different influencing factors that are involved.

By using rheological computer programs, however, it is possible to reliably dimension gate systems with a low outlay.

Easy-flow grades

1695	MVR (330°C/2,16 kg) = 45 cm³/10 min; low viscous; easy release; softening temperature (VST/B 120) = 158°C; multi purpose grade; suitable for various lighting applications inside and outside the car (e.g., interior lamps, reflectors/bezels, covers for brake lights and indicator lights).	**1895**	MVR (330°C/2,16 kg) = 18 cm³/10 min; low viscous; easy release; softening temperature (VST/B 120) = 183°C; multi purpose grade; suitable for various lighting applications inside and outside the car (e.g., interior lamps, reflectors/bezels, covers for brake lights and indicator lights).
1697	MVR (330°C/2,16 kg) = 45 cm³/10 min; low viscous; easy release; UV-stabilized; softening temperature (VST/B 120) = 157°C; suitable for various car lighting applications (lamp covers, headlamp lenses).	**1897**	MVR (330°C/2,16 kg) = 18 cm³/10 min; low viscous; easy release; UV-stabilized; softening temperature (VST/B 120) = 182°C; suitable for car lighting applications (lamp covers, headlamp lenses).
1795	MVR (330°C/2,16 kg) 30 cm³/10 min; low viscous; easy release; softening temperature (VST/B 120) = 173°C; multi purpose grade; suitable for various lighting applications inside and outside the car (e.g., interior lamps, reflectors/bezels, covers for brake lights and indicator lights).	**2095**	MVR (330°C/2,16 kg) = 8 cm³/10 min; low viscous; easy release; softening temperature (VST/B 120) = 203°C; multi purpose grade; suitable for various lighting applications inside and outside the car (e.g., interior lamps, reflectors/bezels, covers for brake lights and indicator lights).
1797	MVR (330°C/2,16 kg) = 30 cm³/10 min; low viscous; easy release; UV-stabilized; softening temperature (VST/B 120) = 172°C; suitable for car lighting applications (lamp covers, headlamp lenses).	**2097**	MVR (330°C/2,16 kg) = 8 cm³/10 min; low viscous; easy release; UV-stabilized; softening temperature (VST/B 120) = 202°C; suitable for car lighting applications (lamp covers, headlamp lenses).

Standard grades

1603	MVR (330°C/2,16 kg) = 25 cm³/10 min; high viscous; UV-stabilized; softening temperature (VST/B 120) = 159°C; suitable for various lighting applications inside and outside the car as well as for covers for industrial and domestic lamps.	**1800**	MVR (330°C/2,16 kg) = 10 cm³/10 min; high viscous; softening temperature (VST/B 120) = 185°C; multi purpose grade.
1703	MVR (330°C/2,16 kg) = 17 cm³/10 min; high viscous; UV-stabilized; softening temperature (VST/B 120) = 171°C; suitable for various lighting applications inside and outside the car as well as for covers for industrial and domestic lamps.	**1803**	MVR (330°C/2,16 kg) = 10 cm³/10 min; high viscous; UV-stabilized; softening temperature (VST/B 120) = 184°C; suitable for various lighting applications inside and outside the car (e.g., covers for brake lights and indicator lights, car interior light covers, headlamp lenses, connector pieces for halogen systems) as well as for covers for industrial and domestic lamps.

High-flow grade

2095 HF	MVR (330°C/2,16 kg) = 14 cm^3/10 min; very low viscous; softening temperature (VST/B 120) = 203°C; multi purpose grade; suitable for various car lighting applications (e.g., reflectors and bezels).

Medical grade

1745	MVR (330°C/2,16 kg) = 17 cm^3/10 min; high viscous; easy release; softening temperature (VST/B 120) = 170°C; suitable for superheated steam sterilization up to 143°C, representative sample met the requirements of USP Class VI at the time of testing; suitable for various medical devices.

Flame-retardant grades

FR1892	MVR (330°C/2,16 kg) = 18 cm^3/10 min; low viscous; easy release; V-2/1,5 mm resp. V-0/3,0 mm (UL 94); softening temperature (VST/B 120) = 183°C; transparent colors possible; suitable for visors of firemen's helmets.	**DP1-9354**	MVR (330°C/2,16 kg) = 12 cm^3/10 min; high viscous; V-0/1,5 mm resp. V-0/3,0 mm (UL 94); 5VA/3,0 mm (UL 94); softening temperature (VST/B 120) = 185°C; only opaque colors.
FR1897	MVR (330°C/2,16 kg) = 18 cm^3/10 min; low viscous; easy release; UV-stabilized (fulfills the requirements of EN 170); V-2/1,5 mm resp. V-0/3,0 mm (UL 94); softening temperature (VST/B 120) = 183°C; transparent colors possible; suitable for visors of firemen's helmets.		

Reflective White grades

RW1695	MVR (330°C/2,16 kg) = 45 cm^3/10 min; low viscous; easy release; high light reflectivity; high light opacity; softening temperature (VSTB 120) = 158°C.	**RW1697**	MVR (330°C/2,16 kg) = 45 cm^3/10 min; low viscous; easy release; UV-stabilized; high light reflectivity; high light opacity; softening temperature (VSTB 120) = 157°C.

Apec® – Typical values

Properties	Test conditions	Units	Standards	Easy-flow grades 1695	1697	1795	1797
Rheological properties							
• Melt volume-flow rate (MVR)	330°C; 2.16 kg	cm^3/10 min	ISO 1133	45	45	30	30
Melt mass-flow rate (MFR)	330°C; 2.16 kg	g/10 min	ISO 1133	46	46	31	31
• Molding shrinkage, parallel	60 x 60 x 2 mm^3; 500 bar holding pressure	%	ISO 2577	0.7	0.7	0.8	0.8
Molding shrinkage, transverse	60 x 60 x 2 mm^3; 500 bar holding pressure	%	ISO 2577	0.7	0.7	0.8	0.8
Mechanical properties (23°C/50% r. F.)							
• Tensile modulus	1 mm/min	MPa	ISO 527-1, -2	2350	2350	2350	2350
• Yield stress	50 mm/min	MPa	ISO 527-1, -2	68	68	71	71
• Yield strain	50 mm/min	%	ISO 527-1, -2	6.3	6.3	6.6	6.6
• Nominal tensile strain at break	50 mm/min	%	ISO 527-1, -2	>50	>50	>50	>50
• Charpy impact strength	23°C	kJ/m^2	ISO 179/1eU	NB	NB	NB	NB
• Charpy impact strength	-30°C	kJ/m^2	ISO 179/1eU	NB	NB	NB	NB
• Puncture maximum force	23°C	N	ISO 6603-2	5200	5200	5200	5200
• Puncture maximum force	-30°C	N	ISO 6603-2	6000	6000	6000	6000
• Puncture energy	23°C	J	ISO 6603-2	54	54	54	54
• Puncture energy	-30°C	J	ISO 6603-2	58	58	58	58
Flexural modulus	2 mm/min	MPa	ISO 178	2400	2400	2400	2400
Flexural strength	5 mm/min	MPa	ISO 178	100	100	105	105
Ball indentation hardness	–	N/mm^2	ISO 2039-1	120	120	125	125
Thermal properties							
• Deflection temperature under load, Af	1.80 MPa	°C	ISO 75-1, -2	136	135	148	147
• Deflection temperature under load, Bf	0.45 MPa	°C	ISO 75-1, -2	149	148	162	161
Vicat softening temperature	50 N; 120 K/h	°C	ISO 306	158	157	173	172
RTI, tensile strength	1.5 mm/3.0 min	°C	UL 746B	140	140[1)]	140	140[1)]
RTI, tensile impact strength	1.5 mm/3.0 min	°C	UL 746B	130	130[1)]	130	130[1)]
RTI, electric strength	1.5 mm/3.0 min	°C	UL 746B	140	140[1)]	140	140[1)]
• Coefficient of linear thermal expansion, parallel	23 to 55°C	10^{-4}/K	ASTM E 831	0.65	0.65	0.65	0.65
• Coefficient of linear thermal expansion, transverse	23 to 55°C	10^{-4}/K	ASTM E 831	0.65	0.65	0.65	0.65
Burning behavior UL 94	Thickness: 1.5 mm	Class	UL 94	HB	HB[2)]	HB	HB
Burning behavior UL 94	Thickness: 3.0 mm	Class	UL 94	HB	HB[2)]	HB	HB
Burning behavior FMVSS	Thickness: 1.0 mm	mm/min	ISO 3795	0	0	0	0
• Oxygen index	Method A	%	ISO 4589	26	26	25	25
Glow wire temperature (GWR)	Thickness: 2.0 mm	°C	IEC 695-2-12	850	850	850	850
Electrical properties (23°C/50% r. F.)							
• Relative permitivity	100 Hz	–	IEC 250	3	3	3	3
• Relative permitivity	1 MHz	–	IEC 250	2.9	2.9	2.9	2.9
• Dissipation factor	100 Hz	10^{-4}	IEC 250	10	10	10	10
• Dissipation factor	1 MHz	10^{-4}	IEC 250	90	90	80	80
• Volume resistivity	–	Ohm · m	IEC 93	1E + 15	1E + 15	1E + 15	1E + 15
• Surface resistivity	–	Ohm	IEC 93	1E + 16	1E + 16	1E + 16	1E + 16
• Electric strength	–	kV/mm	IEC 243-1	35	35	35	35
• Comparative tracking index CTI	Solution A	Rating	IEC 112	250	250	250	250
Comparative tracking index CTI M	Solution B	Rating	IEC 112	125	125	125	125
Electrolytic corrosion	–	Rating	IEC 426	A1	A1	A1	A1
Other properties (23°C)							
• Water absorption (saturation value)	In water at 23°C	%	ISO 62	0.3	0.3	0.3	0.3
• Water absorption (equilibrium value)	23°C/50%	%	ISO 62	0.12	0.12	0.12	0.12
• Density	–	kg/m^3	ISO 1183	1180	1180	1170	1170
Material-specific properties							
Refractive index	–	–	ISO 489-A	1.578	1.578	1.576	1.576
Light transmittance (color-no. 551022)	1 mm	%	ISO 5036-1	90	90	90	90
• Light transmittance (color-no. 551022)	2 mm	%	ISO 5036-1	89	89	89	89
Light transmittance (color-no. 551022)	3 mm	%	ISO 5036-1	88	88	88	88
Processing conditions for test specimen							
• Injection molding – melt temperature	–	°C	ISO 294	330	330	330	330
• Injection molding – mold temperature	–	°C	ISO 294	100	100	100	100
• Injection molding – flow front velocity	–	mm/s	ISO 294	200	200	200	200

Apec® – Typical values

Properties	Test conditions	Units	Standards	Easy-flow grades 1895	1897	2095[3]	2097
Rheological properties							
• Melt volume-flow rate (MVR)	330°C; 2.16 kg	cm³/10 min	ISO 1133	18	18	8	8
Melt mass-flow rate (MFR)	330°C; 2.16 kg	g/10 min	ISO 1133	19	19	8	8
• Molding shrinkage, parallel	60 x 60 x 2 mm³; 500 bar holding pressure	%	ISO 2577	0.85	0.85	1.05	1.05
Molding shrinkage, transverse	60 x 60 x 2 mm³; 500 bar holding pressure	%	ISO 2577	0.85	0.85	1.05	1.05
Mechanical properties (23°C/50% r. F.)							
• Tensile modulus	1 mm/min	MPa	ISO 527-1, -2	2350	2350	2400	2400
• Yield stress	50 mm/min	MPa	ISO 527-1, -2	72	72	75	75
• Yield strain	50 mm/min	%	ISO 527-1, -2	6.7	6.7	6.8	6.8
• Nominal tensile strain at break	50 mm/min	%	ISO 527-1, -2	>50	>50	>50	>50
• Charpy impact strength	23°C	kJ/m²	ISO 179/1eU	NB	NB	NB	NB
• Charpy impact strength	-30°C	kJ/m²	ISO 179/1eU	NB	NB	NB	NB
• Puncture maximum force	23°C	N	ISO 6603-2	5200	5200	5000	5000
• Puncture maximum force	-30°C	N	ISO 6603-2	6000	6000	5500	5500
• Puncture energy	23°C	J	ISO 6603-2	54	54	50	50
• Puncture energy	-30°C	J	ISO 6603-2	58	58	48	48
Flexural modulus	2 mm/min	MPa	ISO 178	2400	2400	2450	2450
Flexural strength	5 mm/min	MPa	ISO 178	108	108	110	110
Ball indentation hardness	–	N/mm²	ISO 2039-1	127	127	130	130
Thermal properties							
• Deflection temperature under load, Af	1.80 MPa	°C	ISO 75-1, -2	157	156	173	172
• Deflection temperature under load, Bf	0.45 MPa	°C	ISO 75-1, -2	174	173	192	191
Vicat softening temperature	50 N; 120 K/h	°C	ISO 306	183	182	203	202
RTI, tensile strength	1.5 mm/3.0 min	°C	UL 746B	150	150	150	150
RTI, tensile impact strength	1.5 mm/3.0 min	°C	UL 746B	130	130	130	130
RTI, electric strength	1.5 mm/3.0 min	°C	UL 746B	150	150	150	150
• Coefficient of linear thermal expansion, parallel	23 to 55°C	10^{-4}/K	ASTM E 831	0.65	0.65	0.65	0.65
• Coefficient of linear thermal expansion, transverse	23 to 55°C	10^{-4}/K	ASTM E 831	0.65	0.65	0.65	0.65
Burning behavior UL 94	Thickness: 1.5 mm	Class	UL 94	HB	HB	HB	HB
Burning behavior UL 94	Thickness: 3.0 mm	Class	UL 94	HB	HB	HB	HB
Burning behavior FMVSS	Thickness: 1.0 mm	mm/min	ISO 3795	0	0	0	0
• Oxygen index	Method A	%	ISO 4589	25	25	25	25
Glow wire temperature (GWR)	Thickness: 2.0 mm	°C	IEC 695-2-12	850	850	800	800
Electrical properties (23°C/50% r. F.)							
• Relative permitivity	100 Hz	–	IEC 250	2.9	2.9	2.9	2.9
• Relative permitivity	1 MHz	–	IEC 250	2.8	2.8	2.8	2.8
• Dissipation factor	100 Hz	10^{-4}	IEC 250	10	10	10	10
• Dissipation factor	1 MHz	10^{-4}	IEC 250	90	90	90	90
• Volume resistivity	–	Ohm · m	IEC 93	1E + 15	1E + 15	1E + 15	1E + 15
• Surface resistivity	–	Ohm	IEC 93	1E + 16	1E + 16	1E + 16	1E + 16
• Electric strength	–	kV/mm	IEC 243-1	35	35	35	35
• Comparative tracking index CTI	Solution A	Rating	IEC 112	300	300	600	600
Comparative tracking index CTI M	Solution B	Rating	IEC 112	100	100	100	100
Electrolytic corrosion	–	Rating	IEC 426	A1	A1	A1	A1
Other properties (23°C)							
• Water absorption (saturation value)	In water at 23°C	%	ISO 62	0.3	0.3	0.3	0.3
• Water absorption (equilibrium value)	23°C/50%	%	ISO 62	0.12	0.12	0.12	0.12
• Density	–	kg/m³	ISO 1183	1150	1150	1130	1130
Material-specific properties							
Refractive index	–	–	ISO 489-A	1.573	1.573	1.566	1.566
Light transmittance (color-no. 551022)	1 mm	%	ISO 5036-1	90	90	90[5]	90
• Light transmittance (color-no. 551022)	2 mm	%	ISO 5036-1	89	89	90[5]	89
Light transmittance (color-no. 551022)	3 mm	%	ISO 5036-1	88	88	90[5]	88
Processing conditions for test specimen							
• Injection molding – melt temperature	–	°C	ISO 294	330	330	330	330
• Injection molding – mold temperature	–	°C	ISO 294	100	100	100	100
• Injection molding – flow front velocity	–	mm/s	ISO 294	200	200	200	200

Apec® – Typical values

Properties	Test conditions	Units	Standards	Standard grades			
				1603	1703	1800	1803
Rheological properties							
• Melt volume-flow rate (MVR)	330°C; 2.16 kg	cm³/10 min	ISO 1133	25	17	10	10
Melt mass-flow rate (MFR)	330°C; 2.16 kg	g/10 min	ISO 1133	26	17	10	10
• Molding shrinkage, parallel	60 x 60 x 2 mm³; 500 bar holding pressure	%	ISO 2577	0.75	0.85	0,9	0.9
Molding shrinkage, transverse	60 x 60 x 2 mm³; 500 bar holding pressure	%	ISO 2577	0.75	0.85	0,9	0.9
Mechanical properties (23°C/50% r. F.)							
• Tensile modulus	1 mm/min	MPa	ISO 527-1, -2	2350	2350	2350	2350
• Yield stress	50 mm/min	MPa	ISO 527-1, -2	68	70	72	72
• Yield strain	50 mm/min	%	ISO 527-1, -2	6.3	6.7	6.8	6.8
• Nominal tensile strain at break	50 mm/min	%	ISO 527-1, -2	>50	>50	>50	>50
• Charpy impact strength	23°C	kJ/m²	ISO 179/1eU	NB	NB	NB	NB
• Charpy impact strength	-30°C	kJ/m²	ISO 179/1eU	NB	NB	NB	NB
• Puncture maximum force	23°C	N	ISO 6603-2	5700	5500	5500	5500
• Puncture maximum force	-30°C	N	ISO 6603-2	6600	6400	6300	6300
• Puncture energy	23°C	J	ISO 6603-2	62	60	60	60
• Puncture energy	-30°C	J	ISO 6603-2	70	68	65	65
Flexural modulus	2 mm/min	MPa	ISO 178	2400	2400	2400	2400
Flexural strength	5 mm/min	MPa	ISO 178	103	103	106	106
Ball indentation hardness	–	N/mm²	ISO 2039-1	120	120	121	121
Thermal properties							
• Deflection temperature under load, Af	1.80 MPa	°C	ISO 75-1, -2	137	149	160	159
• Deflection temperature under load, Bf	0.45 MPa	°C	ISO 75-1, -2	150	162	175	174
Vicat softening temperature	50 N; 120 K/h	°C	ISO 306	159	171	185	184
RTI, tensile strength	1.5 mm/3.0 min	°C	UL 746B	140[1]	140	150	150
RTI, tensile impact strength	1.5 mm/3.0 min	°C	UL 746B	130[1]	130	130	130
RTI, electric strength	1.5 mm/3.0 min	°C	UL 746B	140[1]	140	150	150
• Coefficient of linear thermal expansion, parallel	23 to 55°C	10^{-4}/K	ASTM E 831	0.65	0.65	0.65	0.65
• Coefficient of linear thermal expansion, transverse	23 to 55°C	10^{-4}/K	ASTM E 831	0.65	0.65	0.65	0.65
Burning behavior UL 94	Thickness: 1.5 mm	Class	UL 94	HB[2]	HB	HB	HB
Burning behavior UL 94	Thickness: 3.0 mm	Class	UL 94	HB[2]	HB	HB	HB
Burning behavior FMVSS	Thickness: 1.0 mm	mm/min	ISO 3795	0	0	0	0
• Oxygen index	Method A	%	ISO 4589	26	25	25	25
Glow wire temperature (GWR)	Thickness: 2.0 mm	°C	IEC 695-2-12	900	850	850	850
Electrical properties (23°C/50% r. F.)							
• Relative permitivity	100 Hz	–	IEC 250	3	3	2.9	2.9
• Relative permitivity	1 MHz	–	IEC 250	2.9	2.9	2.8	2.8
• Dissipation factor	100 Hz	10^{-4}	IEC 250	10	10	10	10
• Dissipation factor	1 MHz	10^{-4}	IEC 250	90	80	80	80
• Volume resistivity	–	Ohm · m	IEC 93	1E + 15	1E + 15	1E + 15	1E + 15
• Surface resistivity	–	Ohm	IEC 93	1E + 16	1E + 16	1E + 16	1E + 16
• Electric strength	–	kV/mm	IEC 243-1	35	35	35	35
• Comparative tracking index CTI	Solution A	Rating	IEC 112	250	250	450	450
Comparative tracking index CTI M	Solution B	Rating	IEC 112	125	125	100	100
Electrolytic corrosion	–	Rating	IEC 426	A1	A1	A1	A1
Other properties (23°C)							
• Water absorption (saturation value)	In water at 23°C	%	ISO 62	0.3	0.3	0.3	0.3
• Water absorption (equilibrium value)	23°C/50%	%	ISO 62	0.12	0.12	0.12	0.12
• Density	–	kg/m³	ISO 1183	1180	1170	1150	1150
Material-specific properties							
Refractive index	–	–	ISO 489-A	1.578	1.578	1.573	1.573
Light transmittance (color-no. 551022)	1 mm	%	ISO 5036-1	90	90	90[5]	90
• Light transmittance (color-no. 551022)	2 mm	%	ISO 5036-1	89	89	90[5]	89
Light transmittance (color-no. 551022)	3 mm	%	ISO 5036-1	88	88	90[5]	88
Processing conditions for test specimen							
• Injection molding – melt temperature	–	°C	ISO 294	330	330	330	330
• Injection molding – mold temperature	–	°C	ISO 294	100	100	100	100
• Injection molding – flow front velocity	–	mm/s	ISO 294	200	200	200	200

Apec® – Typical values

				High-flow grade	Medical grade	Reflective White grades	
Properties	**Test conditions**	**Units**	**Standards**	**2095 HF**	**1745**	**RW1695**	**RW1697**
Rheological properties							
• Melt volume-flow rate (MVR)	330°C; 2.16 kg	cm^3/10 min	ISO 1133	14	17	45	45
Melt mass-flow rate (MFR)	330°C; 2.16 kg	g/10 min	ISO 1133	14	17	48	48
• Molding shrinkage, parallel	60 x 60 x 2 mm^3; 500 bar holding pressure	%	ISO 2577	1	0.85	0.7	0.7
Molding shrinkage, transverse	60 x 60 x 2 mm^3; 500 bar holding pressure	%	ISO 2577	1	0.85	0.7	0.7
Mechanical properties (23°C/50% r. F.)							
• Tensile modulus	1 mm/min	MPa	ISO 527-1, -2	2400	2400	2450	2450
• Yield stress	50 mm/min	MPa	ISO 527-1, -2	75	70	70	70
• Yield strain	50 mm/min	%	ISO 527-1, -2	6.9	6.8	6	6
• Nominal tensile strain at break	50 mm/min	%	ISO 527-1, -2	>50	>50	50	50
• Charpy impact strength	23°C	kJ/m^2	ISO 179/1eU	NB	NB	NB	NB
• Charpy impact strength	-30°C	kJ/m^2	ISO 179/1eU	NB	NB	NB	NB
• Puncture maximum force	23°C	N	ISO 6603-2	–	5500	5100	5100
• Puncture maximum force	-30°C	N	ISO 6603-2	–	6400	5900	5900
• Puncture energy	23°C	J	ISO 6603-2	–	60	52	52
• Puncture energy	-30°C	J	ISO 6603-2	–	68	50	50
Flexural modulus	2 mm/min	MPa	ISO 178	2450	2400	2500	2500
Flexural strength	5 mm/min	MPa	ISO 178	112	105	105	105
Ball indentation hardness	–	N/mm^2	ISO 2039-1	132	120	125	125
Thermal properties							
• Deflection temperature under load, Af	1.80 MPa	°C	ISO 75-1, -2	173	148	137	136
• Deflection temperature under load, Bf	0.45 MPa	°C	ISO 75-1, -2	192	161	150	149
Vicat softening temperature	50 N; 120 K/h	°C	ISO 306	203	170	158	157
RTI, tensile strength	1.5 mm/3.0 min	°C	UL 746B	–	–	–	–
RTI, tensile impact strength	1.5 mm/3.0 min	°C	UL 746B	–	–	–	–
RTI, electric strength	1.5 mm/3.0 min	°C	UL 746B	–	–	–	–
• Coefficient of linear thermal expansion, parallel	23 to 55°C	10^{-4}/K	ASTM E 831	0.65	0.65	0.6	0.6
• Coefficient of linear thermal expansion, transverse	23 to 55°C	10^{-4}/K	ASTM E 831	0.65	0.65	0.6	0.6
Burning behavior UL 94	Thickness: 1.5 mm	Class	UL 94	HB[2]	HB	V2[2]	V2[2]
Burning behavior UL 94	Thickness: 3.0 mm	Class	UL 94	HB[2]	HB	HB[2]	HB[2]
Burning behavior FMVSS	Thickness: 1.0 mm	mm/min	ISO 3795	0	0	–	–
• Oxygen index	Method A	%	ISO 4589	25	25	–	–
Glow wire temperature (GWR)	Thickness: 2.0 mm	°C	IEC 695-2-12	800	850	–	–
Electrical properties (23°C/50% r. F.)							
• Relative permitivity	100 Hz	–	IEC 250	–	3	–	–
• Relative permitivity	1 MHz	–	IEC 250	–	2.9	–	–
• Dissipation factor	100 Hz	10^{-4}	IEC 250	–	10	–	–
• Dissipation factor	1 MHz	10^{-4}	IEC 250	–	80	–	–
• Volume resistivity	–	Ohm · m	IEC 93	–	1E + 15	–	–
• Surface resistivity	–	Ohm	IEC 93	–	1E + 16	–	–
• Electric strength	–	kV/mm	IEC 243-1	–	35	–	–
• Comparative tracking index CTI	Solution A	Rating	IEC 112	–	250	–	–
Comparative tracking index CTI M	Solution B	Rating	IEC 112	–	125	–	–
Electrolytic corrosion	–	Rating	IEC 426	–	A1	–	–
Other properties (23°C)							
• Water absorption (saturation value)	In water at 23°C	%	ISO 62	0.3	0.3	0.3	0.3
• Water absorption (equilibrium value)	23°C/50%	%	ISO 62	0.12	0.12	0.12	0.12
• Density	–	kg/m^3	ISO 1183	1130	1170	1240	1240
Material-specific properties							
Refractive index	–	–	ISO 489-A	1.566	1.578	[4]	[4]
Light transmittance (color-no. 551022)	1 mm	%	ISO 5036-1	90[5]	88	[4]	[4]
• Light transmittance (color-no. 551022)	2 mm	%	ISO 5036-1	90[5]	87	[4]	[4]
Light transmittance (color-no. 551022)	3 mm	%	ISO 5036-1	90[5]	86	[4]	95[4,6]
Processing conditions for test specimen							
• Injection molding – melt temperature	–	°C	ISO 294	330	330	330	330
• Injection molding – mold temperature	–	°C	ISO 294	100	100	100	100
• Injection molding – flow front velocity	–	mm/s	ISO 294	200	200	200	200

Apec® – Typical values

Flame-retardant grades		
FR1892	FR1897	DP1-9354
18	18	12
19	19	12
0.85	0.85	0.9
0.85	0.85	0.9
2350	2350	2350
72	72	72
6.7	6.7	6,8
>50	>50	>50
NB	NB	NB
NB	NB	NB
5200	5200	5200
6000	6000	6000
54	54	58
58	58	62
2400	2400	2400
108	108	106
127	127	121
157	156	160
174	173	175
183	182	185
140[1]	–	140
130[1]	–	130
140[1]	–	140
0.65	0.65	0.65
0.65	0.65	0.65
V2	V2	V0
V0	V0	V0
0	0	0
32	32	33
960	960	960
2.9	2.9	2.9
2.8	2.8	2.8
10	10	10
90	90	90
1E + 14	1E + 14	1E + 14
1E + 15	1E + 15	1E + 15
35	35	35
225	225	225
100	100	100
A1	A1	A1
0.3	0.3	0.3
0.12	0.12	0.12
1150	1150	1150
1.573	1.573	[4]
90[5]	89[7]	[4]
90[5]	88[7]	[4]
89[5]	87[7]	[4]
330	330	330
100	100	100
200	200	200

- These property characteristics are taken from the CAMPUS® plastics data bank and are based on the international catalog of basic data for plastics according to ISO10350.

[1] Expected RTI.
[2] Covestro Test.
[3] Not available in clear transparent color 551022; please use alternatively Apec® 2097 551022.
[4] Only opaque colors.
[5] Natural colored.
[6] Light reflection acc. to JIS8722 (color-no. 010226).
[7] Disclaimer of Warranty (See warranty on page 23).

Typical value

These values are typical values only. Unless explicitly agreed in written form, they do not constitute a binding material specification or warranted values. Values may be affected by the design of the mold/die, the processing conditions and coloring/pigmentation of the product. Unless specified to the contrary, the property values given have been established on standardized test specimens at room temperature.

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