ARNITEL® TPE

General Information on Properties

a DSM Product

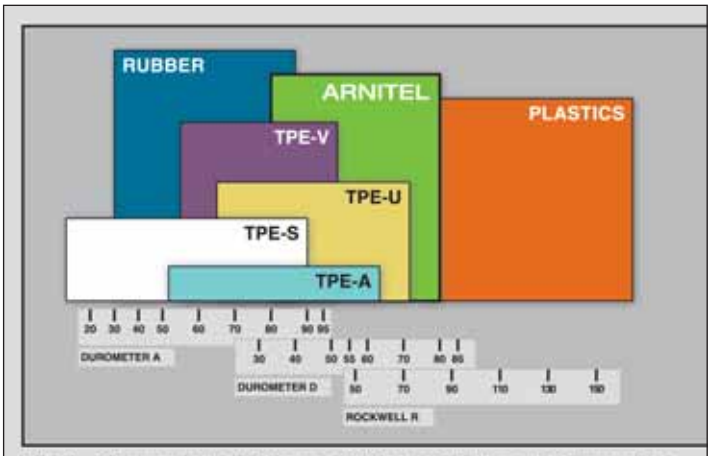
ARNITEL® TPE
dedication makes the difference

Unlimited. DSM

Arnitel General Information on Properties

Arnitel - Properties Engineered For Applications

Table 1 Positioning of Arnitel copolyester elastomer relative to other TPE's on a hardness scale.



TPE-V = Thermoplastic Elastomer of Vulcanized Rubber in Polypropylene
TPE-S = Polystyrene based Thermoplastic Elastomer
TPE-U = Polyurethane based Thermoplastic Elastomer
TPE-A = Polyamide based Thermoplastic Elastomer

Table 2 Arnitel product line overview.

	Hardness (Shore D)					
	25	35 / 40	46	55 / 58	63	74
Injection Molding	E	E/P	E/P	E/P/U	E/P	E
Extrusion	E	E/P	E/P	E/P/U	E/P	E
Extrusion (cast)		P	E/P	E/P/U		E
Blow Molding		P	E	P		

P = General purpose poly-ether-ester grade
E = Specialty poly-ether-ester grade
U = Specialty poly-ester-ester grade

Arnitel is a family of thermoplastic copolyester based elastomers (TPE-E's or COPE). These copolyesters combine the strength and processing characteristics of engineering plastics with the performance of thermoset elastomers providing benefits in processing and productivity. As thermoplastics, they do not require vulcanization to obtain their optimal properties, which often leads to substantial reductions in part cost. Relative to other elastomers, polyester-based materials offer the most consistent performance over their entire operating temperature range since their properties vary little from low to high temperature extremes.

Arnitel grades are optimized to provide specific performance in selected applications. Arnitel is offered in a range of hardnesses, based on three different types; general purpose polyetherester types, specialty polyetherester types and specialty polyesterester types; and with viscosities tailored to the processing techniques employed for the targeted applications. To find the most suitable grade for your application, contact DSM.

Flexibility

Arnitel has exceptional flexibility and can perform or even outperform functions that normally require conventional rubbers. Available in a wide range of hardnesses from 25 to 74 Shore D (see Table 2), Arnitel is uniquely positioned to replace metals, thermoplastics, leather and rubber, often with a reduction in finished part costs.

DSM has a number of masterbatches to further enhance specific properties of the standard portfolio, like a heat stabilizer masterbatch and a UV stabilizer masterbatch. Next to this, specific grades are available that are additionally stabilized or flame retardant (UL94V-2 and UL94V-0). For details please contact your local DSM representative.

Table 3 Comparative features of different thermoplastics elastomers (TPE).

Type	Strength	Weakness
TPE-V	- low hardness - good water resistance	- poor creep at high T - poor resistance grease and oil - low flexibility at low T - poor in painting / printing
TPE-S	- good elasticity - low hardness - good water resistance	- poor mechanical properties - poor high T properties - poor resistance to grease and oil - poor thermo oxidative stability - poor in painting / printing
TPE-U	- good elasticity - low hardness - good abrasion resistance	- poor creep at high T - poor mech. properties at high T - inconsistent processing
Arnitel	- good low T elasticity - good high T mech. properties - good high T stability - good resistance grease and oil	- restricted low hardness range
TPE-A	- low hardness - good water resistance	- poor high T properties - poor thermo oxidative stability

Product Scope

Characteristics of Arnitel

Figure 1 CAE of Arnitel in CVJ boots.

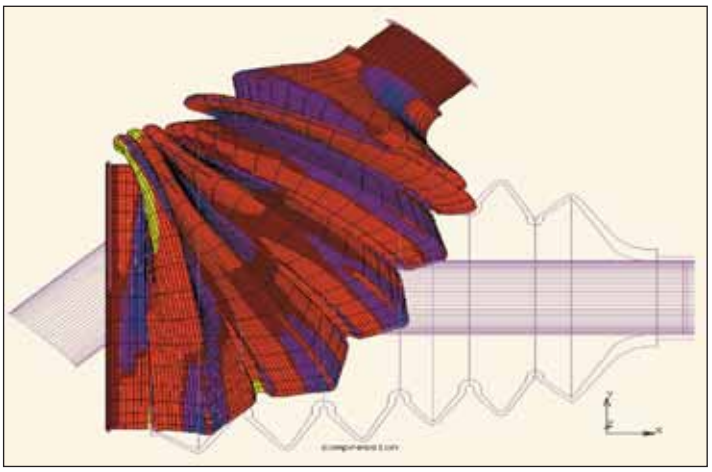


Figure 2 Retention of burst pressure (23°C vs 150°C).

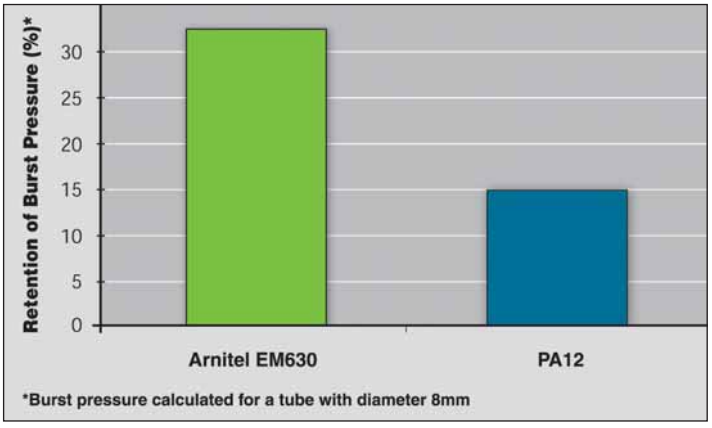
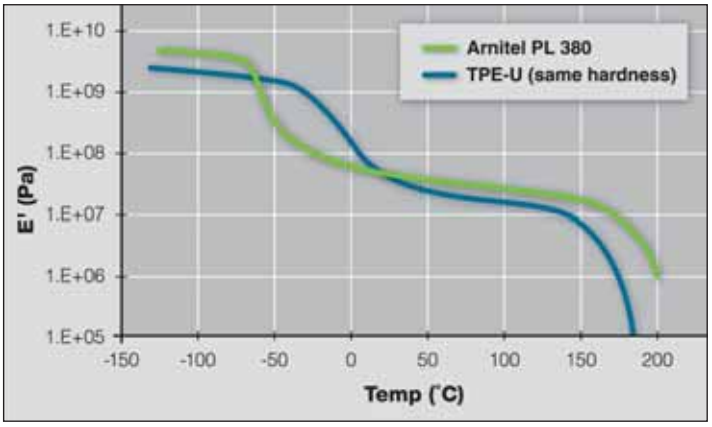


Figure 3 Dynamic modulus of Arnitel TPE versus TPE-U.



Mechanical Properties

Fatigue resistance. Arnitel has outstanding resistance to flexural fatigue both at high temperatures and sub-zero temperatures. Applications such as constant velocity boots and rack and pinion bellows are subjected to temperatures from as low as -45°C (-50°F) to a high of 140°C (285°F), and also encounter very high levels of flexural fatigue. Arnitel in such applications perform far better than conventional rubbers (CR-rubber) giving a very long component life, to last the life of the car itself. Arnitel is the material of choice for applications where performance is critical at very low as well as very high temperatures.

Strength at high temperatures. Arnitel retains its strength and stiffness up to high temperatures. In automotive pneumatic tube and hose applications such as air brake tubing, pneumatic tubing and air-ducts for turbochargers, an important requirement is a high burst pressure. Burst pressure is related to the yield stress of the material. Arnitel can withstand very high burst pressures and retains its properties better at higher temperatures than competitive materials such as PA12 (see Figure 2).

Even though at room temperatures the burst pressure of PA12 is higher than that of Arnitel, the performance of Arnitel EM630 at 150°C (300°F) (for example) is much higher than that of PA12. The superior retention of properties of Arnitel, even at temperatures as high as 150°C and especially burst pressure, provides more safety and greater reliability in applications such as airbrake tubing.

One of the key features of Arnitel is its flat modulus (so-called rubber plateau) over a very broad temperature range. In Figure 3 the modulus of PL380 shows a more or less "flat" behavior from below -40°C to over 150°C (-40°F to over 300°F), whereas the TPE-U only shows this from 25°C up to 100°C (75°F up to 210°F).

This means for the low temperature region Arnitel still demonstrates a rubber behavior down to -40°C whereas the TPE-U is already a stiff and brittle material. On the high end Arnitel TPE is capable of bearing mechanical loads up to over 150°C. In that temperature range the TPE-U is already significantly softening and is no longer capable of bearing loads.

Kink resistance. Arnitel is used in applications for transmitting pressure primarily as a component of an actuation system such as in pneumatic tubes and hydraulic tubes where kink resistance becomes extremely important. The kink resistance can directly be seen through the stress – strain behavior of the material (see Figure 4). The kink resistance is best for materials that show an elastic plateau over a wide range of strain values and that do not show a distinct strain softening beyond the yield point.

The low hardness grades of Arnitel show high resistance to kinking. Arnitel EM400 and Arnitel EM550 are widely used for applications such as tubes where kinking needs to be avoided and also strength is important.

Creep resistance. Arnitel has excellent resistance to creep (see Figure 5). In critical automotive applications where the retention of mechanical properties under constant stresses for very long durations is required, Arnitel's high resistance to creep makes it the material of choice, contributing to greater safety and extended durability.

Compression set. Arnitel has excellent resistance to compression set compared to other thermoplastic elastomers (see Figure 6). The excellent resistance to compression set makes Arnitel last longer than competition in applications such as railway pads, seals, and train buffers.

Figure 4 Typical stress-strain curves of Arnitel EM400 and Arnitel EM550 (both these grades demonstrate broad elastic plateaus).

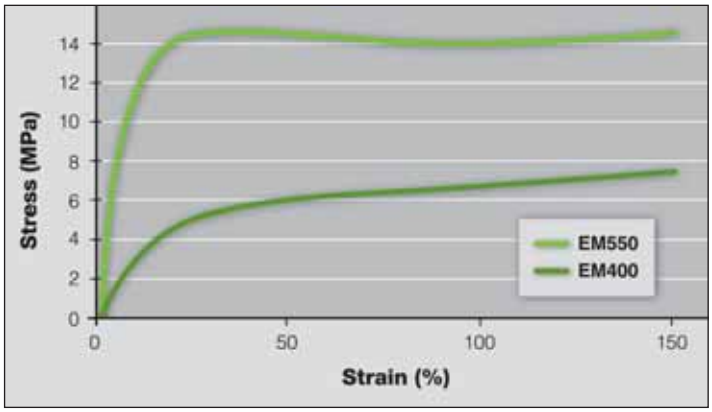


Figure 5 Arnitel creep resistance at 23°C.

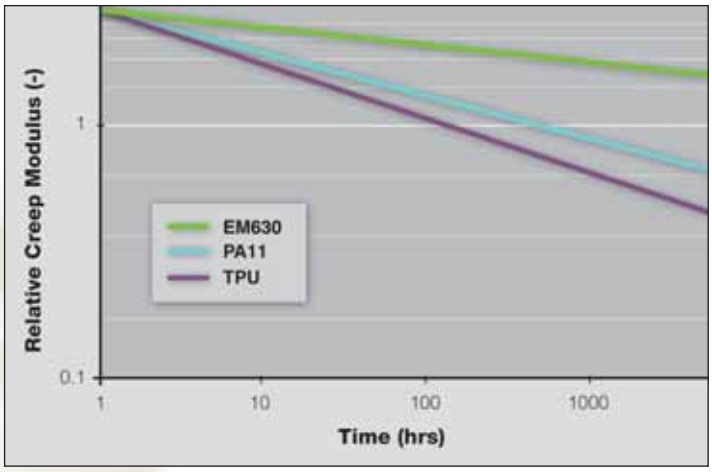


Figure 6 A comparison of Arnitel's compression resistance versus other materials.

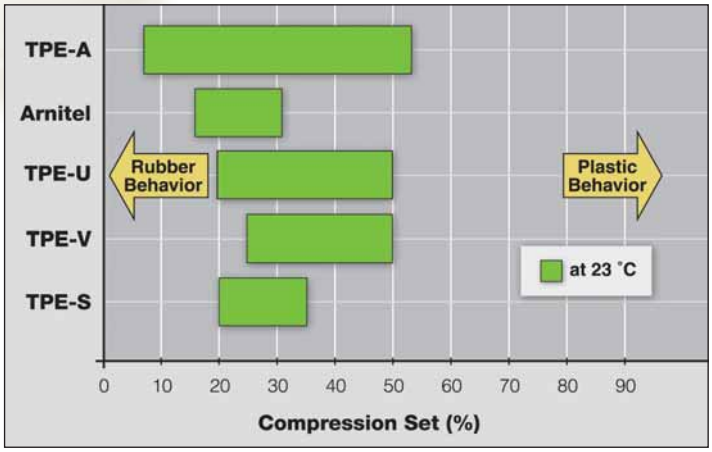


Figure 7 Chemical resistance of Arnitel.

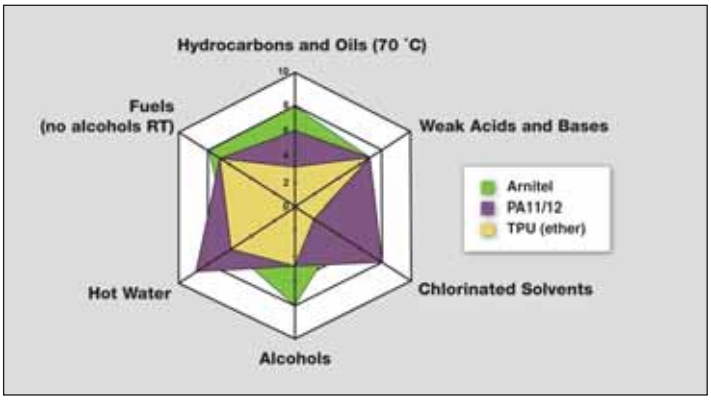


Figure 8 Upper continuous use temperature of Arnitel vs. other TPE's.

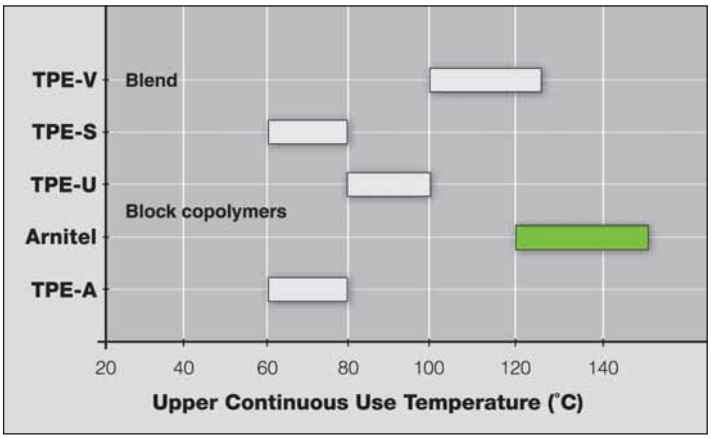
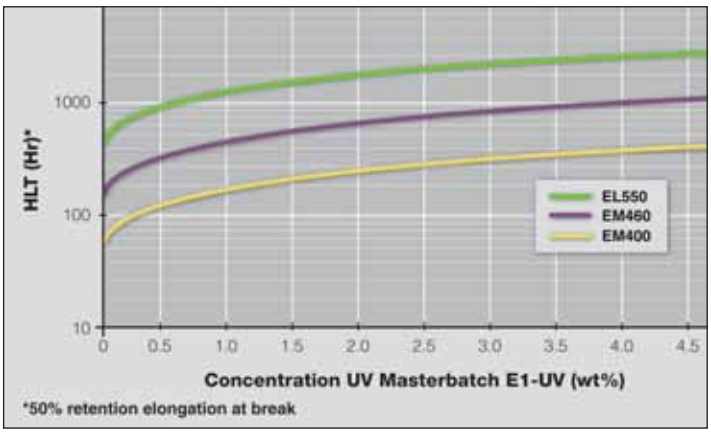


Figure 9 Half life time of Arnitel E at different concentrations of UV masterbatch loadings.



Chemical Properties

Arnitel has very good resistance to automotive greases and oils (see Figure 7). This makes Arnitel highly suitable for use in automotive applications in contact with greases and oils at high temperatures such as cable ties, fuel lines, and hydraulic tubes and hoses. The chemical resistance of Arnitel increases with the hardness. Arnitel U shows the best chemical resistance, followed by Arnitel E and Arnitel P. The soft grades of Arnitel are soluble in halogenated hydrocarbons at room temperature, whereas the harder grades will only dissolve at elevated temperatures. Arnitel, in general, is sensitive to strong acids. High temperature applications are not suitable if there is continuous contact with acid.

Thermal Properties

Arnitel is extensively used in applications over a very wide range of temperatures. Arnitel retains its mechanicals at very low temperatures of -40°C (-40°F) right up to 150°C (300°F) (see Figure 8). Arnitel is the material of choice when it comes to life saving applications at critically low temperatures such as airbag covers where Arnitel guarantees a splinter free performance even at -40°C (-40°F) where other elastomers dangerously splinter. Arnitel retains its mechanical's at high temperatures. For this reason Arnitel is used in under the hood automotive applications such as air ducts.

In addition, Arnitel U offers continuous use temperatures up to 160°C (320°F) and unique aging properties.

UV Resistance

Arnitel has excellent intrinsic UV resistance. Colored grades of Arnitel do not discolor when exposed to sunlight for extended hours (see Figure 9). In outdoor applications where it is necessary for the application to be colored such as in ski laminates, mobile antennas, and railway pads, Arnitel provides attractive solutions and delivers value. By using special masterbatches, UV resistance can be enhanced further.

Membrane Permeability

From the world of construction to the medical, textile, packaging industries, there is growing demand for high-tech films and coatings that combine a number of properties including flexibility, elasticity, and permeability to water vapor, chemical resistance and thermal resistance.

Moisture permeability. Arnitel's high moisture vapor transmission rate makes it highly suited for film applications requiring breathability and water impermeability, and yet it is easily melt processable. Arnitel has the advantage of being elastic and waterproof, while still having excellent mechanical properties. Arnitel films exhibit high abrasion resistance, high thermal stability, good resistance to weathering and chemicals and, being monolithic and not microporous, are impermeable to bacteria and blood.

Arnitel approvals. Specific Arnitel grades are approved by FDA for food contact and some grades are approved by and USP VI, and ISO 10993 standards.

Low permeability to automotive fuels. While Arnitel's permeability to moisture is an advantage for some applications, Arnitel's very low permeability and low absorption of automotive fuels makes it a winner for applications where the transfer of automotive fuel is required. Arnitel's lower permeability when compared with PA12 gives Arnitel a distinct edge in performance over competition.

Figure 10 Desorption from film surface.

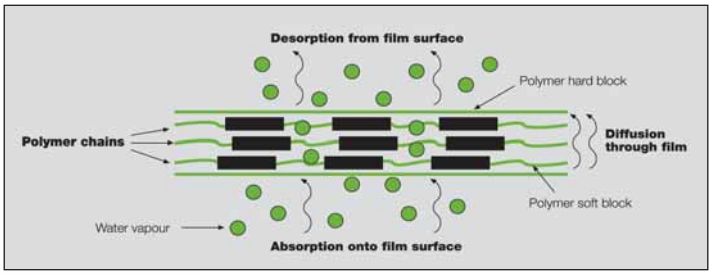
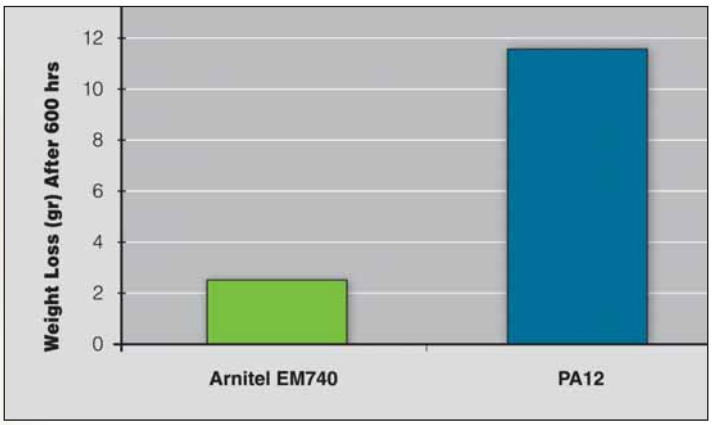


Figure 11 Permeation of M25 at 60°C.



Permeability

Processing with Arnitel

Packaging. Arnitel is supplied dry in airtight moisture-proof packaging, so pre-drying is not needed. The granules are supplied ready for use in standard bags of 20 or 25 kg (45 to 55 lb). To obtain optimum consistency in processing, we advise to pre-dry the material to a constant moisture content. This is especially important for a running change over.

Moisture absorption. Granules that have been exposed to ambient air for too long, will pick up a certain degree of moisture. To avoid processing problems and any adverse effect on the quality of the moldings, moisture absorption prior to molding must be limited as much as possible. During storage, packaging should be kept closed and undamaged.

Safety. Under normal conditions, Arnitel does not present a toxic hazard through skin contact or inhalation. During processing, avoid contact with hot or molten polymer and do not inhale fumes.

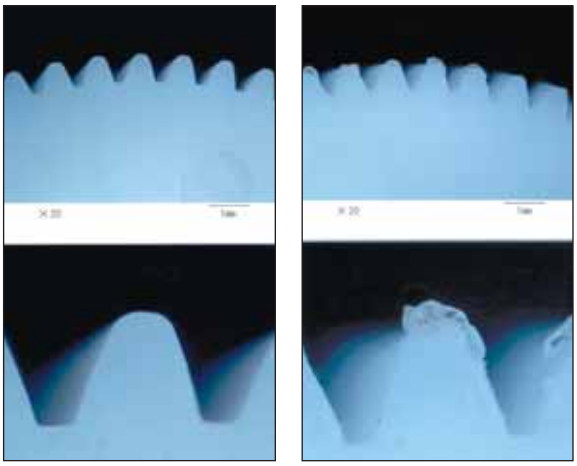
Arnitel can be injection molded, blow molded and extruded. There are different grades available to suit these separate conversion processes.

Table 4 Advantages of Arnitel over other elastomers for 2K molding.

	Hardness (A scale - D scale)	Temperature range	Grease resistance	Effect of skin salt	UV resistance	Density	Optimum adhesion in 2K molding with
TPE-S	50A-50D	-50~70	-	Stains	+	0.9~1.1	PE / PP / PS
TPE-V	50A-55D	-35~100	--	Stains	+	0.9~1.0	PE / EPDM
Arnitel	70A-74D	-45~150	++	None	++	1.1~1.3	PBT / PC / ABS / PVC / PET
TPE-A	70A-50D	-45~80	++	None	++	0.95~1.1	PA

++ very good + good - bad -- very bad

Figure 12 Flash free molding for low noise gears using Arnitel (left) vs other TPE (right).



The world's best precision component manufacturers prefer Arnitel over competition because of Arnitel's ease of molding. Arnitel does not flash and has very high crystallization rates which ensure high rates of cooling. The low melt viscosity of Arnitel results in energy savings due to the lower injection pressures. Lower pressures also enable the molding of intricate components, with lower tonnage machines.

Also extrusion processors prefer to use Arnitel because of the higher throughputs that are possible with Arnitel due to its high crystallinity and the faster cooling rates that are possible as well as the availability of grades developed specifically for processing via extrusion. Processing temperatures for Arnitel are in the range of 200 to 250°C (390 to 480°F) with mold temperatures in the range of 10 to 50°C (50 to 120°F).

Two component molding (2K molding). Arnitel can be over-molded on other plastics to give a soft-touch feel combined with good mechanical properties (see Table 4), and for enhancing grip to improve torsion transport. Overmolding with Arnitel is also used for sound dampening applications such as in door latches.

Overmolding can be easily achieved by injection molding on molded components which are designed with ribs, grooves, etc which act as under-cuts that the overmolding can hold on to.

Arnitel has excellent molecular adhesion to polar polymers such as polycarbonate, polyvinyl chloride, styrenics such as ABS, etc. The high chemical bonding creates excellent adhesion between the Arnitel and the polar polymer surfaces. For crystalline polymers, adhesion of Arnitel on the component is achieved by increasing the inlay temperature of the component over which the overmolding is to be done.

2K molding is also used to enhance the appeal of applications. Both pre-coloring and masterbatches can be used for coloring Arnitel molded components. When using masterbatch, excellent part appearance is achieved with Arnitel-based or universal masterbatches.

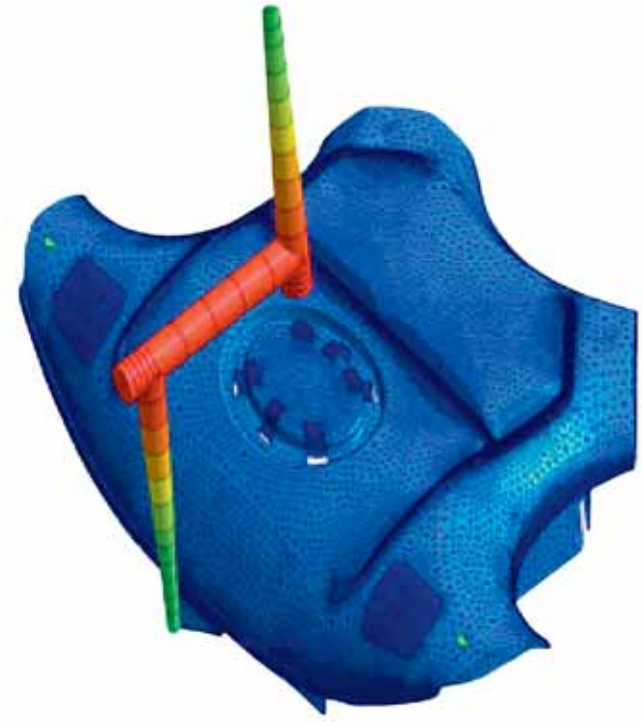
Designing with Arnitel

Design

Arnitel grades cover a wide range of viscosities and hardness, making it highly suitable for any plastics conversion technology, such as blow molding and injection molding, extrusion processing, slush (roto)molding. This gives designers broad flexibility in the application of performance elastomeric solutions.

Designing molded components with Arnitel is made easier by its excellent and consistent flow behavior, coupled with its toughness as an elastomer. Complex shapes can be accommodated, with thin wall sections, without major problems in demolding leading to part rejects.

Two component molding of soft touch materials onto hard structural materials enhances aesthetics and customer appeal. Arnitel opens opportunities to combine hard and soft materials, for different color and tactile experiences, because of its excellent adhesion in molding or welding to polycarbonate, PC/ABS blends and polyesters.



Europe
The Netherlands

DSM Engineering Plastics
Poststraat 1
P.O. Box 43
6130 AA Sittard
Tel. +31 46 47 70075
Fax +31 46 47 70101

USA
North America

DSM Engineering Plastics
P.O. Box 3333
2267 West Mill Road
Evansville, IN 47732-3333
Tel. +1 812 435 7500
Fax +1 812 435 7702

Asia Pacific

DSM Engineering Plastics
Suite A, 10th Floor
Century BA-Shi Building
No. 25 Mid Chongqing Road
Shanghai 200020, China
Tel. +86 21 6386 3080
Fax +86 21 6386 2198

DSM Engineering Plastics

www.dsmep.com - www.arnitel.com