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Tailored Plastic Components

PTFE generation with improved properties profile

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In terms of its chemical composition Moldflon by ElringKlinger is largely identical with conventional PTFE. Unlike PTFE, though, this thermoplastic material can be processed by thermoplast methods – a significant advantage with regard to economy and processing of large-volume PTFE production. New degrees of freedom in forming the material by means of injection-molding enable the realization of complex component geometries, which previously could not be achieved – or only achieved with great difficulty – by machining processes. Other possibilities of Moldflon include the extrusion of continuous profiles, fibers and films as well as the manufacture of parts, using the transfer-molding process.


Figure 1: Moldflon enables tailored shapes

Polytetrafluoroethylene (PTFE), a partially crystalline material made from tetrafluoroethylene (TFE), with a melting temperature of 327°C, continues to be the most important member of the family of fully fluorinated materials. PTFE has high-temperature resistance, virtually universal chemical resistance, light and weather resistance, very good sliding properties, is anti-adhesive, non-combustible and physiologically harmless. Due to its very high molecular weight of up to 10^8 g/mol, however, its melting viscosity is so high that it can only be processed using special pressing and sintering techniques (suspension PTFE) or so-called paste extrusion (emulsion PTFE).

Further development of PTFE

Through co-polymerization with a small amount of a perfluorinated modifier, PPVE (perfluoropropylvinylether), and reduction of the molecular weight a product is generated, which is processed according to the methods typically used for PTFE, but which has a clearly improved properties profile. In particular this refers to reduced cold flow, lower permeation, reduced pore volume as well as the lower stretch void index (SVI). In addition, other properties of the fluorothermoplastic PFA, such as weldability, were incorporated into the so-called second PTFE generation as modified PTFE is sometimes referred to.

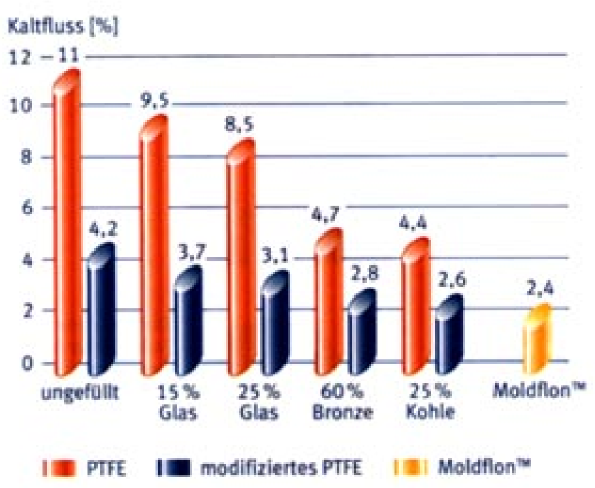

Figure 2: Cold flow under pressure load

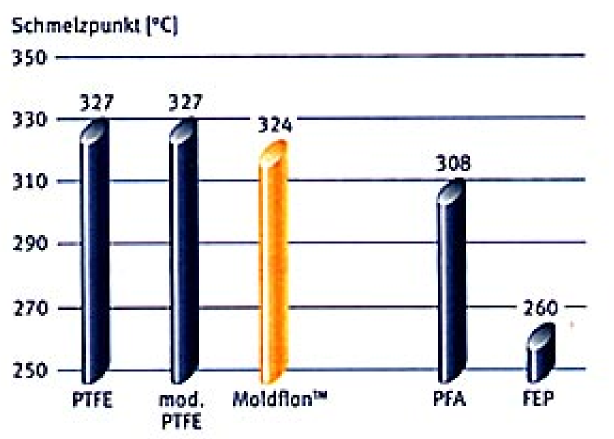

Figure 3: Melting Temperature of fluorothermoplastics

Moldflon represents a continuation of this PTFE development, which includes the use of patents of ETH (Eidgenössische Technische Hochschule) Zurich. Either by using the methodology of the second PTFE generation or through other polymer-chemical measures, individually or in combination with others, a product is created which combines all previously described properties with the possibilities of thermoplastic processing (Figure 1). This symbiosis, in particular, yields high levels of economy through:

- Tailored shapes
- Large-scale production
- Short cycle (lead) times
- Sprue recycling
- Conservative consumption of resources
- Low supporting requirements
- High process reliability/stability

Disadvantages, particularly in terms of temperature resistance and permanent service temperature, of the type that used to be inevitable in previous projects of this kind have been reduced to a minimum. Moldflon thus closes a gap in the previously available portfolio of perfluorinated PTFE and fluorothermoplastic products

Moldflon properties profile

The table lists the material's basic data. Furthermore, Moldflon offers properties such as low cold flow and high temperature resistance. The polymer structure reduces cold flow significantly. Hence it is possible to achieve values lower than those of modified PTFE compounds (Figure 2) without the disadvantages caused by fillers. Filler-related disadvantages, which can be avoided this way, include limited chemical resistances, limited approval ranges for food, oxygen and other critical applications, and increased porosity. In applications with tribological loads the increase of the friction coefficient caused by fillers has a negative impact.

With regard to chemical resistance, anti-adhesive

Typical Properties of Moldflon™		
Properties	Unit	Value
Bulk density Test procedure according to DIN EN ISO 60	g/l	1200
Density Test procedure according to DIN 53 479 Buoyancy procedure	g/cm³	2,160
Melting point Test procedure according to DIN EN ISO 3146	°C	318

properties, ageing resistance and electrical insulation, Moldflon is up to par with PTFE in every respect. Due to this properties profile the material is particularly well suited for applications involving high thermal, chemical, electrical or mechanical loads. With respect to mechanical loads, Moldflon offers particular advantages under pressure loading.

Moldflon's high temperature resistance (Figure 3) has not been matched yet by any other fluorothermoplastic material suitable for melt-processing. With a melting temperature between 315°C and far beyond 320°C this material shows significant benefits over other fully fluorinated thermoplastics such as PFA, FEP or MFA. Starting from the base of modified PTFE on the one hand, this largely bridges the gap to PFA, MFA or FEP, on the other.

Melt flow index MFR 372/5 Test procedure according to DIN EN ISO 1133	g/10 min	5
Mechanical Properties		
Tensile strength Test procedure according to ASTM D 4894 / DIN 53455 (2-mm plate)	MPa	25
Elongation at break Test procedure according to ASIM D 4894/ DIN 53455 (2-mm-plate)	%	380
Yield strength Test procedure according to ASTM D 4894 / DIN 53455 (2-mm sheet)	MPa	14
E-Modulus Test procedures ISO 12086-2, Method 511, 2-mm pressed sheets 23°C 50°C 100°C 150°C 200°C	MPa MPa MPa MPa MPa	460 420 210 170 80
Deformation under load Following ASTM D 621; 15 MPa, 23 °C, 100 h/permanent	%	2,4
Other Properties		
Poisson ratio		0,4

Case studies and applications

Of course a material development like this one does not necessarily lead to the positive evolution of all characteristics; in some respects a regression may even have to be accepted. In the case of Moldflon this primarily concerns flex fatigue properties, which have deficits with the high-melting types. For the developer, the issue now is to define tailored applications which consider the complete performance spectrum of a material.

Figure 4 shows the requirements matrix of a sealing application subjected primarily to static loads. High requirements exist in terms of temperature and chemical resistance, electrical properties and deformation under load, the cold flow. The figure shows that conventional PTFE, on the one hand, does not meet the requirements in terms of cold flow while, on the other, its excellent flex fatigue properties are not required by the application. Proceeding from the basis of pure material parameters, system solutions using Moldflon lend themselves to further optimization through pinpoint use of the special aspects of thermoplastics processing. In this particular case, for example, it is possible to further improve the intrinsic material properties of the new material with regard to reducing cold flow by covering embedded parts. A reduction of the production steps by means of insertion techniques and avoidance of major waste, which typically occurs with machining of PTFE, are additional advantages of this system solution.

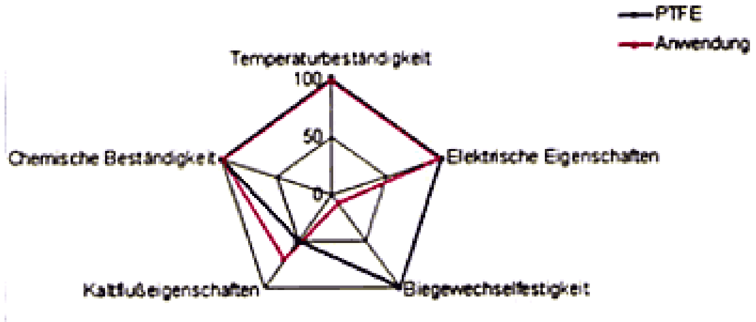

Figure 4: Requirements matrix of a sealing application subjected primarily to static loads

Outlook

Moldflon is merely at the beginning of its life cycle. Extensive work remains to be done with regard to developing a complete product family. Aside from aspects related to the various processing technologies the different types of requirements profiles of the individual applications must be considered. These include the development of Moldflon types with electrostatic dissipation capabilities for Atex applications and the manufacture of custom-tailored compounds.

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