A newly developed polyamide 12 can replace metal in medical, dental and laboratory equipment applications

Stiff, Tough and Resistant

Polyamide 12. A newly developed polyamide 12 provides extremely high stiffness together with high toughness. No conventional polyamide has so far been able to match these properties. This opens up potential for novel heavy-duty applications, particularly in fields such as medical, dental and laboratory technology, where good chemical resistance is just as important as mechanical strength.

FRANZ FELSBERGER

PE104187

Polyamide 12 has a good track record of over 30 years in challenging applications [1, 2]. The desirable feature is its very high chemical and hydrolysis resistance compared to other polyamides and engineering plastics. The conventional PA 12 grades from Ems-Grivory, Domat/Ems, Switzerland, have the lowest moisture absorption of all commercially available polyamides, and also offer outstanding dimensional stability and very good aging behavior in weathering and heat. In addition, it offers outstanding mechanical characteristics, such as high impact strength even at low temperatures. To extend the material's possibilities as a substitute for metals, Ems-Grivory has improved the stiffness and toughness of the proven Grilamid L. The new product line is known as Grilamid SST (Super Stiff and Tough).

Optimized Combination of Stiffness and Toughness

The new Grilamid SST has particularly high values for the three characteristics stiffness, strength and impact toughness. The new material thus increases the known high performance of the glass fiber-reinforced Grilamid grades, which are therefore predominantly used for high-impact and structural applications. They include very high, constant energy absorption, characterized by high notched impact strength together with high elongation at break. Grilamid SST now permits the manufacture of highly stiff, extremely impact resistant precision parts that in many cases still used to be made of metal. Ideal applications are parts for laboratory equipment, particularly medical and dental instruments (Title photo), since they not only need to be mechanically robust, but also chemically resistant and repeatedly sterilizable (Fig. 1). With Grilamid SST, this can be done over hundreds of cycles at a temperature of 134 °C and a pressure of 2 bar without affecting the part quality.

Even the basic grade of Grilamid SST has a stiffness of 18,000 MPa and competes with established substitutes for metal die-castings, such as PPS-GF, PSU-GF or PA MXD6-GF. By comparison with these, it combines a significantly higher elongation at break of 3.5 % with a high

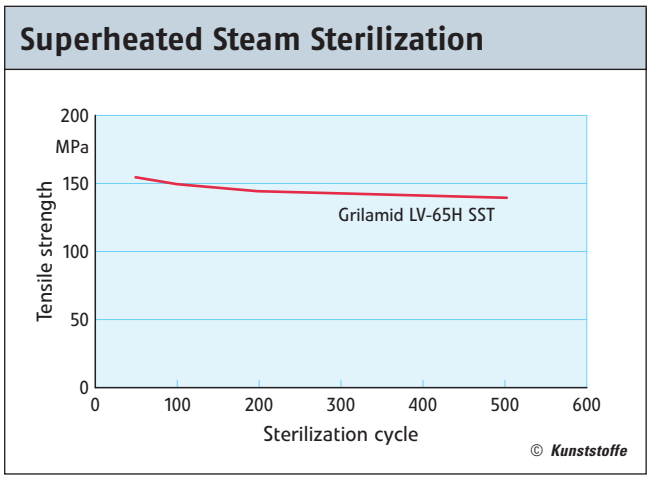

Fig. 1. Grilamid SST polyamide 12 has extremely constant breaking strength over several hundred cycles of superheated steam sterilization (134 °C, 2 bar, 7 minutes)

Translated from Kunststoffe 2/2008, pp. 78–80

impact strength. This leads to an increased energy absorption and very robust material behavior (Fig. 2). Individual Grilamid SST grades even offer a stiffness of up to 22,000 MPa without compromising toughness. These "extreme impact" modified grades have extremely high notched impact strengths of 25 and 35 kJ/m^2. Until now, such high impact strengths could only be achieved with long glass fiber-reinforced materials, which only have average stiffness values and are often more difficult to process (Figures 3 and 4).

Drop tests on injection molded test specimens confirm the very high toughness of Grilamid SST products. In falling weight tests (similar to ISO 6603, drop height: 0.5 m, drop energy: 10 joules), there was a good correlation of the material's notched impact strength with the toughness of the injection molded part. For example, in a dry state, PA 66-GF50 breaks after only the first impact, while test specimens of Grilamid LVX-65H SST – with almost twice the notched impact strength – withstands more than ten impacts without breaking.

Easy-Flow Solution for Warp Problems

Glass fiber-reinforced materials show critical part warpage in many cases. With Grilamid SST, this effect is significantly reduced, as shown by studies on U-profile-shaped test specimens. Grilamid LVX-65H SST shows up to four times lower warpage than a standard PA12-GF50.

Comparison of Properties

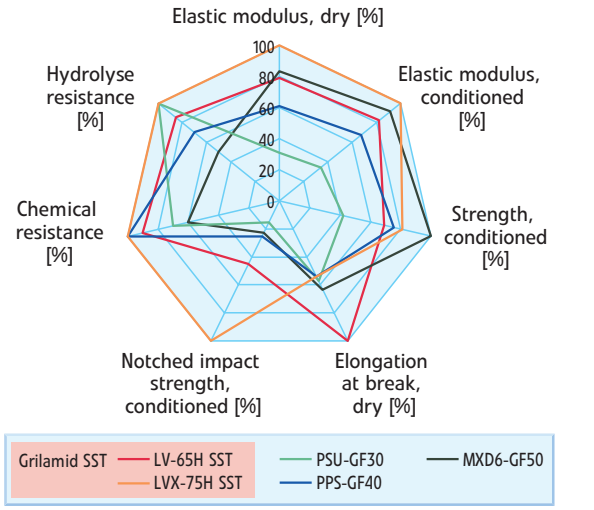

Fig. 2. Network diagram comparing different properties (red: Grilamid LV-65H SST; orange: Grilamid LVX-75H SST "Extreme Impact"; green: PSU-GF30, blue: PPS-GF40, black: PA MXD6-GF50)

Manufacturer

Ems-Chemie AG
Business Unit Ems-Grivory Extrusion Polymers
Reichenauer Strasse
CH-7013 Domat/Ems
Switzerland
Tel. +41/81/6 32-7980
Fax +41/81/6 32-7401
www.emsgrivory.com

Grilamid L has very good flow behavior in highly glass fiber-reinforced formulations; Grilamid SST grades can be suitably optimized to offer up to 30 % longer flow paths. Their flowability is comparable to unreinforced PA 12. Extremely small precision parts can be produced easily and with low internal stresses. This also allows the material's extremely high notched impact strengths to be used in complex thin-walled parts. Glass fiber-reinforced Grilamid can also be used for applications with wall thicknesses up to 12 mm. Such large wall thicknesses are often not possible with other engineering plastics because the shrinkage stresses are too high and there are critical voids.

Stable, Economic Production

Grilamid SST has a broad processing window and can be injection molded at low cavity temperatures below 100 °C and in a very wide melt-temperature window. Overall, then, processing is more reliable than with other high-performance plastics, such as PPS, PSU or PA MXD6, which must be processed with cavity wall tem- ▶

Stiffnesses

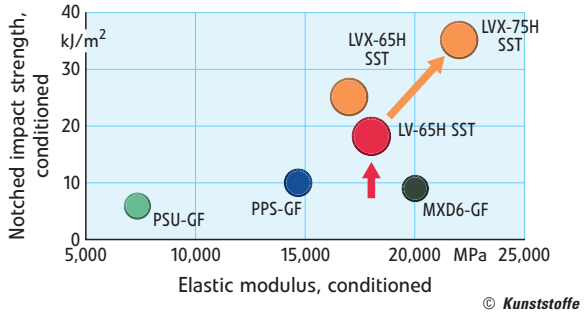

Fig. 3. Comparison of the property combination of notched impact strength versus elastic modulus, conditioned, for different high-performance plastics (red: Grilamid LV-65H SST; orange: Grilamid LVX-65H SST "Extreme Impact" and Grilamid LVX-75H SST "Extreme Impact"; green: PSU-GF30, blue: PPS-GF40, black: PA MXD6-GF50)

Strain Behavior

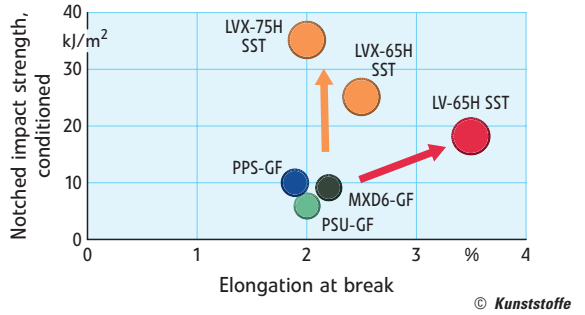

Fig. 4. Comparison of the property combination of notched impact strength, conditioned, versus elongation at break for different high-performance plastics (red: Grilamid LV-65H SST; orange: Grilamid LVX-65H SST "Extreme Impact" and Grilamid LVX-75H SST "Extreme Impact"; green: PSU-GF30, blue: PPS-GF40, black: PA MXD6-GF50)

peratures up to 160 °C and require complicated temperature control with oil-heating equipment. In addition, the melt temperatures of PPS and PSU, at 340 and 390 °C respectively, are significantly higher and the processing windows very much smaller. There is a considerable advantage with highly complex molds with slides and small cores, which require much less complicated temperature control. The use of Grilamid SST ensures constantly high product quality; the low reject rates, as well as reduced energy consumption of manufacturing, represent attractive cost saving potential.

Grilamid SST can be readily combined with soft plastics (e. g. silicone, PEBA, TPE and TPU) as well as transparent polyamides (Grilamid TR) in multicomponent injection molding. This further increases the range of applications, permitting, e. g., the production of high-impact housings with viewing windows resistant to spray water. This includes robust electronic housings (Fig. 5) required, e. g. for mobile phones, PDAs, industrial scanners, sports equipment, mobile navigation equipment or marine applications.

Summary

Robust Grilamid SST is recommended for applications that require high reliability and durability under challenging service conditions. Prominent among its excellent mechanical properties are its particularly high stiffness and toughness, making Grilamid SST suitable for challenging precision components in mechanical engineering and industry. Its outstanding chemical and hydrolysis resistance and repeated sterilizability benefits the medical, dental and laboratory equipment sectors. The use of Grilamid SST pays off in highly stressed parts in sports, leisure and marine applications and in thin-walled high-impact electrical housings.■

REFERENCES

1 Schaaf, S.: Polyamide. Verlag Moderne Industrie, Landsberg/Lech 1997

2 Polyamid 12 – Technischer Kunststoff für höchste Ansprüche. Firmenschrift Ems-Grivory, Domat/Ems 2003

THE AUTHOR

DIPL.-ING. FRANZ FELSBERGER, born in 1969, is responsible for the electrical and industrial market development for the product groups Grilamid SST and polymer bonded magnets (PBM) at Ems-Grivory, Domat/Ems, Switzerland;
franz.felsberger@emsgrivory.com

