A New Roto Material

for higher temperatures and lighter weight applications

by Aldo Quaratino, Matrix Polymers

OEMs, particularly in the automotive sector, are seeking polymers that can withstand higher and higher operating temperatures, while also looking for weight reduction in their rotomoulded parts at the same time. The main driver behind these demands in the automotive world is the need to meet more stringent regulations of CO_2 emissions. This is leading to an increase in the temperature of engines and associated components. As a result, the temperature requirements for the fuel tanks are rising as higher temperature fuels are being returned to the tanks.

To meet these higher temperature requirements, Matrix Polymers has now developed a new polyamide alloy called Revolve "PA HIU". This material can withstand operating temperatures of 140-150°C and at the same time can deliver significant weight savings.

This material has also been designed so that it is easy to rotomould and it does not require any complicated processing, such as needing an inert atmosphere within the mould. Revolve PA HIU can be moulded using conventional rotomoulding equipment, with traditional steel or aluminium moulds.

As with any material it is important to find the right moulding conditions to achieve optimum mechanical and aesthetic properties. It is best to monitor the internal air temperature in order to ensure that the polymer has fully sintered and cured. Matrix found that optimum properties were achieved with a peak internal temperature (PIAT) of around 230-235°C - see Figure 1. The moulding trials were carried out on a Ferry 190 carousel machine in the company's Rotomoulding Technical Centre in the UK.

Operating Temperature Resistance

The physical properties of all polymers are affected by temperature. At elevated temperature they become soft, and lose strength and rigidity. Therefore, it is critical to assess how a material behaves in elevated temperature conditions. Figure 2 shows the tensile modulus (stiffness) per ISO 527 of PA HIU at various operating temperatures. The data shows that even at 150°C this material retains good rigidity. In comparison, any polyethylene material at the same temperature would have completely melted.

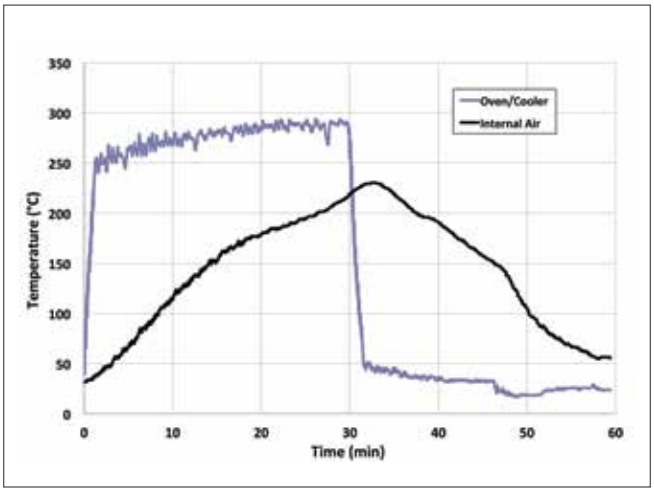

Figure 1 Internal Air Temperature trace for Revolve PA HIU

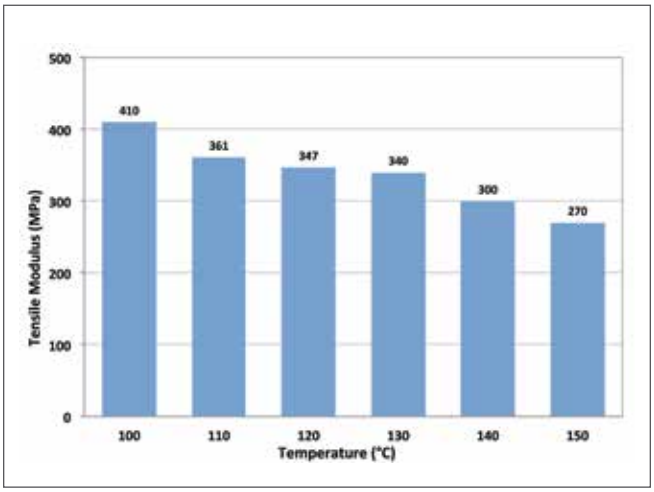

Figure 2 Tensile Modulus for Revolve PA HIU

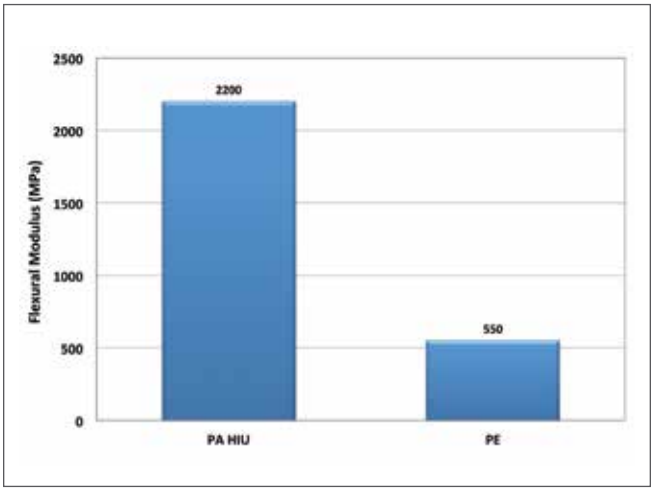

Figure 3 Flexural Modulus for Revolve PA HIU

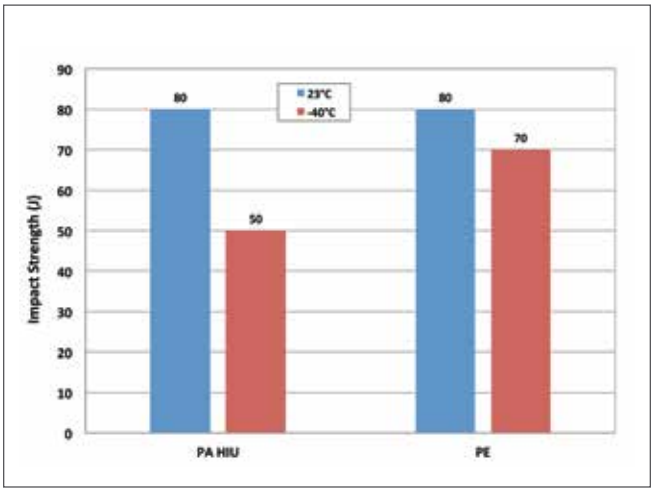

Figure 4 Impact Strength for Revolve PA HIU

Stiffness

Another enhancement PA HIU offers is its high Flexural Modulus (stiffness). Figure 3 illustrates that this material is an extremely stiff rotomoulding material, with 4 times the flexural modulus value of a typical medium density polyethylene, at ambient conditions (23°C, per ISO 178). With this type of performance difference, the rotational moulder has the opportunity to consider reducing the wall thickness of the part, which will in turn improve the value proposition to the OEM.

Toughness

Falling dart impact testing (per the ARM guideline) was carried out for Revolve PA HIU and compared with a general purpose PE grade (0.935 g/cm^3, 6.5 g/10 min) for 5mm thick samples – see Figure 4. Prior to testing the specimens were conditioned in a freezer at -40°C and in a controlled temperature room at 23°C for 24 hours before being impacted. From Figure 4 it can be seen that Revolve PA HIU exhibits excellent impact performance at room temperature. Generally speaking polyamides do not perform well when it comes to low temperature impact, so the drop-off for the -40°C condition is to be expected. However, the low temperature impact performance for this particular material is reasonably good compared to other polyamides.

Part Weight Reduction

For automotive applications the weight of the part is critical in helping to improve the fuel consumption of the vehicle. By reducing fuel consumption, CO_2 emissions are automatically reduced as well. The use of engineering polymers such as polyamides offer as much as a 50% weight saving over comparable parts made from metals. In accordance with the European Automobile Manufacturers' Association (ACEA), it has been indicated that 5% less weight means an average fuel saving of 3%. The rotational moulding process using polyamide materials offers one of the best solutions to the increasing challenges within this sector. Over the past 10 years, the quality of rotomoulded products has increased dramatically as a result of the advancements in mould manufacture and in rotational moulding machines that can now precisely control how heat is transferred to the mould, allowing engineering polymers to be more easily processed. Rotomoulding

can offer great levels of flexibility, allowing moulders to manufacture intricate and complex geometries by using well-engineered solutions which could otherwise be very expensive if realised by using other plastic processes. Revolve PA HIU has a much lower density when compared to other high performance polymers – see Figure 5. This is a significant economic advantage when studying the cost versus performance aspect of using polyamide.

Summary

Although polyethylene is dominant in our industry, it is well known that polyethylene cannot be the solution to every technical problem due to inherent limitations such as a lack of high temperature resistance and lack of stiffness. Expanding the horizon of rotomoulding by learning how to use materials such as polypropylene (PP), polyamide (PA), fluoropolymer (PVDF) and polycarbonate (PC) can add value to rotomoulded products and expand the range of applications for rotomoulders, which in turn can help to penetrate new and potentially lucrative markets. We believe this industry needs more advanced and higher performance polymers so that it can continue to compete with other processes and can continue to grow. In Matrix, we are doing everything we can to help rotomoulders who would like to embrace the future. Revolve PA HIU is a new material which has been designed to meet the increasingly demanding requirements of OEMs, particularly in the automotive sector and other areas.

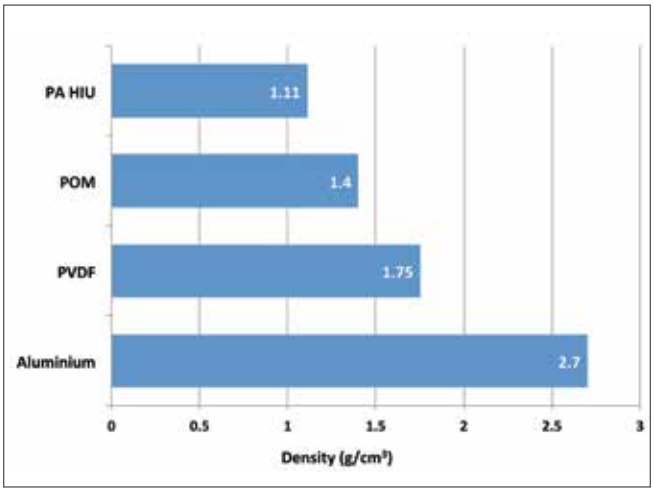

Figure 5 Density of Engineering Polymers and Aluminium

This development is part of an on-going program at Matrix Polymers aimed at inventing new materials for rotomoulders, that will expand the range of products that can be produced by the process and thereby help in the growth and continued success of the rotomoulding industry. The company's vision with regards to development of new materials can be seen at: https://www.youtube.com/watch?v=mGf2RyH63bI