Creating New Roto Applications with Matrix's Advanced Polyamide 6 (PA6) Powders

by Martin Coles, Matrix Polymers

The late Professor Roy Crawford once said that "..the full potential of the Rotational Moulding process will never be realised until a full palette of plastics materials is available to the designer."

This is a comment that Matrix Polymers took to heart and at the ARMO Rotomoulding conference in Nottingham in 2015, the company presented their vision for the future of the industry – https://www.youtube.com/watch?v=mGf2RyH63bI

It is clear that the industry has been 'held back' by the almost total dominance of Polyethylene and the lack of easy to use and cost-effective alternative materials. Whilst Polyethylene is a fantastic, tough, forgiving to use, easy to grind, readily available, and very low-cost material, it still has a lot of limitations – such as poor scratch resistance, lack of stiffness, is difficult to decorate, and has poor high temperature resistance.

So, Matrix announced a new focus on the Research & Development of alternative non-Polyethylene materials for Rotomoulding. This was backed up with new investment in plant and equipment, such as cryogenic grinding to produce powders out of difficult to grind materials, to help make this vision a reality.

During the development of new materials, a big emphasis has been made on making them practical, easy to mould, and able to be used in conventional Rotomoulding machines.

One of product groups that has come out of this programme is Polyamide 6 (PA6) powder, which has now become fully commercialised. There are two grades available, a standard version and a higher cost impact-modified one. Both, with care, can be moulded on conventional Rotomoulding equipment and do not require any complicated additional processes, such as drying or needing an inert atmosphere or blanket within the mould. The material

Pipe connector

can also be moulded in traditional steel or aluminium moulds.

A new high-performance application for a high performance PA6 material

A luxury European car manufacturer was looking to have an air duct produced by Rotomoulding for their new and very powerful iconic sports car. They turned to Maus GmbH, the premier Rotomoulding mould maker in Germany, to help develop the application and CNC mould, and Maus involved Matrix in discussions regarding the best material to use for this new product.

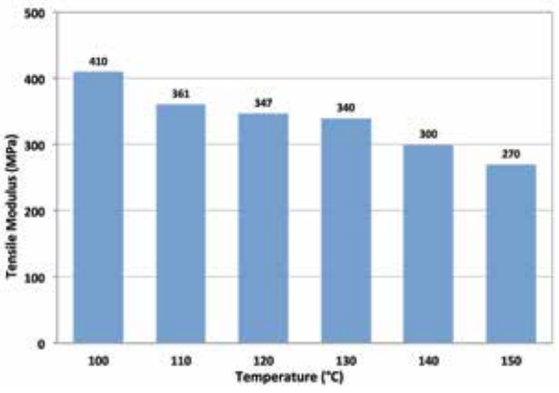
The ducting is needed to collect cold air and deliver this to the ceramic braking discs, so they do not overheat during extreme braking. The production volumes are small, but the requirements for aesthetic look, tolerances, and performance are very high. The mouldings have to withstand high temperatures, especially near the ceramic brakes, and they have to be tough, stiff, be light-weight, and be made to very tight and exacting tolerances. Additionally, the inner surface of the mouldings is fully visible at the front of the sports car, so they need to be as black and glossy as possible.

Maus manufactured the CNC machined aluminium moulds and produced the jigs for CNC routing of the openings, as well as providing milling programmes for the post moulding operations.

The impact modified black version of Matrix's PA6 material, Revolve PA HIU, met all the criteria demanded by the OEM and underwent rigorous testing before the start of production.

High operating temperatures

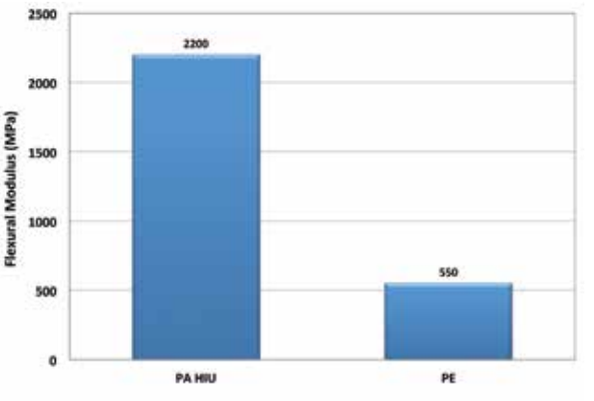
Being able to cope with continuously high operating temperatures was a critical requirement for this application and PA HIU scores well in this area. The physical properties of all polymers are affected by temperature. At elevated temperatures they become soft and lose strength and rigidity.



(Top) Matrix Polymers comp powder Revolve PA HIU Black

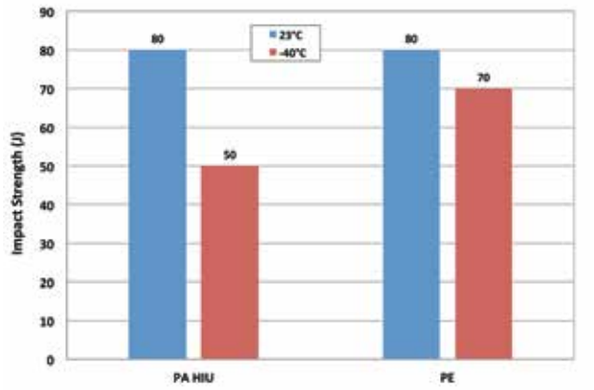
(Bottom) Figure 1 – High Temperature Tensile Modulus (stiffness) for Revolve PA HIU

Figure 1 shows the tensile modulus (stiffness) of PA HIU at temperatures ranging from 100 to 150 degrees C. Even at 150 degrees C this material still performs well and retains good rigidity. In comparison, any Polyethylene material at this temperature would have completely melted.



Great stiffness, shot-weight reduction and light-weight parts

Another crucial requirement was that the material had good stiffness so that parts can be made with as little material as possible to keep weight down to a minimum. This is a common request in the automotive sector.



PA HIU is an extremely stiff Rotomoulding material and has 4 times the flexural modulus (stiffness) than a typical medium density Polyethylene (at ambient conditions – 23 degrees C, per ISO 178) – see Figure 2. This means that mouldings can be made with the minimum of powder, saving weight, and cost.

It is worth mentioning that this stiffness and light-weighting potential gives the Rotational Moulder the opportunity to reduce wall thicknesses, which in turn can improve the value proposition to the end user, particularly in the automotive sector.

Good toughness and impact strength

Most Rotomoulding applications require a good level of toughness and impact strength and this application is no different. PA HIU has a comparable impact strength to general purpose medium density Polyethylene at 23 degrees C. It is less good at minus 40 degrees C, but the performance is still acceptable – see Figure 3.

How easy is it to mould PA HIU?

Matrix has designed this material to be easy to Rotomould and it does not require any complicated processing and there is no need for an inert atmosphere. Revolve PA HIU is pre-dried and can be moulded on conventional Rotomoulding equipment and with traditional steel or aluminium moulds.

As with any material it is very important to find the right moulding conditions to achieve optimum mechanical and physical properties. It is best to monitor the internal air temperature to ensure that the powder has fully sintered and melted out. In internal testing on Matrix's Ferry 190 carousel machine in the company's Rotomoulding Technical Centre in the UK, it was found that optimum properties were achieved with a Peak Internal Air Temperature (PIAT) of around 230-235 degrees C – see Figure 4.

This material flows well and as this application demonstrates, mouldings can be produced with good wall thickness distribution and internal surface finish with minimal pin-holing.

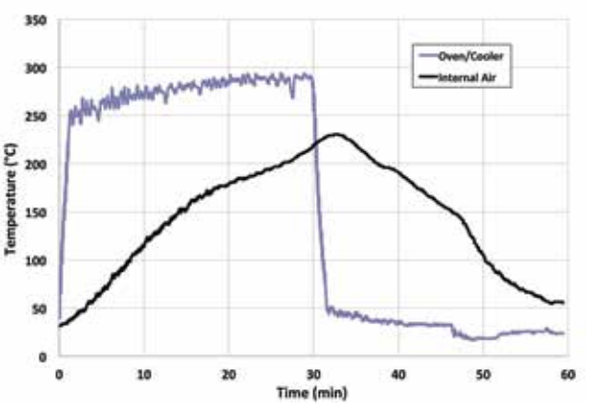
New materials help create new applications

Whilst Matrix's Polyamide 6 (PA6) powders

(Top) Figure 2 – Flexural Modulus (stiffness) for Revolve PA HIU, compared to LLDPE

(Bottom) Figure 3 – Impact Strength for Revolve PA HIU compared with LLDPE (ARM test at 5mm wall thickness)

have been developed primarily for the automotive sector, this material can also be used for other applications. As well as the key features of high temperature resistance (140-150 degrees C), very high stiffness (4 times the stiffness of medium density Polyethylene), and the fact that they can be moulded on conventional Rotomoulding equipment, these materials also exhibit other benefits such as high scratch resistance and paintability.



Opportunities include the substitution of Liquid PA6 for making fuel tanks and the replacement of existing Rotomoulding products made from other materials. There is also a whole world of products being made from traditional materials, such a steel, which require stiffness, hardness and high temperature resistance that have up until now been beyond the scope of Rotomoulded Polyethylene.

Matrix Polymers is happy to work with any Rotomoulders or OEMs about potential new Rotomoulding applications and to listen to thoughts and ideas about new materials. Creating new materials must be the way forward for our industry and Matrix is committed to investing in Research and Development to make the company's vision become reality.

For more information, go to Matrix Polymers at matrixpolymers.com

Figure 4 – Internal Air Temperature trace for Revolve PA HIU – Matrix Tech Centre