GESAMTVERBAND DER ALUMINIUMINDUSTRIE e.V.

Light, readily machinable and with excellent thermal conductivity

Aluminium rolling ingots and rolled products – advantageous as mould-making materials

Aluminium is enjoying growing popularity in the field of mould and die making. It is being increasingly used for higher stressed tooling for series production thanks to newly developed alloys and coatings. Mould makers and material suppliers report here about their experiences – and offer some useful practical tips.

“Aluminium can make full use of its advantages when it comes to moulds for PET bottles,” says Jürgen Röders, managing director of Röders GmbH in Soltau. The company manufactures blow-moulding moulds for PET bottles, in sizes up to three litres, using 15 automated machines that have been largely developed in-house. The most important advantage of aluminium in this application is firstly its low density. This is an essential prerequisite for limiting the mass inertia forces when opening and closing the moulds, which has to be done very quickly: in modern plants, the output is several tens of thousands of bottles an hour.

From the processor’s point of view, aluminium offers a number of other benefits. Milling is easy and thus economical; the same is true for final polishing. High speed cutting (HSC) milling has proven to be an added benefit for Röders. The RXP series HSC milling centres developed in-house allow free surfaces of the mould to be machined very quickly with extremely high accuracy. In addition to the resultant cost benefits during milling, there are additional savings during final polishing because the effort required is reduced to a minimum.

With aluminium – moulds made quickly

“Many plastic parts are needed today in small to medium-sized lots at very short notice – and this is where we rely on aluminium moulds,” points out Robert Hofmann, managing director of Modellbau Robert Hofmann GmbH in Lichtenfels. A graphic example of this are mobile phones, the housings of which have to change at extremely short intervals to keep pace with young people’s changing fashion trends. And even with products mass-produced in the Far East, reference design models and pre-

production models have to be produced in Germany as part of the product development process.

With its Speed-System-Tooling (SST) concept, Modellbau Hofmann can implement the steps in the whole process chain from mould design, via mould making through to the supply of finished parts or assembled components extremely quickly. Aluminium's good machinability using modified and optimised milling and erosion machines plays a key role here. With specially modified tool assemblies, multi-component injection mouldings can be produced using SST tools within the shortest possible time.

As an example of the speed with which such a project can be carried out, one can cite the case of the ventilation nozzles for a carmaker that consist of 30 components. It took just four weeks from the start of the project to the production of the first mass-produced parts, including the design of the components and the mould. It only took another week for the finishing phase, which included the printing and lacquering as well as laser marking and complete assembly.

With aluminium – moulds made at optimal cost

"We are the technology leader for blow-moulding moulds for plastic parts and we export worldwide," explains Franz-Peter Esser, owner and managing director of Kremann und Esser in Kierspe. With 60 employees, the company supplies clients in the automobile, packaging and toy sectors with technically challenging moulds for the production of large-format blow-moulded parts such as drums and liquid containers, fuel tanks, hat shelves in cars as well as vehicle air ducts. Aluminium, steel and zinc are the materials competing to be used as metallic moulds for mass-production. The advantages of aluminium are cost and speed during both manufacturing and use. Although the raw material costs for moulds made from aluminium and steel are approximately the same on a volume basis, the amount of machining required with aluminium is about 40-50% less. In addition to the cost differential per se, the time taken to actually make a mould also plays a decisive role because many customers are under enormous pressure of time to launch their new models as quickly as possible. The time difference between the 10-12 weeks that used to be needed to produce a mould and the mere 5-7 weeks needed with aluminium today can be almost worth its weight in gold. At Kremann und Esser these advantages have led to a continuous increase in the use of aluminium instead of steel and zinc in the last 15 years. This is clearly illustrated by the figures for

zinc, which is used for moulds with precast cavities: consumption has declined from around 120 tonnes a year to today's figure of only about 20 tonnes.

Practical tips

"The significantly higher thermal conductivity compared to steel is also one of the important advantages of aluminium," points out Armand Bayer, sales manager of the 'sauer product' business unit at Sauer & Sohn KG in Dieburg. This is of considerable importance particularly for mould making for plastics because the thermal conductivity affects the rate of heating and cooling and thus the cycle time. From practical experience, cycle time reductions of up to 30-40% are possible, especially with thick-walled plastic parts. Another positive consequence of the superior thermal conductivity is more uniform distribution of heat, with correspondingly beneficial effects with respect to mould distortion and part accuracy.

Although by its very nature aluminium is softer and thus less wear resistant than hardened tool steels, this disadvantage can often be compensated for by appropriate surface treatment to such an extent that it achieves adequate service lives even when processing highly abrasive plastics. An extremely broad range of different processes is available here, such as hard anodising, titanium nitrite coating, or nickel or chromium plating. In addition, special chemical coatings facilitate the removal of parts from the mould. If suitable alloys are chosen, aluminium surfaces can also be deep etched to produce an attractive surface pattern.

Aluminium can be electric-discharge machined without difficulty, and it is possible to achieve metal-removal rates several times higher than those for steel. In addition, the 'white layer' that occurs with steel, which is extremely hard and requires considerable polishing effort, does not form on aluminium. The polishing required is thus reduced to a minimum. With respect to processing parameters, the following rule of thumb is often used in practice for both die-sinking and wire electro-discharge machining: depending on the surface area of the electrode and the desired surface finish, use the same pulsed current and ignition current as for the erosion of steel but reduce the pulse duration somewhat or slightly increase the duration of breaks.

When it comes to magnetically clamping the metal to be machined with surface grinding machines, one can get round the disadvantage that aluminium is non-magnetic by

encasing the aluminium plate in a steel frame. Alternatively, vacuum clamping systems are available. During grinding, ample quantities of cooling lubricant should be used.

Modern aluminium mould materials

“An important prerequisite for the success that aluminium has been able to achieve in mould making was the development of high-strength, weldable and almost stress-free grades of alloy with large thicknesses,” recalls Klaus Mechsner, Applications Engineer Plate at Aleris Aluminum Koblenz GmbH. The company has its own foundry and rolling mill, and produces aluminium alloys with customised properties. Depending on the gauge, various technologies are used: cold rolling and stretching can be used for plate thicknesses up to 250 mm; controlled compression is used for thicker material. To ensure a low level of residual stresses – an important prerequisite for minimising distortion after machining – there is a stretcher with a maximum pulling force of 80 MN (8000 tonnes).

However, strength and low residual stresses alone are not enough: other properties, such as machinability, polishability and photo-etchability, are also important. These require a wrought microstructure, which can only be obtained by rolling or forging. Three alloys with the appropriate properties have been developed for the different fields of application in mould making: the ‘classical’ weldable alloy Giantal is manufactured in plate thicknesses up to 1000 mm and has a hardness of 75 HB. It is characterised by a low level of residual stress and good machinability. Weldural, an alloy with good welding properties, is significantly stronger and has a hardness of 130 HB; it is suitable for use at higher temperatures and is available in thicknesses up to 700 mm. The Hokotol alloy with a hardness of 180 HB and meets even higher strength requirements; it is available in thicknesses up to 300 mm. Besides particularly highly stressed cavities, the preferred field of application here is components subjected to high stresses, such as mould frames or base plates.

Rapid and flexible production of aluminium

“Our strength is rapid response to special client requirements, including orders for small quantities and special sizes,” explains Horst Bütow, sales manager at Honsel AG’s rolling mill in Meschede. In view of the growing diversity of materials and the large range of sizes on offer, stockists often experience shortages, especially for variants that are less commonly in demand. For the mould maker, who is usually under enormous pressure of time in any case, this often results in a real emergency. As most

manufacturers have geared their plants to maximum productivity and cost efficiency, these are hardly suited for the rapid and economical production of small lots.

Honsel has the plant technology at its disposal, however, that enables it to supply precisely this market segment in an optimal manner. The company is also in a position to melt quantities much smaller than a tonne at short notice and to roll this down to the size required by the customer – and to do all of this at competitive prices. In addition, Honsel can also react very flexibly when it comes to dimensions. Whereas conventional rolled products are often only supplied in increments of 10-mm, Honsel is willing to supply client-defined intermediate sizes, such as 72 instead of 80 mm. This helps the mould maker avoid the unnecessary production of expensive chips. The company also responds flexibly to customers who want a finished surface instead of an as-rolled finish, and if requested to do so will also mill the product to the required final thickness. Such H-S-P plate (Honsel-Special-Plan) has extremely tight tolerances of only ± 0.1 mm, so the mould maker can start milling a cavity straight after clamping.

Approx. 11,170 characters (including spaces)

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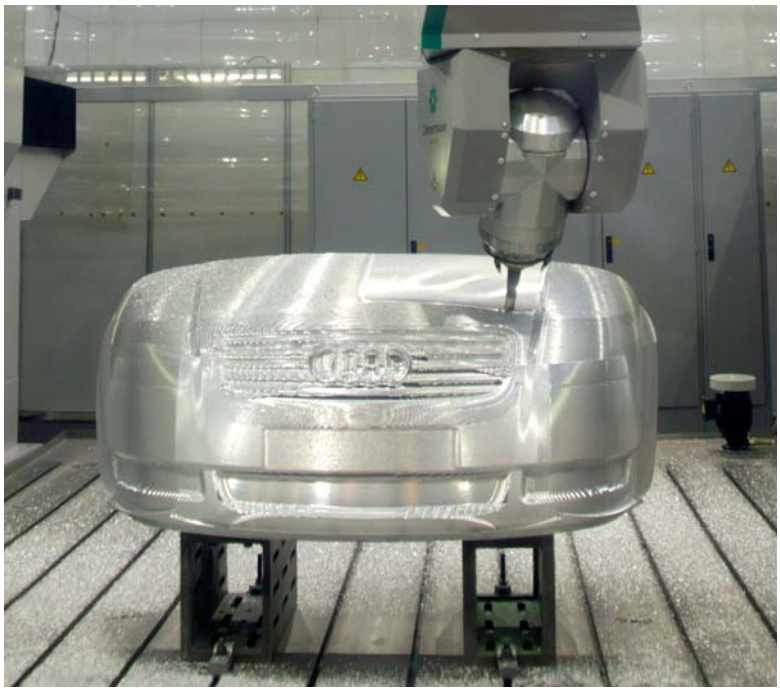

Aluminium’s good machinability makes short processing times possible even with large-format parts (photo: Klaus Vollrath)

Injection-moulding mould made from aluminium by sauer product (photo: sauer product)