



Producing gloss extruded shape products for special applications

-Experience from practice-

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PRODUCING GLOSS EXTRUDED SHAPE PRODUCTS FOR SPECIAL APPLICATIONS

-EXPERIENCE FROM PRACTICE-

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Abstract

The TRIMET / GERHARDI gloss alloy is a high purity aluminum extrusion alloy. It is characterized by an extremely homogenous microstructure without internal defects or inclusions. This material composition and the special processing know-how allow considerably higher productivity. Due to the optimal polishing and brightness properties and to excellent bending quality, the gloss alloy is especially suited to the production of surface sensitive components such as trim parts, roof racks, decorative fittings, door handles, cover plates for automotive application and power train or design elements for high-end audio equipment or the lighting industry. This gloss alloy allows any surface treatment from anodizing to coating to be applied. The paper covers the production of this special extrusion alloy, including quality requirements, qualifying of the alloying material, and process parameters, as well as the latest results from laboratory examinations on PodFa analysis and inclusion identification. Finally, examples of applications are shown and discussed.

Introduction

In Europe, there is a market for extrusion billets used to produce surface sensitive products, that amounts to approximately 15,000 mt per year and it is still rising. The driving force is the automotive industry that uses decorative parts inside and outside the vehicle because this product meets customer needs. The high requirements of the final product may only be met when the whole production process, from the alumina used, up to the end product, is fully optimized and properly designed. To further improve the quality of such products, close cooperation between the producer of extrusion billets and the end manufacturer is necessary. This enables defects to be detected and analysed, and to take steps to improve the production chain.

Trimal BQ process

For the production of extrusion billets, TRIMET has developed a special process named BQ (brilliant quality) to fulfil these high requirements. The production process covers all the steps starting with the alumina used to produce the aluminum raw material at the ESSEN smelter and up to the customized homogenizing process that is adjusted for the end product.

Alumina

The alumina for the pot room process arrives by ship at our port. The first quality check is done here. Samples are taken from the bulk alumina and the iron, silicon, calcium and sodium content are measured by x-ray spectroscopy. These elements are in oxide form. Figure 1 shows an example for the iron oxide and silicon oxide content over a certain period. This monitors the impurity content to keep it low and to maintain the raw alloy in the desired quality.

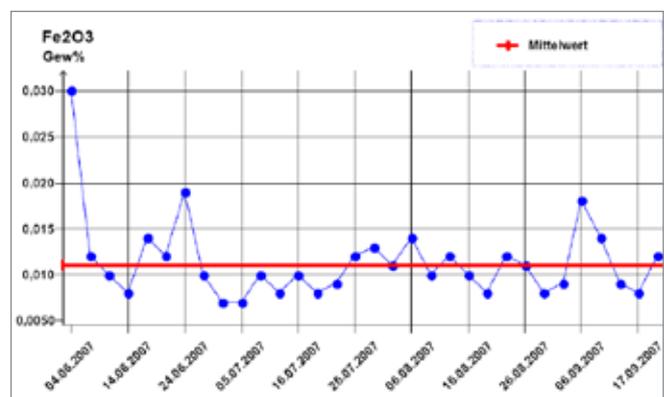
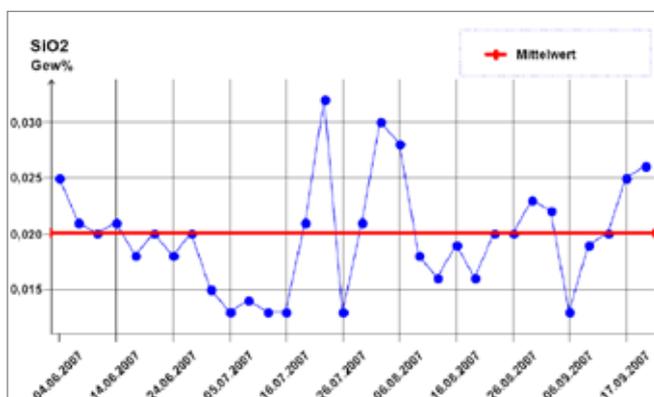


Figure 1. SiO₂ (a) and Fe₂O₃ (b) content of several alumina shipments.

The electrolysis process

The electrolysis process to convert alumina (Al₂O₃) to aluminum is carried out using high purity electrolytic cells commonly known as pots. The alumina for the pots is not used for scrubbing to avoid contamination. The anodes have low iron content and are changed sooner than the standard process anodes. This is more costly but prevents iron contamination from the pins that fasten the anodes to the rods. The anodes are covered with a special mixture of crushed bath and production purity alumina, which protects the anodes against oxidation. The high purity pots are also analyzed every 48 hours, which is more often than the normal frequency. A special bath level control system maintains a constant bath level. The pots are controlled by a 9-box matrix model (1). This has led to better process efficiency and lowered the pot line power consumption.

When the transport crucible containing the potroom metal is transferred to the casthouse, the melt surface dross is skimmed off such that only a thin oxide layer protects the aluminum from oxidation.

Melting and Casting

Figure 2 shows a flow chart of the material handling in the casthouse. In the melting furnace, only ingots or sows from in-house production are added to the potroom metal. Cold metal is used to cool the molten metal down to the desired holding temperature. In the melting furnace, the alloying elements used are master alloys. It is important that the alloying elements are added in a certain order. After stirring, skimming, holding and sampling, the melt is transferred to the casting furnace via a launder system. It is essential that the transfer is carried out laminar to avoid dross formation and hydrogen pick-up.

All master alloys or other additions to the melt are from certified suppliers and they are checked for chemical analysis, non-metallic inclusions and microstructure. The master alloys must meet the DIN-EN 575 standard. For example, the grain refinement rod is checked very closely. A sample of every heat of the rod used is analyzed for oxide lines, TiB₂ inclusions and Al₃Ti morphology. Figure 3 shows possible defects in the rod that are unacceptable in the Trimal BQ-process.

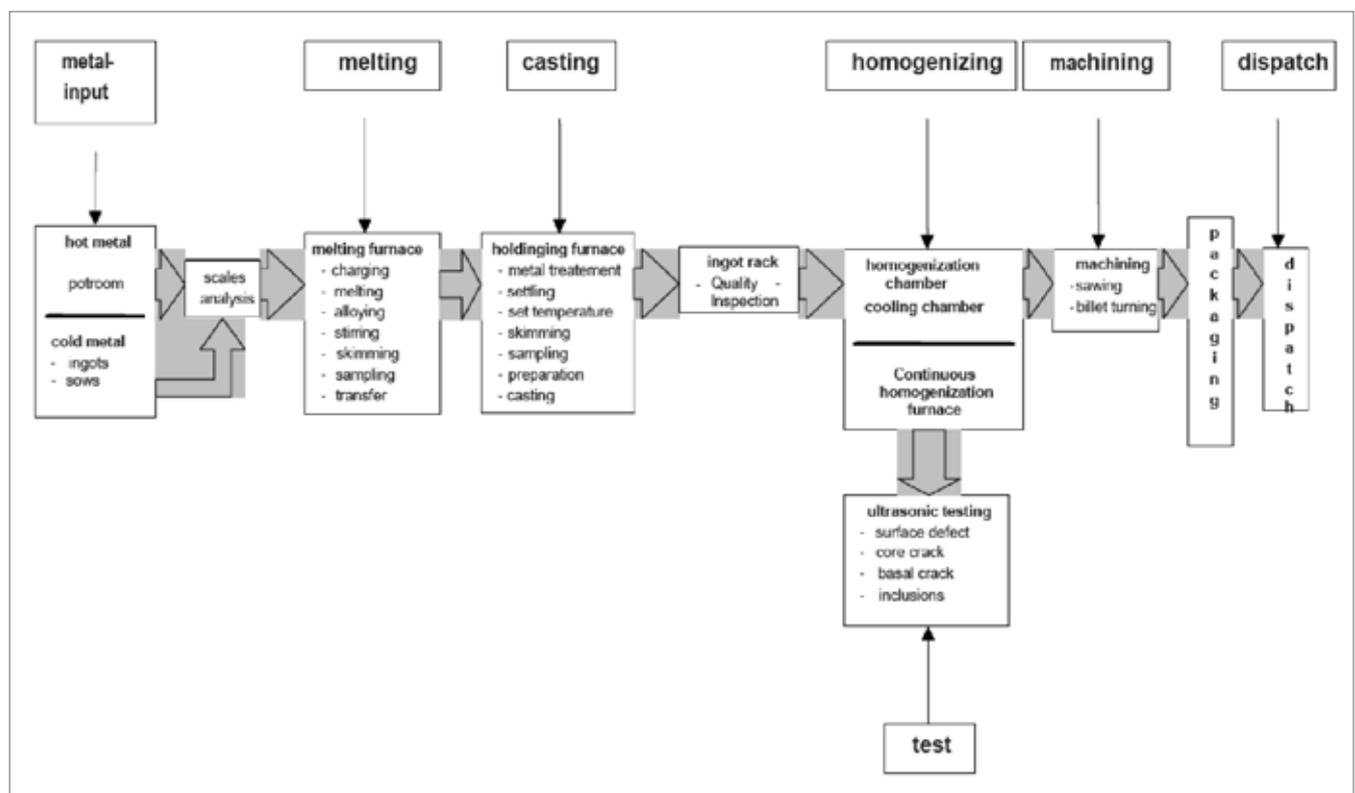


Figure 2. Production-flow cast house.

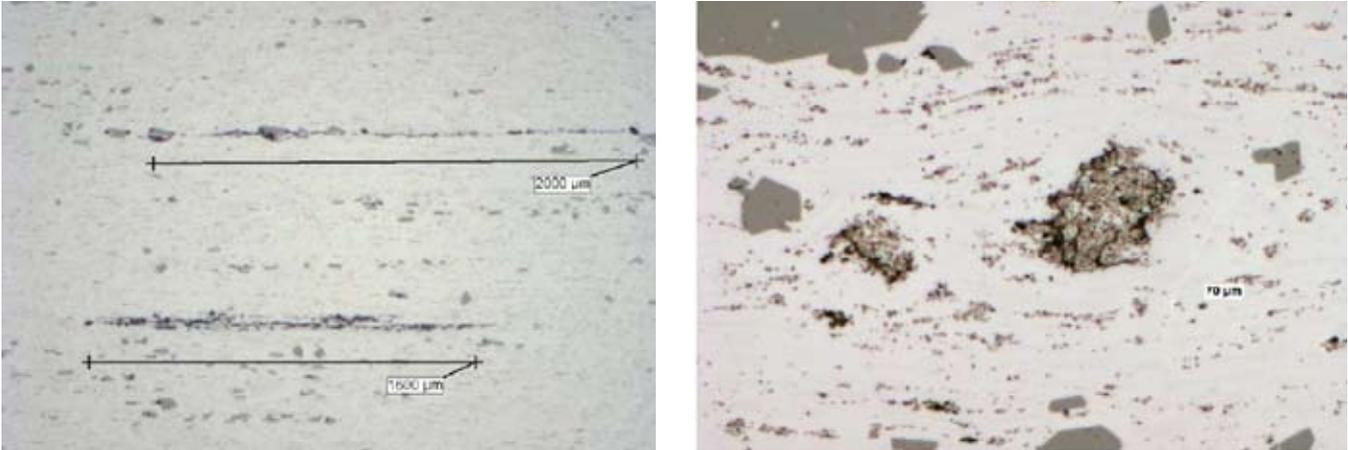


Figure 3. Unacceptable Oxide lines and TiB2 agglomerates in a grain refinement rod.

No master alloy is added in the casting furnace. The metal is cleaned with the impeller technique using argon/chlorine gas. This removes the non-metallic inclusions and the hydrogen from the melt. After a certain holding time, the metal charge is ready for casting.

To check the melt quality, Porous Disc Filtration Apparatus (PodFa) measurements are carried out from time to time. The PodFa is an external test that forces molten metal sampled from the melt through a fine filter disc. The technique requires metallographic preparation and examination of the inclusion content contained on the surface of the fine filter disc. The evaluation results are reported by an experienced technician, in terms of area fraction of the inclusions observed as a function of metal volume passing through the test filter. The standard unit is mm²/kg (2).

Figure 4 shows an example with 100% hot metal and 50% cold metal additions. The samples were taken at the beginning and at the end of the casting cycle, before and after the ceramic-foam-filter system. Regarding inclusion density, it can be shown that there is no significant difference between using 100% molten potroom metal or cold ingots. The filter system works very effectively and removes most of the inclusions from the melt. It can also be stated that the filter system is working properly over the entire casting cycle. A maximum of 0.005mm²/kg of inclusions may be tolerated to ensure a minimum rejection rate for the end product.

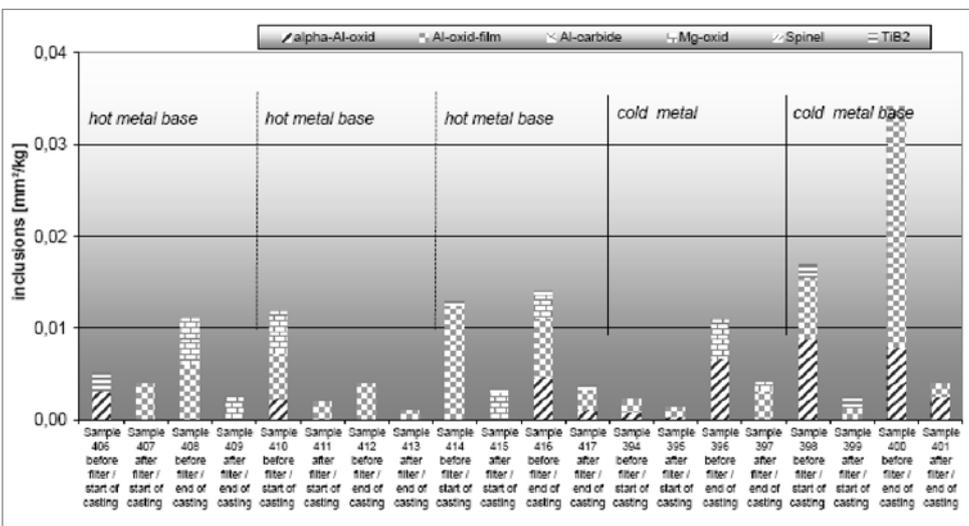


Figure 4. PodFa - measurements to compare inclusion amount using hot metal and cold metal (50%), before and after the ceramic foam filter-system accepted.

Billets of 140mm to 548mm diameter may be produced using the spout floater technique (Figure 5). The whole casting process runs automatically. Casting furnace tilting is controlled by measuring the melt level in the launder system using a laser. The melt level in the casting furnace and the melt level in the launder must be equal so that no waterfall effect occurs.

All the casting parameters for each cast are stored in a database to be used for statistical examinations to improve the process reliability. After the billets are stripped out of the casting pit, the surface of each billet is checked visually for surface defects. Ultra sonic equipment is used to check internal cracks that could occur in the foot area of the billet.

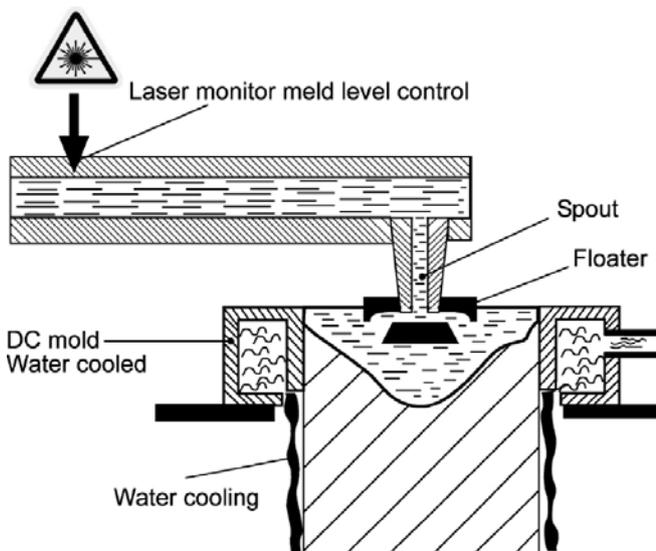


Figure 5. The casting system (3)

The homogenizing process is customized and adjusted for the final product. Holding time, temperature and most important, the cooling rate after homogenizing, have a significant effect on the final product. Samples from homogenized billet slides are taken and checked using light optical microscopy. The main problems are pre-solidification that may cause shades on the surface of the end product; the thickness of the shell zone that is defined by the customer; feather crystals; an equal cell structure; non-metallic inclusions; gas porosity and grain size. An example of homogenous grain size is shown in Figure 6. The tests are carried out according to detailed guidelines, and must be performed by trained and experienced employees.

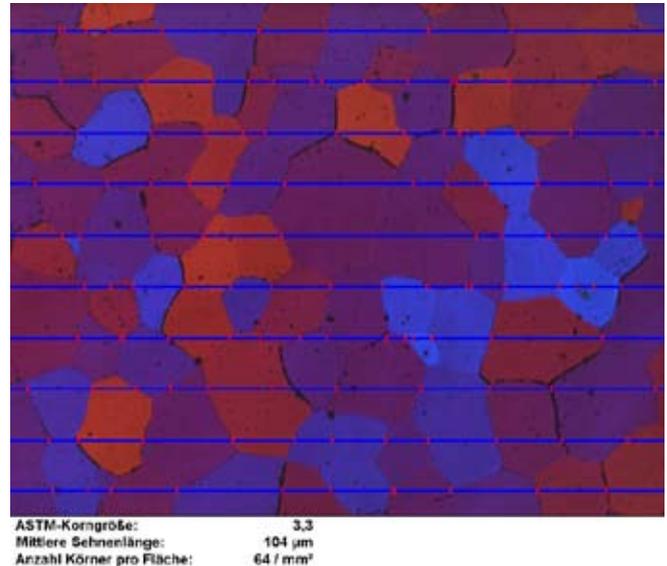


Figure 6. Grain size of a homogenized billet using ASTM standard

From the billet to the extruded shape: Trimal BQ – GERAL BQ

On the basis of the above-described Trimal BQ process, Gerhards Alutechnik produces GERAL BQ, a high quality gloss aluminum extruded shape that has a wide range of applications. It is the result of Gerhards' long-term experience in tooling and extrusion technology.

GERAL BQ – the production process

The process of producing the GERAL BQ gloss extruded shapes starts at the end of the Trimal BQ process with gloss alloy aluminum billets of 203 mm diameter (Figures 7 and 8).



Figure 7. Extrusion press

Essential elements of the GERAL BQ production process are the tooling technology, highly differentiated extrusion parameters and the final heat treatment. The process discharges into an aluminum extruder that has versatile options for the customer with regard to weight, dimensions, processing and surfaces.



Figure 8. Customized sawing

Tooling technique

In order to be able to produce aluminum extruded shapes for decorative applications, a sophisticated tooling technique is needed. Excellent sensitive gloss surfaces cannot be obtained with standard tools that are normally used in the aluminum extrusion process. Special tool steel and defined coating systems are prerequisites for highly wear-resistant aluminum extrusion tools (Figure 9). The know-how in tooling technique for GERAL BQ distinguishes Gerhardt Alutechnik as a producer of high gloss extruded shapes.

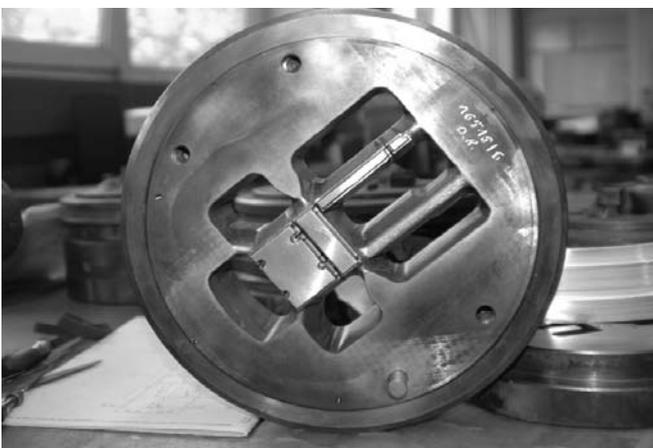


Figure 9. Tool for extruding gloss alloy

Extrusion process

GERAL BQ extruded shapes are produced in an extrusion press (Figure 10). The billet is warmed up to a temperature of 400 -500°C and pressed through the extrusion tool. Depending on the kind of device, the extruded shapes may be up to 100 meters long. The cooling technique requires special attention. To obtain a homogeneous extruded shape, constant cooling must be strictly observed.

The cooling down process is matched for the specific final application. After stretch forming and sawing to the length required by the customer, the extruded shape leaves the production unit extrusion press.

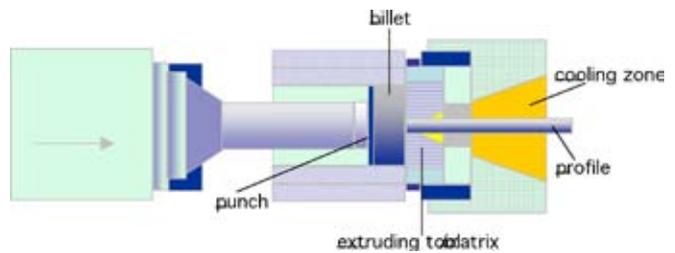


Figure 10. Extrusion process

Heat treatment

The heat treatment is specially adapted to the subsequent type of processing. Its parameters are defined in detail and result from close development cooperation with the customer. Under temperatures of 180°C – 200°C, the extruded shapes undergo a precipitation heat treatment. The only way to produce high quality extruded shapes for decorative applications is to strictly monitor all the production parameters. Broad experience and high quality standards are required to produce a high quality gloss extruded shape, that in turn provides a wider range of processing options.

Bending process

To produce a trim part to match the shape of a car, the Geral BQ extruded shape is bent by a stretcher and roller process. Due to the homogeneous configuration of the material, the shaping process causes only minor orange peel. Technically, excellent quality shaping and short bending radii may be achieved (Figure 11).



Figure 11. Geral BQ after bending process

Surface treatment

After mechanical treatment of the extruded shape, the surface pre-treatment process by sanding and polishing begins. At this stage, there are considerable cost advantages provided by the homogeneous structure of the Geral BQ material. Less surface roughness means less sanding and polishing and considerable cost advantages in the processing chain.

The final gloss and the passivation mechanical surface treatment are achieved by electropolishing the extruded shape (Figure 12). With the electropolishing chemical process, even minimal surface inclusions are eliminated so that a smooth and glossy surface finish is obtained mechanically and chemically. The next anodizing step passivates the shiny structure.

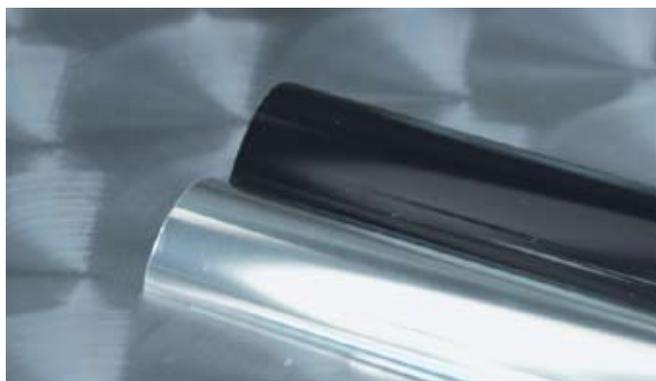


Figure 12. High gloss surface – natural and black

Summary

The BQ2 product is produced by the Trimal BQ process in combination with the Geral BQ extruded shape. It provides a wide range of designing options in color, form and surface finish (high gloss, semi gloss, gloss for EV 1 natural, black, bronze etc.).

BQ2 provides new possibilities for the customer with demanding requirements for product aesthetics and function. It allows greater design possibilities and more production cost leeway. This product is successfully utilised in the automotive, furniture and lighting industries.

The intensive development activities of Gerhards Alutechnik and TRIMET ALUMINIUM AG and the exceedingly sophisticated standard of the production process results in a product that in the future will be synonymous for high quality in decorative applications.

Acknowledgement

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