Germany

25 Years of MUT Advanced Heating with Additional Focus on Additive Manufacturing

In 1994, Heinz-Jürgen Blüm established the company MUT (Mikrowellen, Umwelt Technologie) at the TIP start-up centre in Jena's Industry Park/DE. With its withdrawal from environmental engineering, the company was renamed MUT Advanced Heating in 2003. MUT Advanced Heating's expertise lies in the development, engineering and manufacturing of individual furnace systems in the high-temperature range with defined atmospheres or vacuum. Talking to us together with his business partner Matthias Scharvogel (MS) – Titanium Generation GmbH/DE, Heinz-Jürgen Blüm (HJB) reflected on the history and future strategy of the business.

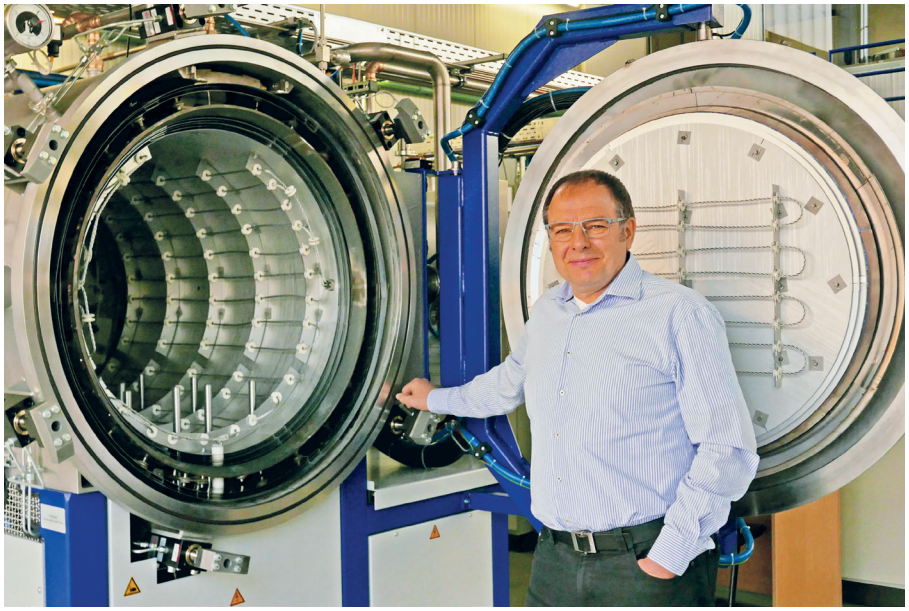

Fig. 1 Heinz-Jürgen Blüm in front of an in-one integrated debinding and sintering ISO furnace for MIM applications (stainless steel, titanium, etc.)

cfi: *What in your view are the highlights in the company's 25-year history?*

HJB: Generally, we have been able to successfully offer system solutions in furnace engineering to meet the increasing requirements in the materials sector (ceramics, powder metallurgy, glass technology), which have led to ever more complex manufacturing processes.

The main changes in recent years have been the necessities for more sophisticated plant engineering, coupled with increased efficiency requirements, which has inevitably led to greater automation of thermal plants, but also their increasing individualization. The requirements for safety systems have also steadily increased. Here, I can certainly spotlight our ISO furnace line – an integrated concept between debinding and sintering furnace in one.

Precondition for this is a very sophisticated control concept, but also reliable safety systems and industry-specific material know-how. To avoid the formation of microcracks or residual binder in the workpieces, extreme cleanness and precise atmosphere control must be guaranteed, This line has proven itself as a benchmark in the branch with regard to sintering quality as we can guarantee permanently clean, stable sintering atmospheres.

cfi: *What advantages can customers expect if they opt for plants from MUT Advanced Heating?*

HJB: We design plants for modern processes for debinding and sintering, for joining techniques, the heat treatment of aggressive substances as well as for the high-pressure and hot gas ranges. Our company's own planning areas in project planning, design, process and safety engineering, electrical engineering and software development assure coherent engineering from one source. We rely on a high production depth and, licensed as a manufacturer of pressure equipment (HPO authorization, welding company), we are able to define in consultation with the end-customer the optimum plant selection and to guarantee the proper and professional execution on the basis of certified procedures. Besides engineering (mechanics, plant engineering, electrics, electronics, automation, control, software, visualization and project planning), and commissioning services, value is attached to services like training of the operatives, software modifications by means of remote maintenance and detailed plant documentation.

Fig. 2 A 2-m³ debinding plant working under hydrogen and partial pressure

cfi: *What R&D activities and production possibilities do you have to secure for innovations of this type?*

HJB: Every powder – be it ceramic or metal – has to be homogeneously mixed with temporary binders for the shaping processes (pressing, extrusion, PIM or additive manufacturing). First, independent of the shaping process used, the quality of the component is essentially influenced by appropriate process control during debinding and sintering. When we present ourselves for the second time at "formnext" in 2018, we can draw on almost 25 years of experience in thermal process engineering because problems with the introduction of additive manufacturing on industrial scale are similar to tasks that we have been working on for years in CIM/MIM-technologies. This expertise we have acquired in cooperation with institutes that are able to analyse in situ the debinding and sintering behaviour of these materials. It is not just a matter of burning out binder without residue, but running the processes as fast as technologically possible. The plant capacity and economic efficiency is a central purchasing argument.

cfi: *You have responded to the ever more extensive applications of additive manufacturing with the development of a new product range – AM Heat Treatment. What are here the new plants for the heat treatment of powders and components as well as for the debinding and sintering of printed components?*

HJB: We have a wide range of proven furnace systems that have been modified to meet the needs of Additive Manufacturing (AM). To this end, we offer suitable furnace technology for powder processing, for debinding and sintering as well as for heat treatment; the DRO rotary tube furnaces for the heat treatment of powders for the processes EBM (Electro Beam Melting) and SLM/SLS (Laser Beam Melting), the RWO line offers a compact, low-cost solution for a wide range of applications in heat treatment and, of course, the above-mentioned ISO series of integrated debinding and sintering furnaces.

cfi: *Besides Technical Ceramics, powder metallurgy has long been one of the industries using your plants. What motivated you to get into the technology of titanium and its alloys?*

HJB: Crucial was certainly to have found in Matthias Scharvogel a partner who brings the material expertise and the process know-how for titanium and its alloys and therefore ideally complements our background.

MS: First, I should like to explain the advantages of this light metal. Titanium forms in air an extremely resistant oxide protective layer (passivation layer) that protects it against many media. Pure titanium is with a value of 6 (according to Mohs) only moderately hard, but even with low alloying additives, a high strength at a relatively low density and therefore interesting specific strength values are achieved.

As a result, titanium alloys are especially suitable for applications in which high corrosion resistance, strength and low weight are important. On account of its hexagonal crystal structure, titanium is relatively difficult to form. In the production of titanium sheets from titanium blocks, rolling makes up around 50 % of the total cost of the product. Here with AM, we are coming to an exciting turning point as here near-net shaping is possible and the biggest disadvantage of the material is receding into the background.

cfi: *What user segments are especially interested in products made of titanium and its alloys?*

MS: Titanium is a common element in the earth's crust, however, it is hardly present in metallic form and therefore has to be recovered from minerals (e.g. rutile, anatase). The kilo price is relatively high, but its combination of properties with low density and high strength with very good corrosion properties make it interesting for many demanding applications.

These include protective equipment for military, applications in seawater and chloride-containing media (seawater desalination plants), structural parts for aerospace as well as automotive industry and use as biomaterial for implants in medical systems and dentistry. But for consumer products such as sport articles and jewellery, too, where the aesthetics of the material is important, titanium is in demand.

cfi: *What competences do the partners Element 22 and MUT Advanced Heating bring to the joint company Titanium Generation GmbH (TiGen)/DE?*

MS: I think what has already been said has shown the relevant competences of MUT Advanced Heating. In addition to this, I want to say something about the experience of Element 22. We have been working for years with MIM of titanium and its alloys. That goes back to the work of HZG (Helmholtz Institute Geesthacht) in the late 1980s.

The first commercial MIM plants for titanium were installed by our predecessor company in 2004. This had, however, a focus on components for medical systems. With the takeover of this company in September 2011, we set ourselves the aim as Element 22 to widen the range of applications of MIM-fabricated titanium components and today we have the world's biggest production capacity for these components.

cfi: *How do you want to develop TiGen further?*

MS: The company specialises in supplying heat treatment and sintering plants

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Fig. 3 Medical component made of titanium

Fig. 4 Titanium MIM-components for consumer goods

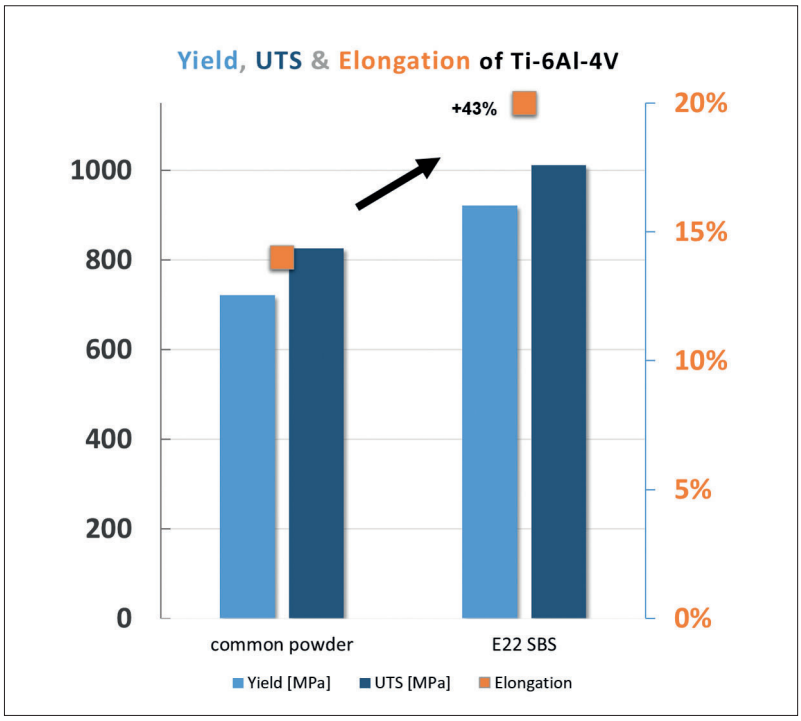

Fig. 5 Due to its vast know-how, the company Element 22 GmbH showed by its patent EP3231536B1 the further optimisation of the titanium materials properties

for titanium materials that are produced with MIM, AM or other shaping processes. On the basis of our many years collecting material know-how we show that the material properties of this material group can be further optimised.

When we realise this, the applications for this group of materials can be widened enormously. Additive manufacturing also offers potential in production because it eliminates the need for expensive, subtractive processes, e.g. cutting.

cfi: *What significance in your view does the HIP process have for titanium-based, additive manufactured component?*

HJB: Depending on the use of the components, this expensive process is not always necessary, We are working on solutions in which with modified debinding and sintering technology and the use of sufficiently fine powders, HIP may not be necessary. For the debinding and sintering process, we reach costs of 3–5 EUR/kg (RWO 1–2 EUR/kg).

A downstream HIP process, on the other hand, costs around 50 EUR/kg. Accordingly, HIP should only be applied where it is absolutely essential, The goal of our developments is to achieve a residual porosity <0,5 % (currently still in the region of 4 %) for materials produced by means of binder jetting but without HIP.

cfi: *What response have you had from formnext 2018, at which you have exhibited together for the second time?*

HJB: We have never come back from a trade fair with so many enquiries to answer and work to do. Besides the talks at our trade fair stand, numerous key contacts have come from networking during the trade fair. A very dynamic and innovative trade fair that we have already scheduled in for next year.

cfi: *Thank you for talking with us.*

KS

Milestones for MUT GmbH

1994	• Founding of the company MUT Mikrowellen Umwelt Technologie by Heinz-Jürgen Blüm as a private company • Company moves into its premises at the Jena Technology Park
1995	• Projects in environmental engineering and environmental remediation • First projects in furnace engineering
1996	• Company becomes as a GmbH, i.e. a limited company • Development of the CAF line of modular laboratory furnaces
1997	• Company moves into the first production facility
1999	• Construction of the company's own production facility and start-up of operation there and renovation of an administration building • Delivery of the first large continuous belt furnace in the BDO line
2001	• Project for plasma reformation of fuels on European scale
2003	• Withdrawal from the environmental engineering business • Change of name to MUT Advanced Heating GmbH • In-house machining of ceramic insulation materials and graphite
2004	• Widening of the furnace engineering portfolio in vacuum furnaces and sintering furnaces • Establishment of graphite and molybdenum furnace lines • Opening of the Eastern European market, representative office in Moscow
2005	• Increase in the company's own depth of production in welding and cutting • Conclusion of the ISO line of integrated sintering and debinding furnaces • Increase in number of employees to 30
2007	• Extension of the production facility with a grey room for industrial manufacture of high-vacuum equipment • Increase in number of employees to 40
2009	• Erection of a new final assembly facility, extension of prefabrication • Increase in number of employees to 50
2010–2017	• Partner in the Bioliq joint project with Karlsruhe Institute of Technology, Karlsruhe/DE • High-pressure high-temperature gas purification of syngas
2011	• Dr Dirk Sprenger joins the management (up to 2015) • Qualification as a pressure device manufacturer (HP0), specialist welding and steel construction company
2013	• Further development of ISO furnaces for integrated debinding and sintering of titanium MIM materials • High-pressure sintering furnaces for heavy metals
2015	• Set-up of a lithium processing plant in USA
2016–2017	• Set-up of an industrial titanium-MIM manufacturing unit (Element 22 GmbH, Kiel/DE)
2017	• First projects for the sintering of 3D-printed components • Joint venture with Element 22 GmbH: Titanium Generation GmbH/DE
2018	• Further development of the RWO furnace line for heat treatment of SLM components
2019	• 25-year company anniversary