SCHMELZMETALL

ADDITIVE MANUFACTURING

and high-performance copper alloys HOVADUR® K for plastic injection moulds

HOVADUR® K and B

Highly thermal conductive alloys for plastic injection moulds

HOVADUR® K and SLM

Selective Laser melted mould inserts with internal cooling

HOVADUR® K and LMD

A perfect combination – High thermal conductive copper alloys and local protection with wear resistant materials

HOVADUR® K and HOVADUR® B

Extremely high thermal conductive alloys – Key technology for plastic injection moulds

The demand of the globalized market, especially for all companies and mould makers producing in high-wage countries, is at the same time simple and merciless: An excellent quality of the moulded part is taken for granted and the cost pressure is constantly increasing.

This means clear definition of the requirements for the injection moulds:

„Optimum quality of the moulded part at the shortest possible cycle time"

The **optimum quality of the moulded part** is achieved if the heat introduced with the plastic is distributed quickly and evenly along the cavity in order to adjust an even temperature of the mould wall.

The shortest cycle time is achieved by quick dissipation of the heat in order to cool down most quickly from injection temperature to demoulding temperature.

High thermal conductivity of the selected alloy is an important condition to meet the thermal requirements.

Our high quality copper alloys HOVADUR® K and HOVADUR® B meet these requirements

Alloy	Tensile strength Rm MPa	Yield strength Rp ,2 MPa	Hardness HB Steel HRC	Elastic Modulus GPa	Thermal conductivity W/mk	Thermal expansion coefficient 10^{-6}/K	Density g/cm³
Beryllium free alloy							
K 220	650	500	190	140	200	16,2	8,8
Beryllium containing alloy							
K 230	700	650	210	135	290	17,2	8,8
K 265	750	700	260	135	260	17,2	8,8
K 350	1.250	1.000	380	135	160	17,0	8,3
Multi alloy aluminium bronze							
B 20	680	320	170	118	50	16	7,55
B 30	740	420	220	115	56	16	7,40
Steel							
1.2343	1.600	1.400	54	216	24	9,7	7,85

For its alloys HOVADUR® K and HOVADUR® B, Schmelzmetall has obtained certification of compliance according to the standard no. 80.30, 1-3 (CE) of the Foodstuffs and Animal Feed Code. The certificates are available for our customers on demand.

HOVADUR® K and Selective Laser Melting

Selective Laser melted inserts made of HOVADUR® K combine high thermal conductivity with cooling close to the contour in the mould

The cycle time of an injection process is determined by the efficiency of the cooling (injection / demoulding temperature).

The quicker the heat can be dissipated, the quicker the part can be demoulded.

Besides the **high thermal conductivity** of the alloys used in the cavity area of the mould, the **cooling close to the contour** is an important element to reduce the cycle time.

Reduction of the cycle time up to **40 %** due to a combination of both technologies

Picture: SLM

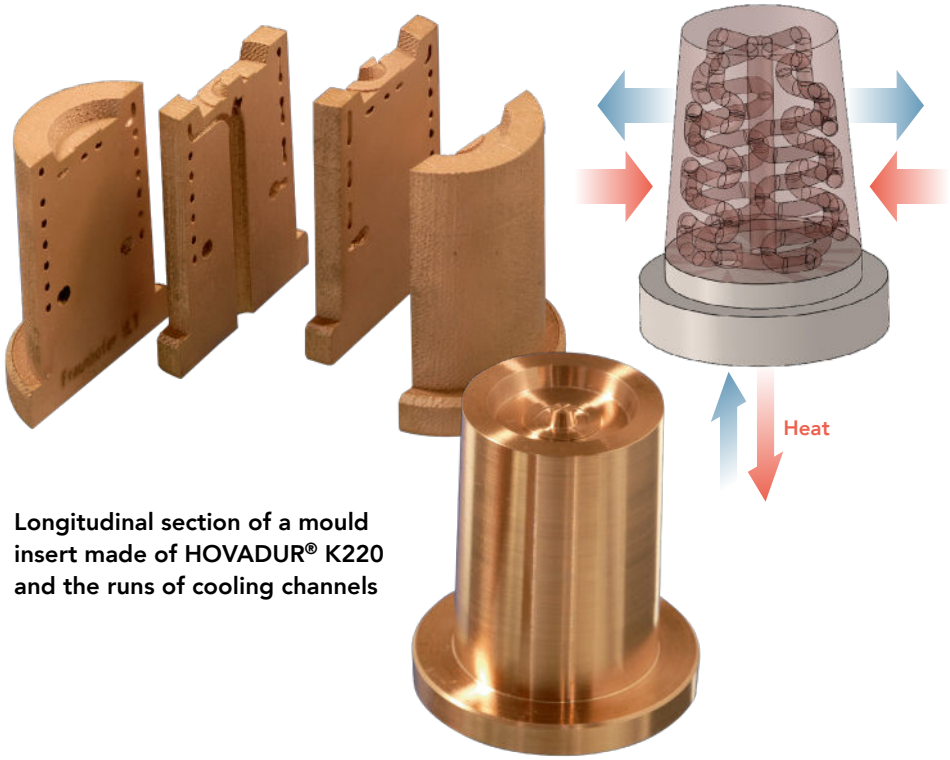
The SLM allows a nearly infinite contouring freedom, even inside the mould

In the scope of several R&D projects, Selective Laser Melting (SLM), also known as Laser Forming or LaserCUSING, has been developed for the HOVADUR® alloys K150 and K220. The results allow a comparison between conventionally and additively manufactured inserts.

This technology offers the possibility to combine high thermal conductivity with cooling close to the contour. In the powder-bed method, parts are built up layer by layer (thickness of layer 30 – 50 µm) by means of a laser.

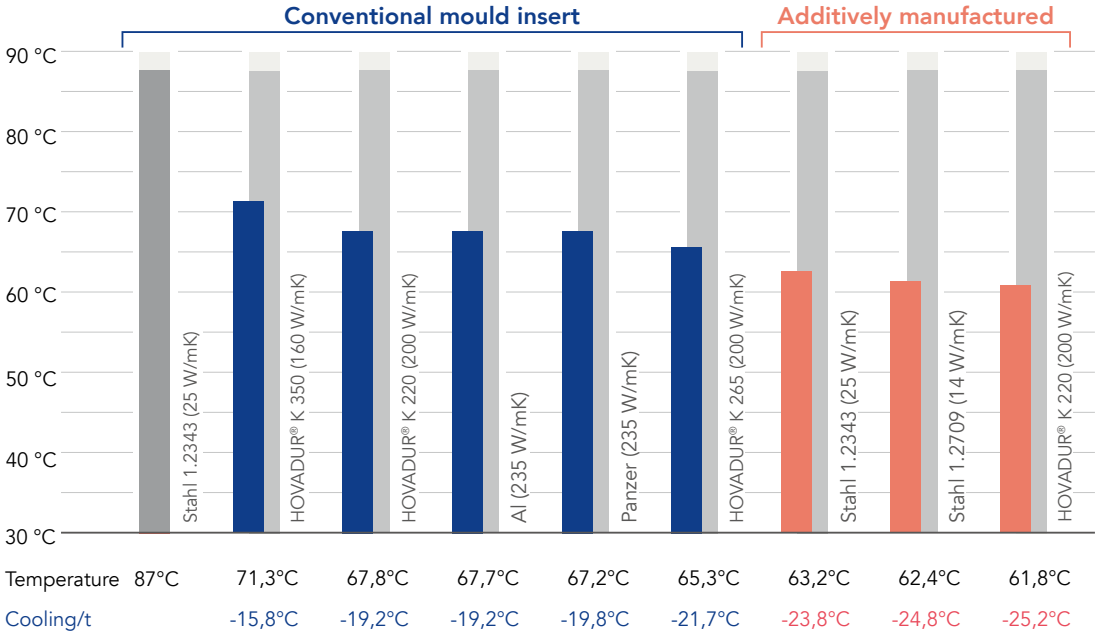
The work of one of these projects was carried out with a four cavity mould for tealight cups at the Süddeutsches Kunststoffzentrum in close cooperation with the Fraunhofer Institut für Lasertechnik in Aachen.

Depending on the power of the laser, **densities of more than 99,5 % have been achieved reliably.**



Longitudinal section of a mould insert made of HOVADUR® K220 and the runs of cooling channels

Comparative studies concerning the demoulding temperature have been carried out for different cycle times. The cycle time started with 27.2 seconds and was reduced to 10.8 seconds. The processed material was a polypropylene PP504P of the company Sabic. Replacing the steel of the inserts by a HOVADUR alloy may already **reduce the cycle time by up to 30 %**. Furthermore, when comparing a conventional insert made of HOVADUR® K220 to an insert made of HOVADUR® K220 produced by additive manufacturing with integrated cooling channels, it becomes evident that a **further reduction of the cycle time up to 10 %** is possible.



Reduction of the cycle time by

30 %

when using mould inserts made of HOVADUR® compared to inserts made of steel

Reduction of the cycle time by another

10 %

when using additively manufactured mould inserts with integrated cooling channels

By means of the appropriate post process (heat treatment), properties corresponding to those indicated in the data sheets of HOVADUR® K150 and K220 can be achieved reliably in additively manufactured mould components.
Besides the thermal tests, the wear behaviour of additively manufactured mould inserts has also been examined.
For this purpose, a polyamide (PA6) with 50 % glass fibre was processed. The inserts were functionalized by etching. On the front and shell surface rhombs have been created, coated and measured by means of an µ-scan, a contactless surface measuring device.
The best wear behaviour has been determined on inserts which had been coated with "electroless nickel" (CNBV) of the company NovoPlan.

Production of mould inserts by SLM – Already profitable today?

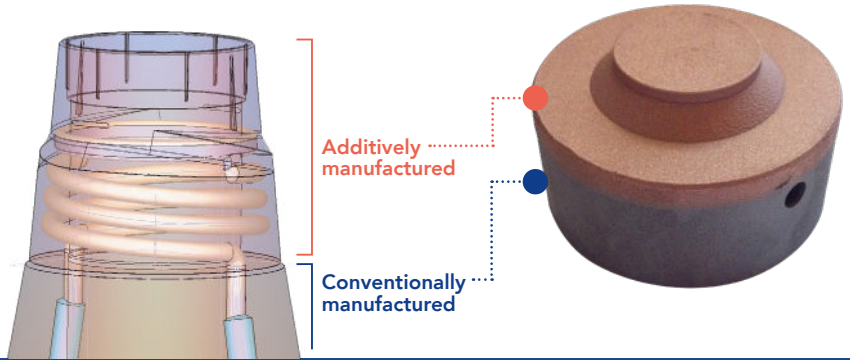
At present, build-up rates of HOVADUR® K150 and K220 are at about 3-4 cm³ / hour.

But this is only the present situation. Build-up rates will increase and thus the SLM technology for our HOVADUR® alloys will become gradually economical.

Hybrid manufacturing of mould inserts with highly efficient cooling – the economical alternative

Often a cooling close to the contour is only necessary in a specific area where it is really needed.

Thus, mould inserts can be produced in a hybrid way. Conventional combined with additive manufacturing allows a significantly more economical production - not only with similar copper alloys but also with a combination of a copper alloy with adapted steels. Thus, you can achieve a reduction of the cycle time and potentially savings in energy.



HOVADUR® K and the LMD technology

The perfect connection - HOVADUR® K alloys showing an excellent thermal conductivity combined with wear resistant materials.

Laser Metal Deposition (LMD) allows to use the potential of HOVADUR® K alloys showing a high thermal conductivity also for wear intensive applications.

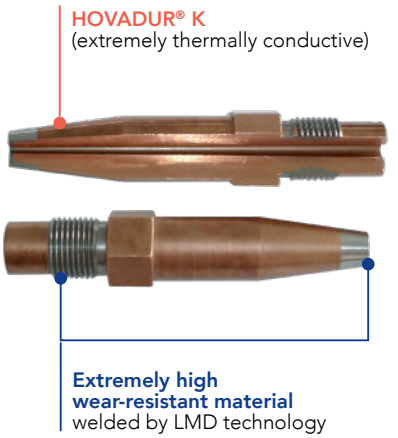
How may we arrive at further taking advantage and developing the potential of our HOVADUR® alloys?

Often, users would like to have a highly thermal conductive HOVADUR® alloy, provided it would be possible to produce it in a wear resistant version - and even better - applicable locally, exactly in line with the individual application. This means requirement and challenge at the same time for us.

Laser Metal Deposition (LMD) offers numerous possibilities exactly for such cases.

Specific long-standing development work enabled Schmelzmetall to put to use this technology for their HOVADUR® alloys. It consists in adding e. g. metal powder by means of inert gas. The base material and the deposit material are fused by laser and metallurgically bonded.

There is a great number of possibilities concerning deposit materials. Even a mixture of powders consisting of a copper alloy and hard-materials may be welded selectively on certain areas. The adjacent photos of a machine nozzle and a hot-runner nozzle are examples for the approaches which result from this new technology.



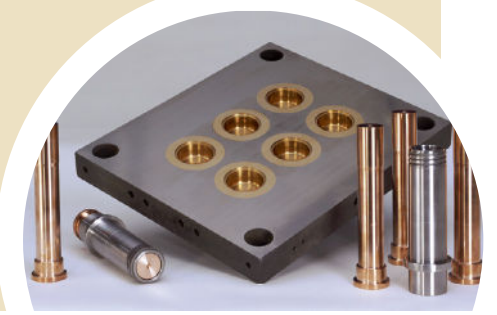
Application of the LMD technology using the example of a nozzle made of highly thermal conductive HOVADUR® K alloy.

Special alloys and key technologies in mould making

To meet the requirements concerning today's plastic injection moulds, many aspects of their construction have to be considered. It is important to identify the requirements on the mould components and the stresses acting on them and to deduce appropriate measures.

Copper alloys can contribute to a large extent to fulfilling the requirements for highest quality of the moulded part and shortest cycle time. Sometimes, a combination of different materials is the best way. This may be achieved by coating or composite technologies.

Moreover, additive manufacturing technologies, such as Laser Metal Deposition (LMD) and Selective Laser Melting (SLM), provide enormous possibilities which should be used in order to remain competitive.



The team of Schmelzmetall Deutschland GmbH is at your disposal for any advice and will accompany your project until series production. Schmelzmetall is a partner who explores new horizons to be able to provide correct answers in future.

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SCHMELZMETALL – Know-how and development are at the same time basis, challenge and future prospect.

Schmelzmetall AG was founded in 1959 in Gurtnellen in the Canton of Uri/ Switzerland. Right from the beginning, the focus was on the development of copper alloys with the best properties of their kind.

Today, Schmelzmetall AG and the whole Schmelzmetall Group are a leading manufacturer of precipitation-hardening high performance copper alloys. The Schmelzmetall Group comprises the following plants: Schmelzmetall AG, Gurtnellen, Schmelzmetall Deutschland GmbH, Steinfeld-Hausen and Schmelzmetall Hungária Kft. in Budapest. The plants in Switzerland and in Hungary are our production sites.

The HOVADUR® alloys produced by Schmelzmetall are melted and cast in a unit under vacuum. Furthermore, no external scrap is added to the alloys. Thus, we achieve the optimum properties. For this reason, Schmelzmetall became the only certified supplier of the alloy for the combustion chamber of the Ariane 5 rocket.

Our central warehouse, our cutting center, our own CNC machining center and a 3D-metal printing machine are situated in our German branch.

Launch of an Ariane 5 rocket from Kourou space center. Schmelzmetall is leading in the development and manufacturing of the alloy used exclusively in the Ariane 5 combustion chamber since 1996. (Photo EADS)

www.schmelzmetall.com

Schmelzmetall Deutschland GmbH
Raiffeisenstrasse 8
DE-97854 Steinfeld-Hausen
Telefon: +49 9359 9720-0
Telefax: +49 9359 9720-40
E-mail: info@schmelzmetall.com

Schmelzmetall AG
Fabrikstrasse 13
CH-6482 Gurtnellen/UR
Telefon: +41 41 886 80 40
Telefax: +41 41 886 80 41
E-mail: info@schmelzmetall.com

Schmelzmetall Hungária Kft.
P.O. Box 93/199
HU-1751 Budapest
Telefon: +36 1 278 51 40
Telefax: +36 1 278 28 58
E-mail: info@schmelzmetall.com