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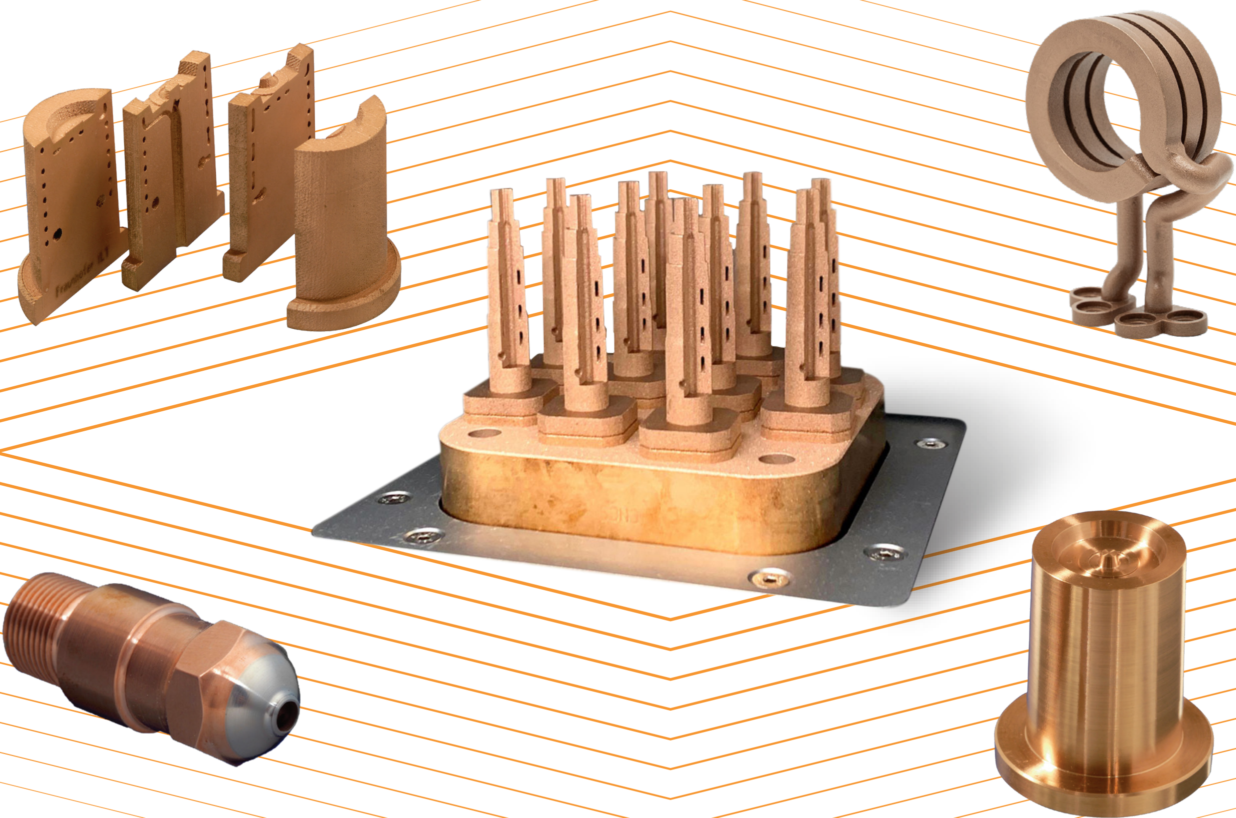
ADDITIVE MANUFACTURING AND HIGH PERFORMANCE AMPCOLOY® ALLOYS
FOR PLASTIC INJECTION MOLDS



AMPCOLOY® and Powder bed fusion–laser beam

PBF-LB 3D-printed mould inserts with internal cooling

AMPCOLOY® and AMPCO® products

Highly thermal conductive alloys for plastic injection molds

AMPCOLOY® and Laser Cladding

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

Excellence in Engineered Alloys

AMPCOLOY® INNOVATIVE SOLUTIONS

High thermal conductivity alloys for plastic injection molds

Plastic injection mold makers face simultaneous pressure on part quality and cycle time. Meeting both requires careful selection of mold materials, particularly in zones where heat extraction directly influences output and product stability.

Defining the right requirements for each mold component is the starting point:

Faster heat extraction. Stable part quality. Shorter cycle times.

The **optimum quality of the molded 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 mold wall.

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

Thermal conductivity is the deciding factor in heat extraction

AMPCOLOY® alloys cover the conductivity range required for high-performance mold making.

Alloy	Tensile Strength Rm (MPa)	Yield Strength Rp0,2 (MPa)	Hardness HB (10/3000)	Elastic Modulus E (GPa)	Thermal conductivity (W/m·K)	Coefficient of thermal expansion (10^{-6}/K)	Density (g/cm³)
Beryllium-free alloy							
AMPCOLOY® 940	689	517	210	131	208	17.5	8.71
AMPCOLOY® 944	938	730	294	151	156	17.5	8.69
Beryllium-containing alloys							
AMPCOLOY® 89	740	680	230	135	300	17.2	8.8
AMPCOLOY® 88	890	680	270	130	230	17.0	8.75
AMPCOLOY® 83	1250	1000	380	131	106	17.5	8.26
Multi-alloy aluminum bronzes							
AMPCO® 45	814	517	228	117	46	16.2	7.53
AMPCO® M4	1000	793	286	124	42	16	7.45
AMPCO® 18	708	361	194	117	63	16.2	7.45

Selected AMPCO METAL beryllium-free alloys hold ISEGA certification for food-contact and pharmaceutical tablet applications. Certificates are available upon request.

AMPCOLOY® AND 3D-METAL-PRINTING

3D-printed inserts made of AMPCOLOY® combine high thermal conductivity with cooling close to the contour in the mold

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

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

Besides the **high thermal conductivity** of the alloys used in the cavity area of the mold, 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

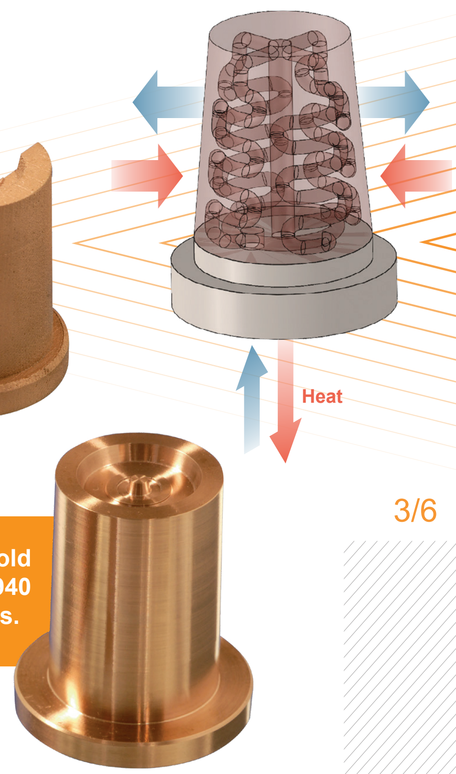
PBF-LB extends design freedom to internal mold features

Through several R&D projects, AMPCO® 18, AMPCOLOY® 972, 940, 89, and 83 have been qualified for PBF-LB processing. The work generated comparative data between additively and conventionally manufactured inserts.

This technology combines the high thermal conductivity of AMPCOLOY® alloys with conformal cooling channels positioned close to the part contour. In the powder-bed method, parts are built layer by layer using a laser.

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

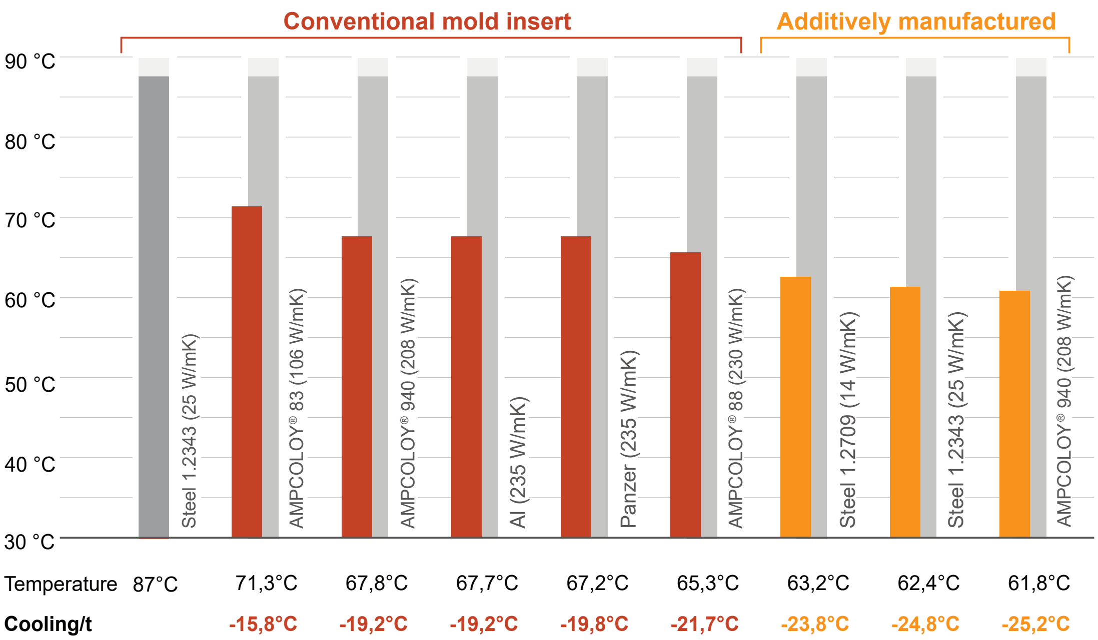
With optimized process parameters, densities above 99.5% have been achieved.



Longitudinal section of a mold insert made of AMPCOLOY® 940 and the runs of cooling channels.

Compared to conventionally produced molds

Comparative studies on the temperature of demolded parts were conducted at different cycle times. The cycle time was reduced from 27.2 to 10.8 seconds. The processed material was a polypropylene PP504P from Sabic. Replacing steel inserts with AMPCOLOY® alloy inserts can reduce cycle time by up to 30%. A further 10% reduction is achievable when comparing a conventional AMPCOLOY® 940 insert with one produced additively and integrated with conformal cooling channels.



Reduction of cycle time by

30%

when using mold inserts made of AMPCOLOY® compared to inserts made of steel

Reduction of cycle time by another

10%

when using additively manufactured mold inserts with integrated cooling channels

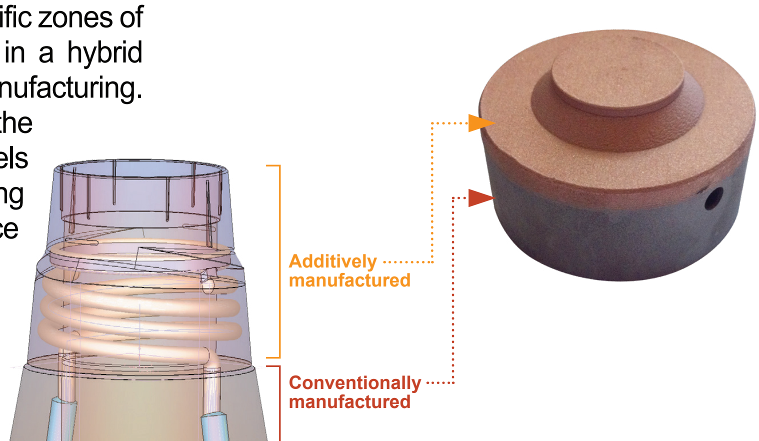
With appropriate post-processing (heat treatment), AMPCOLOY® 940, 972, 89, and 83 reach the properties given in their datasheets when produced additively. Wear behavior was also examined: a polyamide (PA6) with 50% glass fiber reinforcement was processed. Inserts were functionalized by etching, with rhomboid features created on the front and outer surfaces, then coated and measured using a contactless surface measurement device. The lowest wear was measured on inserts coated with electroless nickel (CNBV) from NovoPlan.

Production of inserts by PBF-LB — already economical?

Current build-rates for AMPCOLOY® 972 and 940 are approximately 8-10 cm³/hour.

Hybrid manufacturing of mold inserts with conformal cooling

Conformal cooling is often only required in specific zones of the mold. Inserts can therefore be produced in a hybrid way, combining conventional and additive manufacturing. This allows the use of a copper alloy in the cooling-critical zone alongside adapted steels elsewhere, reducing material and processing costs while maintaining thermal performance where it matters most.



AMPCOLOY® & LASER CLADDING TECHNOLOGY

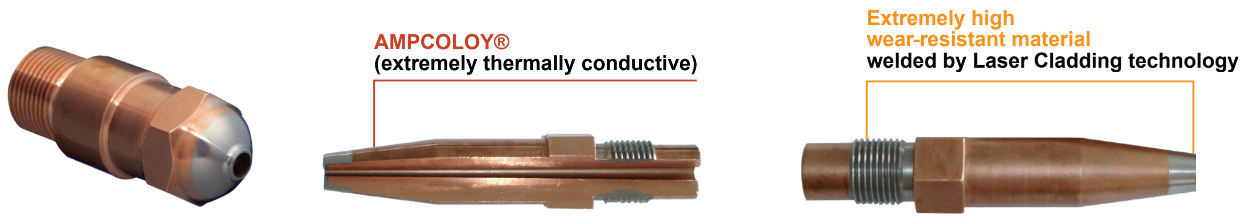
Combining AMPCOLOY® thermal conductivity with wear-resistant surfaces through Laser Cladding

Laser Cladding extends AMPCOLOY® alloys, with their high thermal conductivity, into wear-intensive applications.

AMPCOLOY® alloys are valued for their thermal conductivity, but many applications also require wear resistance, often only in localized zones. Combining both properties in a single component is the engineering challenge that Laser Cladding addresses.

AMPCO METAL has adapted Laser Cladding for use with AMPCOLOY® alloys. In the process, metal powder is fed through an inert gas stream and fused to the base material by laser, creating a metallurgical bond between the two.

A wide range of deposit materials can be used, including blends of copper alloys and hard particles, applied selectively to specific zones of a component. The machine nozzle and hot-runner nozzle shown alongside are examples of components produced using this approach.



Application of the Laser Cladding technology using the example of a nozzle made of highly thermal conductive AMPCOLOY® alloy.

Special alloys and key technologies in mold making

To meet the requirements of today's plastic injection molds, several aspects of their construction have to be considered. It is important to identify the demands placed on each mold component, the stresses acting on them, and the appropriate measures to address them.

Copper alloys improve part quality and shorten cycle times by extracting heat quickly from critical mold zones. Coatings or composite constructions can further balance conductivity, wear resistance, and surface performance.

Additive manufacturing technologies such as Laser Cladding and Powder Bed Fusion (PBF-LB) open new design and repair options for mold components, including localized hardfacing and conformal cooling channels that are difficult to achieve with conventional manufacturing.

The AMPCO METAL team supports your project from alloy selection and prototyping through to series production, and continues to develop alloys, powders, and process know-how as additive manufacturing evolves.

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AMPCO METAL – Copper alloys engineered for additive manufacturing.

INNOVATION IN EVERY LAYER

AMPCO METAL has produced copper-based alloys since 1914. That metallurgical experience now extends to additive manufacturing, where AMPCO® and AMPCOLOY® alloys combine validated mechanical performance with the design freedom of metal 3D printing.

AMPCO® ALLOYS IN ADDITIVE MANUFACTURING

AMPCO alloys develop a fine, uniform microstructure with good elongation and strength. Their heat-treatable properties allow mechanical performance equal to or greater than conventionally produced parts. The design freedom of additive manufacturing extends this further, enabling complex geometries, internal cooling channels, and monolithic components that reduce assembly steps and improve thermal performance.

MATERIAL PORTFOLIO

Our copper alloys are qualified for additive processes including PBF-LB, PBF-EB, Laser Cladding, Metal Injection Molding, and Cold Gas Spraying.

Available materials:

- **AMPCOLOY® 972**
- **AMPCOLOY® 940**
- **AMPCOLOY® 83**
- **AMPCOLOY® 89**
- **AMPCO® 18**

POWDERS FOR EVERY PROCESS

AMPCO METAL supplies powders engineered for consistent flowability, controlled particle size, and low oxygen content. These qualities ensure stable printing conditions, high density, and repeatable properties in every build.

FROM CONCEPT TO COMPONENT

Whether for tooling, heat exchangers, inductors, or complex thermal systems, AMPCO METAL combines alloy development, powder qualification, and process know-how to support customers from initial concept through to qualified production parts.

HEADQUARTERS

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