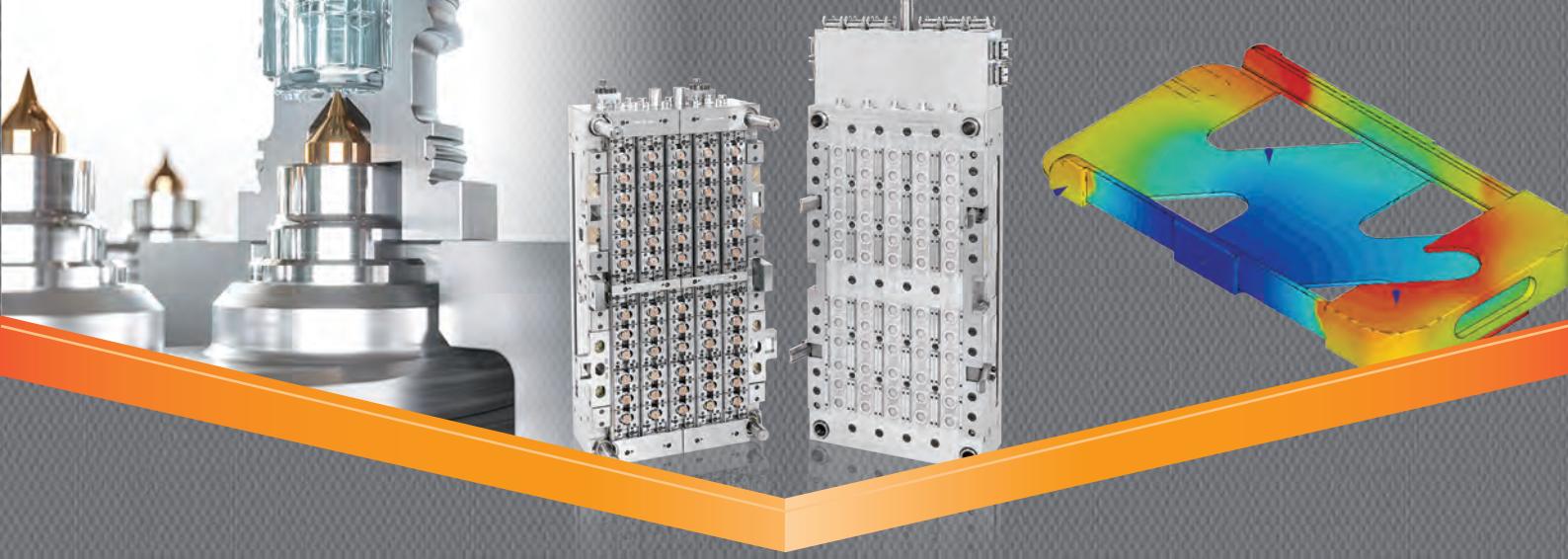


AMPCOLOY®

HIGH CONDUCTIVITY COPPER ALLOYS FOR

Plastic Injection
Plastic Extrusion
Blow Moulding
Thermo Forming

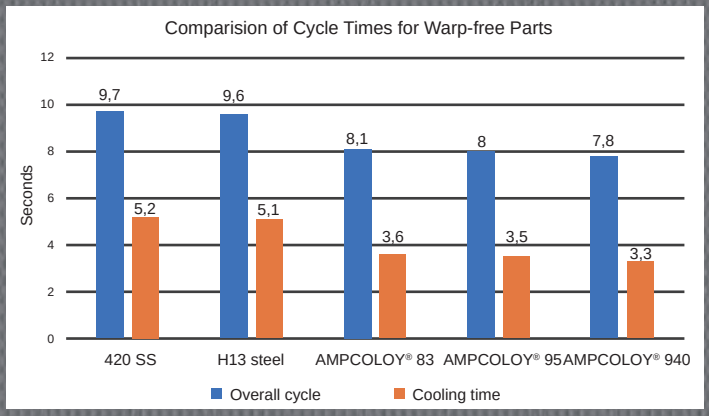
AMPCO®

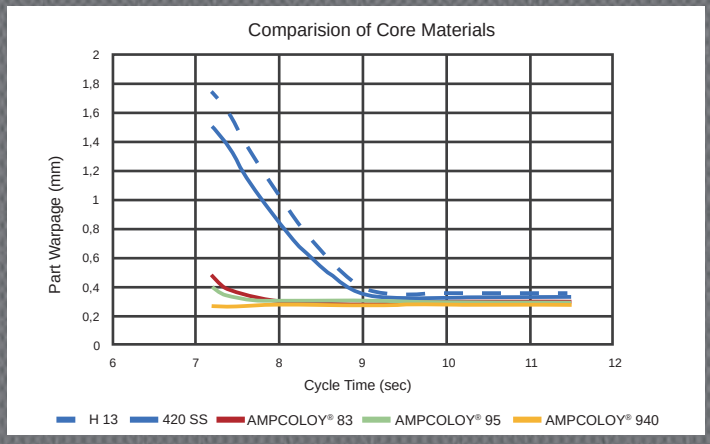
AMPCO METAL EXCELLENCE IN ENGINEERED ALLOYS

AMPCOLOY® alloys:

cycle reductions and quality improvements in plastic injection

AMPCO METAL is the global reference in metals solutions and for production and distribution of specialty copper based alloys.





AMPCO METAL products provides a wide choice of special high-quality, high conductivity alloys, which enhance the performance of plastic molding tools. We offer a comprehensive selection of alloys to optimize thermal conductivity, hardness, corrosion resistance and wear resistance:

AMPCOLOY® 83 in case of copper beryllium alloy, AMPCOLOY® 940 and AMPCOLOY® 944 for higher conductivity alternatives to beryllium copper alloys.

1. **Improved productivity**
Identical processing conditions were established, and each core material was tested with the only variable being cooling time.Graph illustrates the cycle advantages and the reduction in cooling times resulting for using AMPCO® alloys, when compared directly to the conventional mold steels.

2. **Better product quality**
The second graph compares part warpage, in millimeters, between the three AMPCO® alloys and two steel materials at various cycle times. The AMPCO® alloys remove heat so efficiently that the part' s warpage is minimal, even for shorter cycle times.

3. **Longer service life**
The excellent thermal conductivity and diffusivity of AMPCOLOY®alloys facilitate rapid temperature equalization. This minimizes thermal stresses and reduces the tendency for thermal cracking. This is a significant benefit of achieving a long service life. Another characteristic, outstanding corrosion resistance, also contributes to long service life by protecting against chemical attack like PVC or other chemical emitting resins.

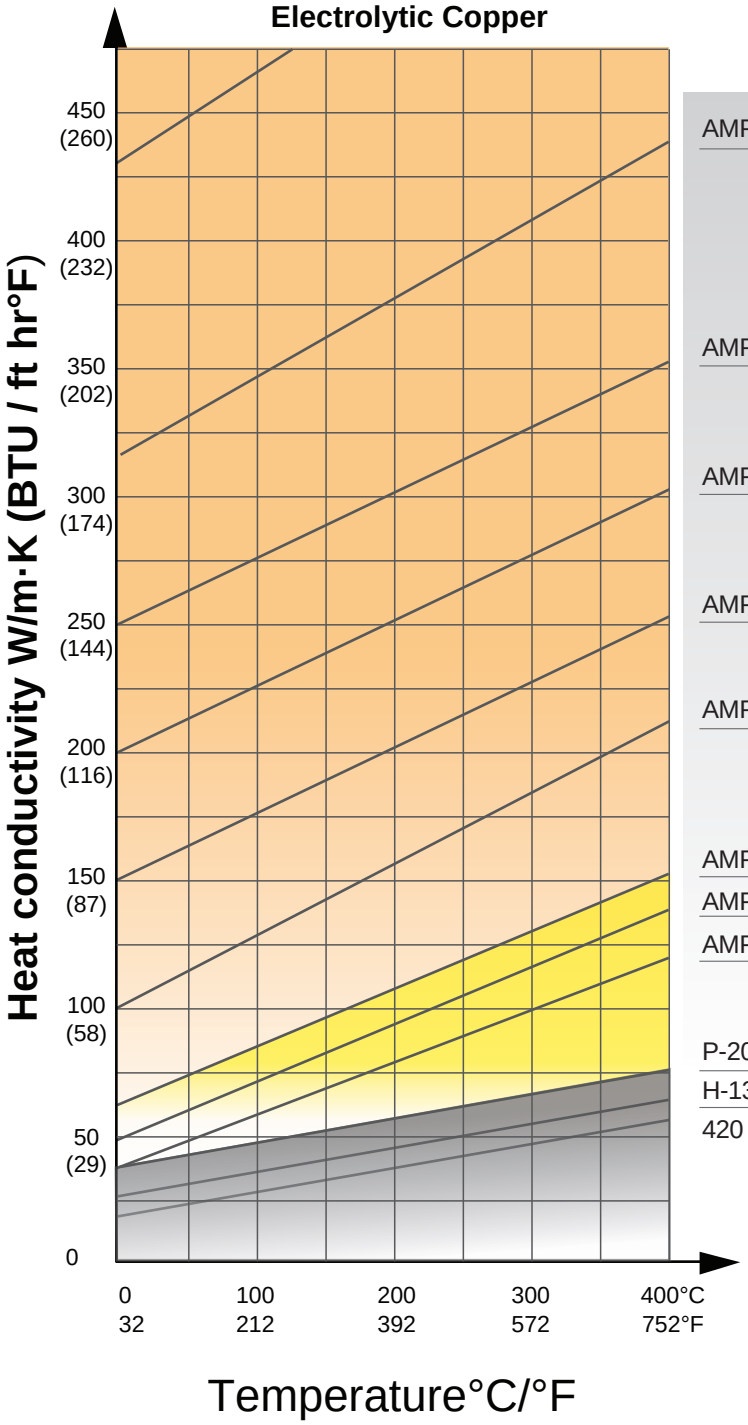
4. **Lower machining costs**
AMPCOLOY® alloys require no additional heat treatment. Distortion and finishing problems associated with this procedure are avoided. The design flexibility for cooling channels, contributes to a significant reduction in machining costs.

AMPCOLOY® alloys:

cycle reductions and quality improvements
in plastic injection

With AMPCOLOY® High Conductivity mold materials, as the mold maker, you will generate mold design savings with **reduced cooling channels** and **reduced cycle times**.

Heat conductivity and hardness

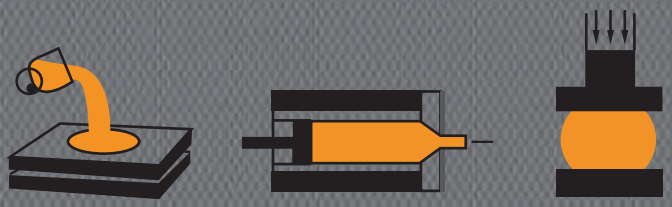


	Hardness	
	Brinell	Rockwell
AMPCOLOY® 972	152	82 B
AMPCOLOY® 95	240	21 C
AMPCOLOY® 940	210	95 B
AMPCOLOY® 944	294	31 C
AMPCOLOY® 83	380	40 C
AMPCO® 18	192	92 B
AMPCO® M4	285	30 C
AMPCO® 21	286	30 C
P-20	285	30 C
H-13	425	45 C
420	490	50 C

The thermal conductivity of **AMPCOLOY®** materials increases with the material working temperature!

AMPCOLOY® 940

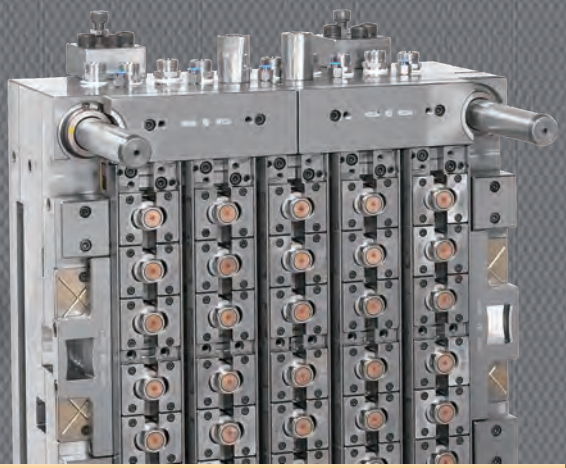
Beryllium Free



Chemical Composition	Mechanical Properties	Extruded	Forged
Cu: Balance Ni: 2,5% Si: 0,7% Cr: 0,4%	Tensile strength: MPa (ksi)	689 (100)	648 (94)
	Yield strength: MPa (ksi)	517 (75)	496 (72)
	Hardness: HBW	210	210
	Elongation: %	13	11
	Coefficient of expansion: 10^{-6}/K (in/°F)	17,5 (9,72x10^{-6})	17,5 (9,72x10^{-6})
	Modulus of Elasticity E: MPa (ksi)	131000 (19000)	131000 (19000)
	Thermal conductivity: W/m·K (BTU/ft hr°F)	20°C (68°F): 208 (0.497) 200°C (392°F): 243 (0.581)	20°C (68°F): 208 (0.497) 200°C (392°F): 243 (0.581)
	Electrical conductivity: %IACS	48	48
	Specific heat cp: J/g·K (Btu/LB·°F)	0,38 (0,091)	0,38 (0,091)
	Maximum working temperature	450°C (572°F)	450°C (572°F)

The above are nominal values. If specific minimum figures are required, please contact your local AMPCO METAL representative.

AMPCOLOY® 940 has a superb combination of high thermal and electrical conductivity, with high hardness and strength, good corrosion and abrasion resistance: Beryllium free. Mould parts for plastic injection moulding, injection-nozzles, cooling pins and hot runner systems.



AMPCOLOY® 940 standard sizes:

Ø 9,5	Ø 12	Ø 13	Ø 16	Ø 20	Ø 25	Ø 30	Ø 33	Ø 36	Ø 40
Ø 45	Ø 51	Ø 57	Ø 61	Ø 64	Ø 66	Ø 71	Ø 76	Ø 81	Ø 86
Ø 92	Ø 102	Ø 111	Ø 122	Ø 132	Ø 142	Ø 160	Ø 180	Ø 255	Ø 305

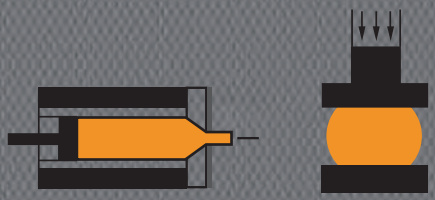
AMPCOLOY® 940 Plates with thickness from 10 mm to 304,8 mm.

AMPCOLOY® 940 welding wire:

To weld repair AMPCOLOY® 940: Use AMPCO-TRODE® 940 or AMPCO-TRODE® 940 laser
After repairing with AMPCO-TRODE® 940, the material becomes softer in the relevant area. This is why we recommend AMPCO-TRODE® 940 laser
To weld AMPCOLOY® 940: Use COPR-TRODE®
To weld AMPCOLOY® 940 and stainless steel: Use AMPCO-TRODE® 10

AMPCOLOY® 944

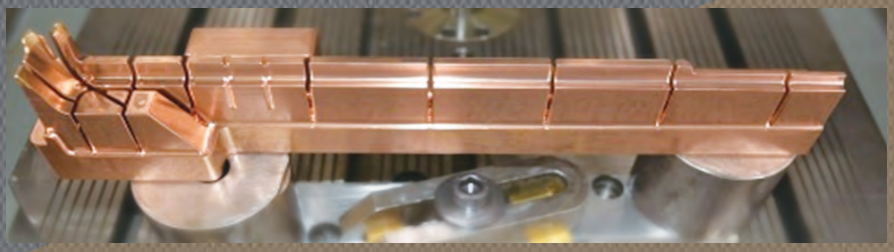
Beryllium Free



Chemical Composition	Mechanical Properties	Extruded	Forged
Cu: Balance Ni: 7% Si: 2% Cr: 1% Other: max. 0,5%	Tensile strength: MPa (ksi)	938 (136)	793 (115)
	Yield strength: MPa (ksi)	730 (106)	655 (95)
	Hardness: HBW	294	270
	Elongation: %	5	4
	Coefficient of expansion: 10-6/K (in/°F)	17,5 (9,72x10^{-6})	17,5 (9,72x10^{-6})
	Modulus of Elasticity E: MPa (ksi)	151000 (21900)	135000 (19600)
	Thermal conductivity: W/m·K (BTU/ft hr°F)	20°C (68°F): 156 (0.373) 200°C (392°F): 190 (0.454)	20°C (68°F): 156 (0.373) 200°C (392°F): 190 (0.454)
	Electrical conductivity: %IACS	30	35
	Specific heat cp: J/g·K (Btu/LB·°F)	0,38 (0,091)	0,38 (0,091)
	Maximum working temperature	400°C (752°F)	400°C (752°F)

The above are nominal values. If specific minimum figures are required, please contact your local AMPCO METAL representative.

AMPCOLOY® 944 has been developed by AMPCO METAL to obtain an alloy with ultimate thermal conductivity, good tensile strength and very good hardness, in order to provide an alternative to Beryllium copper, where stricter health and safety instructions on the use of noxious elements are required. Applications: Plastic injection mould tools and inserts, thermoforming, blow moulding.



AMPCOLOY® 944 standard sizes:

Ø 13	Ø 26,5	Ø 33	Ø 38,1	Ø 50.8	Ø 65	Ø 76.2

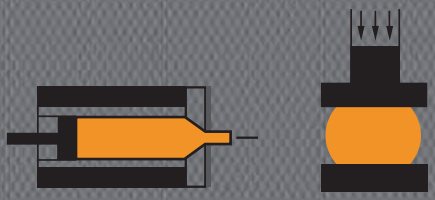
AMPCOLOY® 944 Plates with thickness from 10 mm to 203,2 mm.

AMPCOLOY® 944 welding wire:

For minor weld repair on AMPCOLOY® 944: Use AMPCO-TRODE® 940 or AMPCO-TRODE® 940 laser

To weld AMPCO-TRODE® 944 to Stainless steel (like Stavax): Use AMPCO-TRODE® 10 in TIG or MIG process

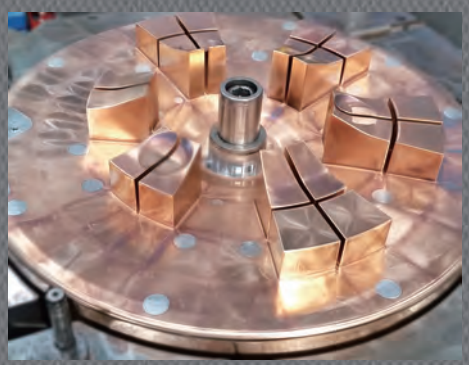
AMPCOLOY® 83

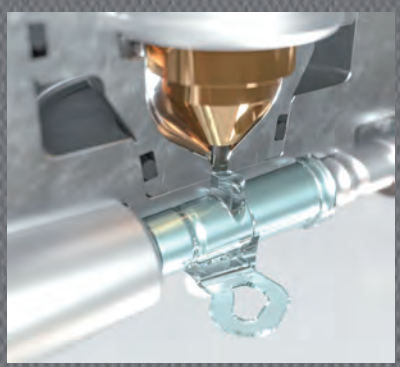


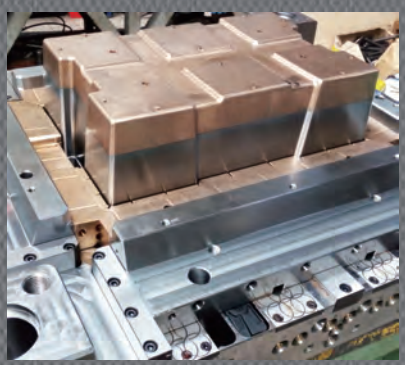
Chemical Composition	Mechanical Properties	Extruded	Forged
Cu: Balance Be: 1,9% Co+Ni: 0,5% Other: max. 0,5%	Tensile strength: MPa (ksi)	1250 (190)	1140 (165)
	Yield strength: MPa (ksi)	1000 (145)	1000 (145)
	Hardness: HBW	380	360
	Elongation: %	4	5
	Coefficient of expansion: 10-6/K (in/°F)	17,5 (9,72x10^{-6})	17,5 (9,72x10^{-6})
	Modulus of Elasticity E: MPa (ksi)	131000 (19000)	128000 (18560)
	Thermal conductivity: W/m·K (BTU/ft hr°F)	20°C (68°F): 106 (0.253) 200°C (392°F): 145 (0.347)	20°C (68°F): 106 (0.253) 200°C (392°F): 145 (0.347)
	Electrical conductivity: %IACS	22	22
	Specific heat cp: J/g·K (Btu/LB·°F)	0,38 (0,1)	0,38 (0,1)
	Maximum working temperature	300°C (572°F)	300°C (572°F)

The above are nominal values. If specific minimum figures are required, please contact your local AMPCO METAL representative.

AMPCOLOY® 83 is a 2% Beryllium copper alloy which displays exceptionally high hardness and strength, combined with good electrical and thermal conductivity. Applications: Injection mould tools and inserts. Cooling pins, hot runner system, injection nozzles, neck rings or bottom plates for blow moulds of plastic bottles.







AMPCOLOY® 83 standard sizes:

Ø 9,5	Ø 12,7	Ø 15,9	Ø 19	Ø 22.2	Ø 25.4	Ø 31.8	Ø 38.1
Ø 44,4	Ø 50,8	Ø 57,1	Ø 63,5	Ø 69,8	Ø 76,2	Ø 88,9	Ø 101,6
Ø 127	Ø 152,4	Ø 203,2	Ø 254	Ø 345,4			

AMPCOLOY® 83 Plates with thickness from 10 mm to 304,8 mm.

AMPCOLOY® 83 welding wire:

To repair AMPCOLOY® 83: Use COPR-TRODE® and AMPCO-TRODE® BeCu(but only on request)
To weld together CuBe alloys: Use COPR-TRODE®
To weld AMPCOLOY® 83 to steel: Use SIL-TRODE® or AMPCO-TRODE® 10
For minor defect repair of CuBe you can also use AMPCO-TRODE® 940
Please respect safety instructions for welding Be-containing alloys

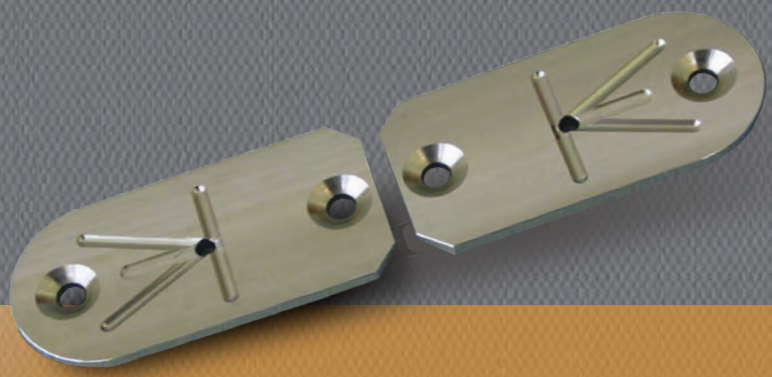
WEAR COMPONENTS

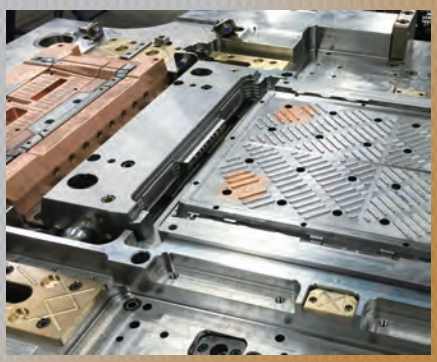
In plastic mould

AMPCO METAL offers an expanded assortment of wear plates, ejectors pins, bushings and other components to the plastic processing industry. Producing the best wear resistant and Nickel free materials, like AMPCO® 18 and AMPCO® 21, guarantees increased durability and lowered maintenance costs over the lifespan of the components. To save precious time and money. There is also a significant benefit in using AMPCO® alloys for the base material in making ejectors sleeves, reducing coefficients of friction with tool steel. Our alloys strategically eliminate all the heat treatments requirements (pre and post heat treatment machinng). They can run against steel without galling. Nitrides of any sort become unnecessary. Conductivity of these alloys has a level far superior of a tools steel like P20.

ALLOY	THERMAL CONDUCTIVITY W/mK (BTU/ft hr °F)	THERMAL DIFFUSIVITY MM^2/S (ft^2 hr)	HARDNESS BRINELL (ROCKWELL B/C)	TENSILE STRENGTH MPa (KSI)	YIELD STRENGTH MPa (KSI)	ELONGATION %	COEFFICIENT OF EXPANSION 10^{-6} 1/K (10^{-6} 1/°F)	COEFFICIENT OF FRICTION (DRY CONDITIONS)
AMPCO® 18	63 (37)	19.8 (0.77)	192 (92B)	724 (105)	358 (52)	14	16 (9)	0.18
AMPCO® 21	43 (25)	15.2 (0.59)	286 (30C)	758 (110)	414 (60)	1	16 (9)	0.21
AMPCO® M4	42 (24)	12.4 (0.48)	285 (30C)	960 (139)	725 (105)	8	16 (9)	0.23

The above are nominal values. If specific minimum figures are required, please contact your local AMPCO METAL representative.

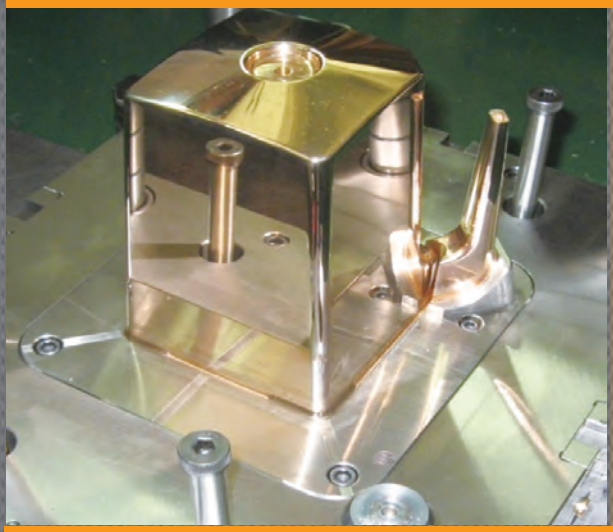




AMPCO® 18 and **AMPCO® M4** can be combined with graphite inserts, to avoid any kind of liquid lubrication.

POLISHING, TEXTURING, EDM'ing

POLISHING



To reach the best possible injected plastic part quality, the material needs to have a very good polishability. AMPCOLOY® 83 and AMPCOLOY® 944 have outstanding mirror polishability. We have made tests with a Swiss polishing company, POLISAR, on round material diameter 63,5mm both in **AMPCOLOY® 83** and **AMPCOLOY® 944**. **AMPCOLOY® 83** hardness 383 HB: Achived roughness overall: Ra= 0,011 µm **AMPCOLOY® 944** hardness 298 HB: Achived roughness in the center: Ra= 0,041 µm Achived roughness in the outside: Ra= 0,016 µm
These very low roughness values correspond to better than:
N1 surface finish for **AMPCOLOY® 83**
N1 to N2 surface finish for **AMPCOLOY® 944**.

TEXTURING

Often, the cavity temperatures in injection moulds have to be increased to be able to exactly replicate surface microstructures or fine-textured mould surfaces. It causes, obviously, long cooling time. Here our **AMPCOLOY®** alloys can also make the difference.

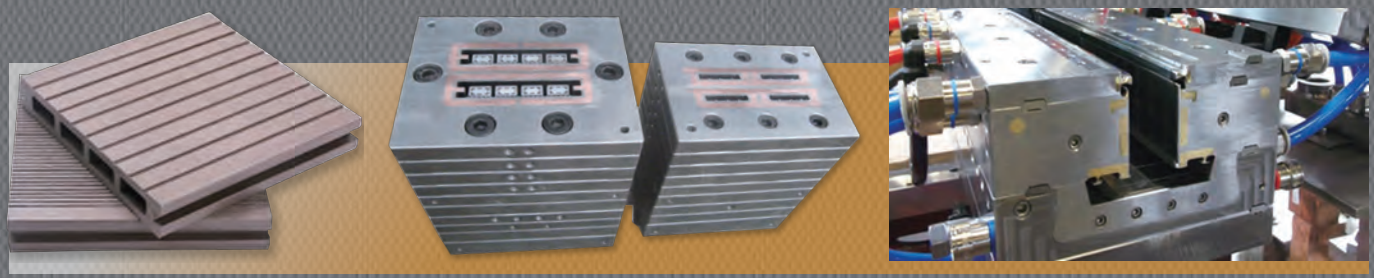
All AMPCOLOY® alloys accept any kind of etchings or texturings.

EDM 'ing

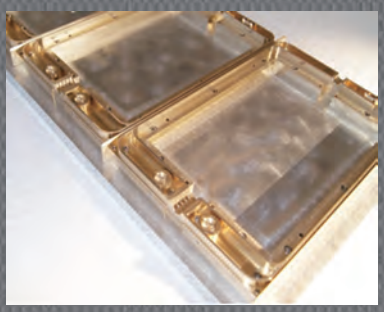
The bronze alloys like AMPCO® 18 ,AMPCO® 21, AMPCO® M4 can be easily electro-eroded with values for settings very comparable to the values needed for the EDM'ing of tool steel used in the mold industry. The group of high conductivity alloys like AMPCOLOY® 940, 944 and 83 can also be electro-eroded. High conductivity alloys are difficult to machine by sinker EDM, because the high conductivity characteristics defeats the EDM removal process. However, today, EDM tools with linear motion systems, improve drastically the removal rates and electrode wear rates of these alloys. On linear motor systems, the motor is the only moving part (Z axis). As the electrode is directly connected to the motor, the system operates at very high speeds without vibrations. The result is a better machining time and surface finish.

BLOW MOULDING, EXTRUSION, THERMO FORMING

In blow molds, **AMPCOLOY®** alloys show a lower wear and improved conductivity and corrosion resistance over aluminum. In pinch-offs and neck rings, these alloys are more conductive than steel, which means faster cycle times, less maintenance and improved part quality.

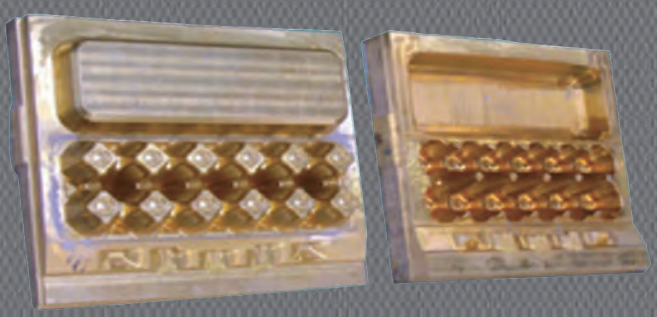


In plastic extrusion, the first extruder plastifies the base material, which is then pushed in a die in order to obtain the desired form. This is then calibrated and cooled down by calibrators. When elements are difficult to cool (long and thin profiles for example) **AMPCOLOY® 940, 944 or 83** are used for the first calibrator (with or without coating). They can produce 300'000 meters before having to change the tool. AMPCO® 18 can also be used, but not for white profiles (because of the iron in the alloy). Once the profile is hard, wear is more important, which is why the next dies are made of carbide.



In thermo forming process, during repetitive HF welding and cooling, the tools and surroundings become quite hot. Reason why cooling time may have to be increased to compensate. One solution is to use welding electrodes in **AMPCO®** bronze material.

Thermo forming blister packaging for bags of blood products.



Pulp moulding dies in bronze. (For fruits tray, eggs mold).

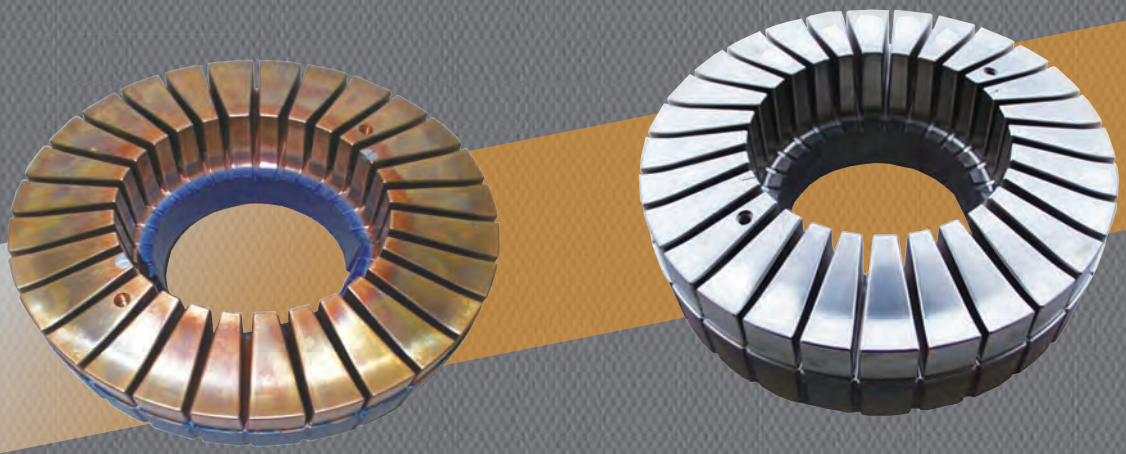
COATINGS and PLATINGS

Coatings and plating of various sorts have proven to be a cost-effective way to further enhance the already impressive performance of AMPCOLOY® alloys in mold applications. It is important to note that coatings and platings do not affect the heat removal characteristics of AMPCOLOY® alloys.

Wear resistance - It is normally related to hardness and coefficient of friction. To increase wear resistance, the AMPCOLOY® alloys can be very easily coated with electroless nickel, hard chrome or PVD (Physical vapor deposition) coatings.

Corrosion resistance - While AMPCOLOY® alloys resist a variety of corrosive environments, the coating will enhance the overall corrosion resistance of the mold. Corrosion also concern the whole mould during the storage (moisture) or even on the vents during gasses compression. We speak about dieseling effect.

Demolding - Related also to the coefficent of friction. Important in case of small or even negative draft angles.
For easier plastic part removal when demolding, electroless nickel can be combined with Teflon (PTFE) or boron nitride.



Example of Electroless nickel coating (25 microns) on AMPCOLOY® 940 alloy. Uniformity coating in the ribs! Material to inject: PP with 25% fiber glass.

ELECTROPLATING: Application of a current between the anode (metal to be deposited) and the cathode (piece to be coated). Thickness depends of the density of the current, it does mean thicker deposits on edges.

PVD: Physical vapor deposition is applied in a vacuum chamber by vaporizing the coating material. The introduction of reactive gas gives a uniform coating even in complex shaped part.

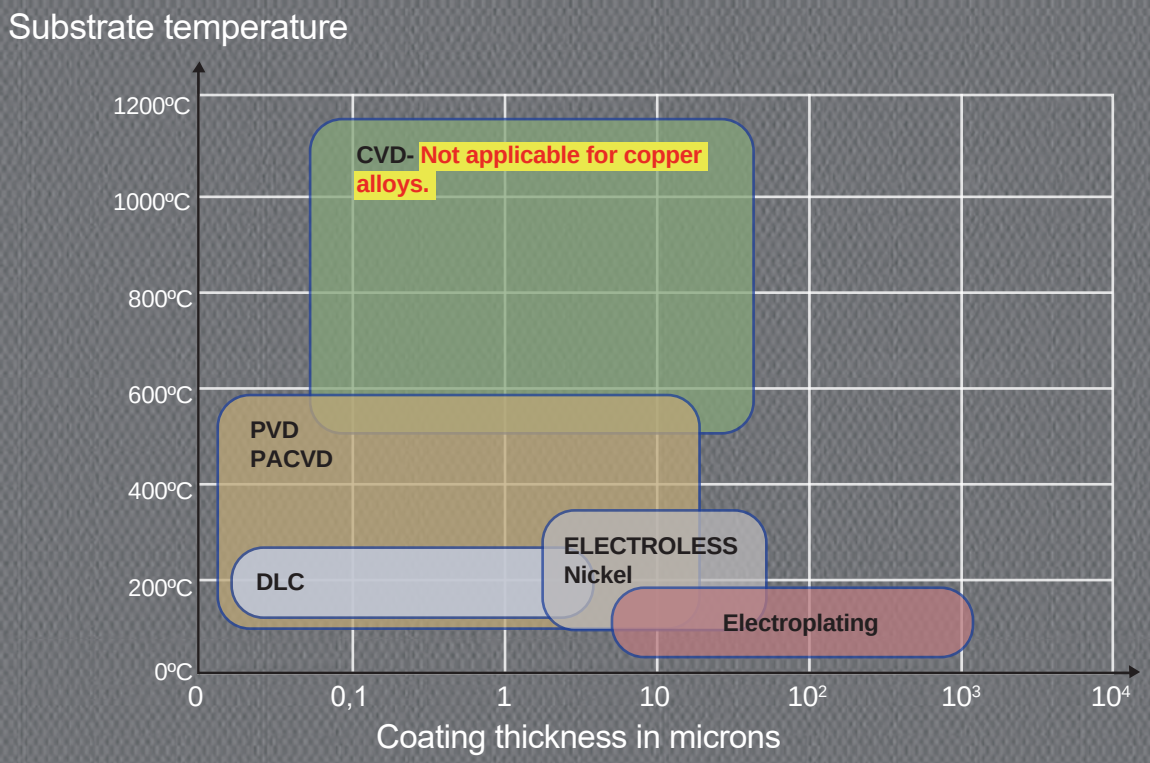
DLC: Diamond Like Carbon. Coating comprised of small particules of carbon. Coating is made generally with PVD process. (PACVD as well) Very high hardness > 90HRC.

PACVD, PECVD: Plasma activated process. A plasma supports the precipitation of layers from the gas phase. Need a much lower temperature than CVD process.

CVD: Chemical vapor deposition. The film material is formed by chemical reactions which take place in the gas phase as well as on the substrate surface. To make surface reactions possible, increased substrate temperatures are required. These may be as high as 1000 °C. Due to the high temperature, it is not a real option for our alloys.

ELECTROLESS NICKEL COATING: Film is applied without current. The ability of this coating to flow into complex shapes is a great advantage over electroplating. The hardness range is controlled by the additives in the plating bath and possible heat treatment after plating.

COATINGS and PLATINGS



Interests of the coatings

From moulder's side:

An asset to increase tool life and meet specifications in terms of number of injections or cycle time

From end user side:

Increased productivity and quality

Less machine downtime

Shorter cycle time

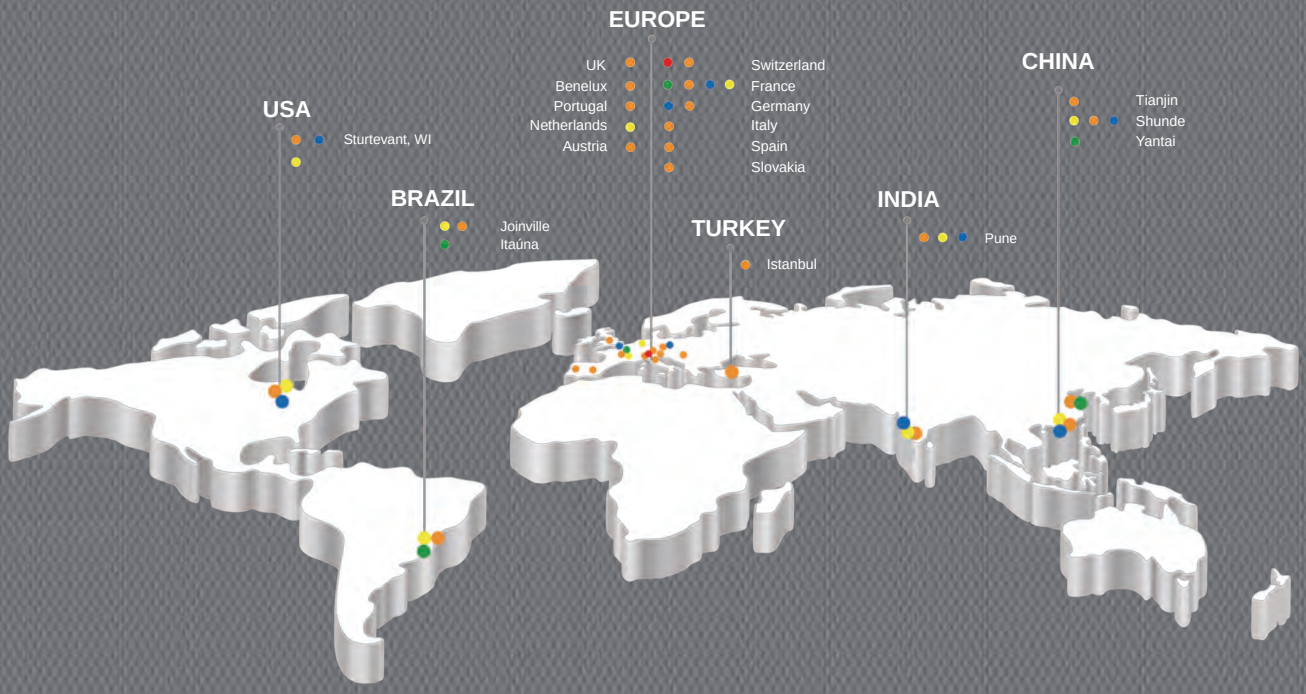
Less waste and better quality of the injected products

From maintenance side:

Possibility to reduce or even eliminate the lubrication of certain elements

Reduced, spaced out and safe cleaning intervention

Δ One overlooked aspect of mold coating is the removal and reapplication. Even super hard coatings can wear, especially because these layers tend to be very thin. In this case, it's important to remove the current coating without damaging the surface of the base material.



AMPCO METAL is proud to participate into saving natural resources by using mostly recycled metal!

EUROPE(Headquarters)
AMPCO METAL S.A.
Route de Chésalles 48
P.O.Box 45,1723 Marly
SWITZERLAND
TOLL FREE PHONE: 800 8080 5050
Tel.: + 41 26 439 93 00
Fax: + 41 26 439 93 01
info@ampcometal.com

BRASIL
AMPCO METAL Brasil Ltda.
Rua Dona Francisca 8400 - galpão 2
Zona Industrial Norte
Joinville, SC - 89219 - 600
Tel.: + 55 47 3305 0020
Fax: + 55 47 3305 0021
infobrasil@ampcometal.com

CHINA
AMPCO METAL (Foshan) Co., Ltd
Warehouse 9-1 No 9 Xinyue road
Jinqiao Industrial city, Wusha
Daliang town, Shunde, Foshan
Guangdong Province, P.R.China.
P.C.528333
TOLL FREE PHONE: 4008 899 028
Tel.: + 86 (0) 757 2232 6571
Fax: + 86 (0) 757 2232 6570
infochina@ampcometal.com

INDIA
AMPCO METAL INDIA PVT. LTD.
A-8/4, Village - Nighoje,
Chakan MIDC, Phase IV, Tal : Khed
Pune – 410501, Maharashtra - INDIA
Tel. +91 2135 610 810
Fax. +91 2135 610 811
Infoindia@ampcometal.com

U.S.A
AMPCO METAL Inc.
1221 Grandview Pkwy
Sturtevant, WI 53177
Tel.: +1 800 844 6008
Fax: +1 847 437 6008
infousa@ampcometal.com

www.ampcometal.com