

ARCAP[®]

ANTICORROSION

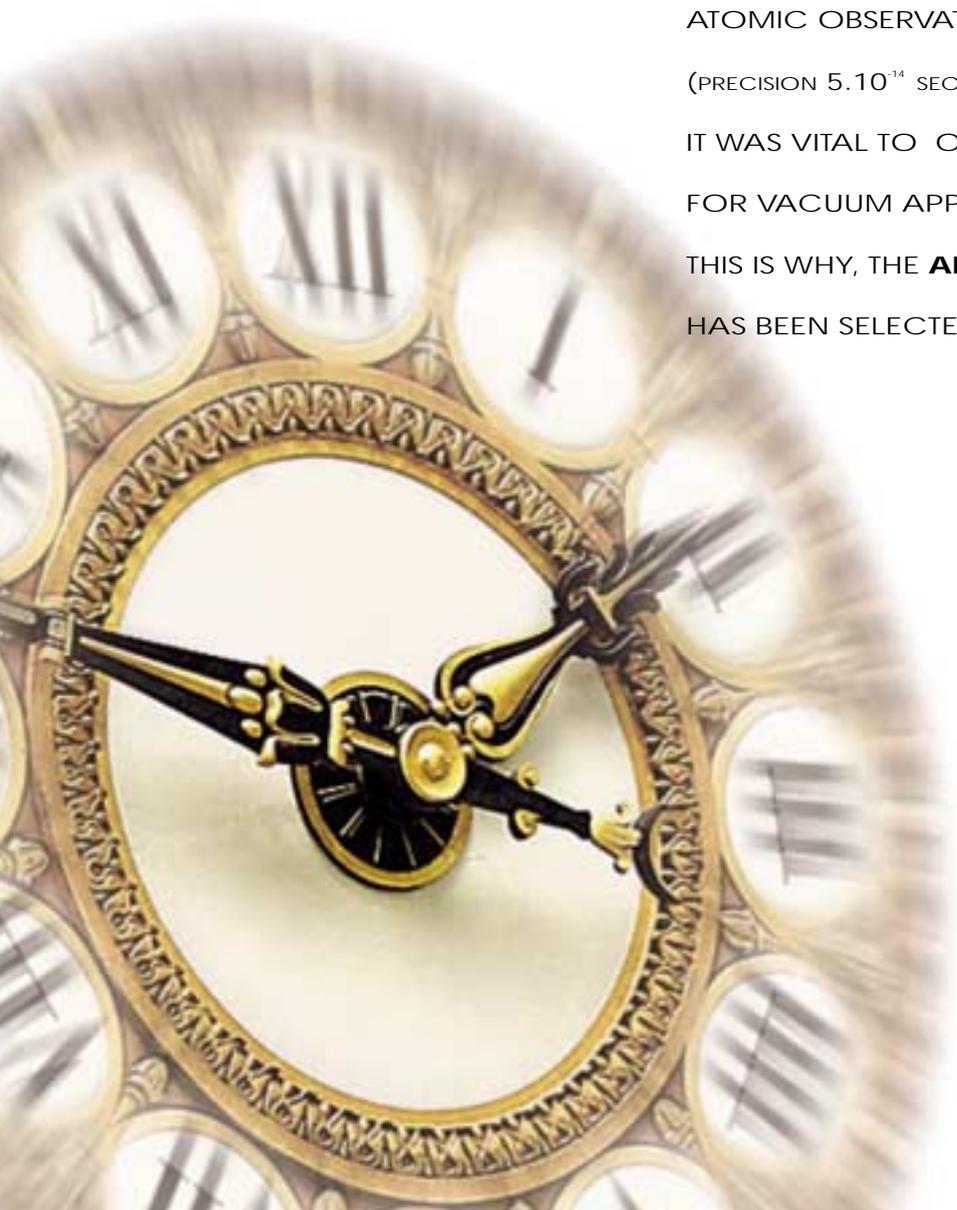




Piece
(230mm x 250mm)
made from
ARCAP AP4
hot forged rod

THE STRUCTURE OF TIME...

IN ORDER TO MAKE THE BODY OF THE PARIS
ATOMIC OBSERVATORY CLOCK,
(PRECISION $5 \cdot 10^{-14}$ SECOND A 10^{-10} TORR),
IT WAS VITAL TO OBTAIN IT FROM A MATERIAL SUITABLE,
FOR VACUUM APPLICATION, AND **COMPLEX TURNINGS**.
THIS IS WHY, THE **AP4 CORROSION** RESISTANCE GRADE
HAS BEEN SELECTED.



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Alloys with high performance

HIGH CORROSION RESISTANCE

ARCAP alloys are very corrosion resistant to the majority of chemical and physical environments.

CLAL can provide data for the corrosion resistance of **ARCAP** alloys.

In particular **ARCAP** alloys have a very high resistance to scaling and clogging of pipes by hard water and the blocking of pipes used for transport powder products such as sodium aluminate, cement, etc.

HIGH MECHANICAL PROPERTIES

In annealed temper **ARCAP** alloys have an elongation up to 45 %, which allows deep drawing.

In spring temper the ultimate tensile strength is above 800 MPa.

NON-MAGNETIC

A detector sensitive to 1/10 of nanotesla, placed at less than 1 mm from **ARCAP** alloys will not show any magnetic interference.

This non magnetism is kept even at very low temperatures (measured at 4.2° k).

STABLE RESISTIVITY

Temperature variations have almost no effect on the resistivity of **ARCAP** alloys.

The temperature coefficient of the grade **AP4** is $4 \times 10^{-5}/^{\circ}\text{C}$ and $25 \times 10^{-5}/^{\circ}\text{C}$ for the other grades.

EXCELLENT BEHAVIOUR AT LOW TEMPERATURE

At low temperatures the mechanical properties of **ARCAP** alloys are improved.

A cryogenic application shows that the ultimate tensile strength and the yield strength increase without any diminution of the elongation or the impact strength.

VERY EASY TO PROCESS

ARCAP alloys are easily processed whether by forging, stamping, deep drawing, machining, welding or brazing.

They are also easily plated.

For free cutting, milling, drilling, deep, drawing

GRADES

AP1D Turned parts

The **AP1D** grade has been developed especially for being machined by lathe.

Its machineability is one of the best of all of the corrosion resistant alloys.

The very good machineability of the **AP1D** grade may be summarised by :

- cutting speed up to **150 m/minute** (according to the type of part, cutting tool and lathe),
- very good quality of surface that can be lapped or polished with a diamond tool, burr free after drilling,
- reduction in frequency of tool sharpening.

AP1C - AP1 Good formability

The **AP1C** grade (used in rods for parts that are to be deformed by torsion, bending, riveting, swaging... and for welding) and the **AP1** grade (sheet, strip, wire, tubes) is

machineable under the same conditions as carbon steel, in other words without difficulty.

AP1M Cast parts

This grade has the same machineability as the **AP1D** grade.

AP4 - AP4M Very good corrosion resistance

The **AP4** grade is less easy to turn than the other grades of **ARCAP**. It can however be

machined without more difficulty than the nickel chromium molybdenum steels.

Mechanical properties

Rolled products

Measurement made in the rolling direction (thicknesses from 0.25 to 1 mm)

GRADES	Standards tempers	AFNOR symbols NFA 02-008	Vickers hardness HV	Ultimate tensile strength MPa	0.2% yield strength MPa	Elongation E % (L ₀ =50 mm)
AP1	annealed	0	≤ 120	≤ 400	≤ 300	≥ 30
	1/4 hard	H11	120-150	370-470	> 300	≥ 20
	1/2 hard	H12	150-170	450-550	> 370	≥ 10
	3/4 hard	H13	165-185	520-600	> 470	≥ 3
	4/4 hard	H14	180-210	≥ 580	≥ 530	≈ 1
AP1C	annealed	0	≤ 130	≤ 450	≤ 300	≥ 30
	1/4 hard	H11	130-165	450-550	> 300	≥ 15
	1/2 hard	H12	160-190	520-620	> 400	≥ 5
	4/4 hard	H14	190-220	620-730	> 550	≥ 1
	spring	H15	≥ 220	≥ 730	≥ 700	
AP4	annealed	0	≤ 140	≤ 520	≤ 300	≥ 30
	1/4 hard	H11	140-180	500-600	> 300	≥ 15
	1/2 hard	H12	175-205	550-650	> 450	≥ 8
	spring	H15	≥ 225	≥ 720	≤ 670	

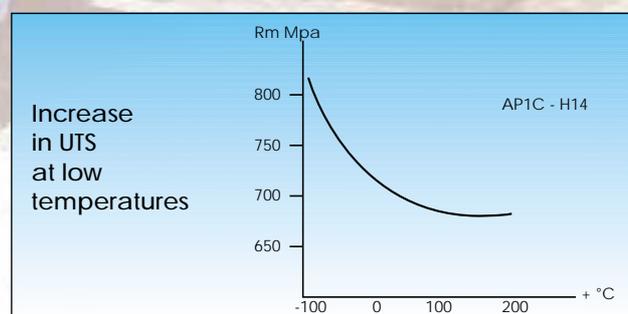
Typical values for references only.

Drawn products

GRADES	Standard tempers		Diameters		Ultimate tensile strength MPa		Elongation E % (L ₀ = 100 mm)
			Fils min 0,2 maxi :	Barres mini 1,5 maxi :	Wire	Rod	
AP1	annealed	0	10	12*	≤ 420	≤ 400	≥ 30
	1/4 hard	H11	10	"	420-480	400-450	≥ 10
	1/2 hard	H12	10	"	480-550	450-500	≥ 5
	3/4 hard	H13	10	"	550-610	500-550	≥ 2
	4/4 hard	H14	9	"	590-650	550-600	≥ 1
	spring	H15	6	"	≥ 650	≥ 600	
AP1C	annealed	0	10	"	≤ 550	≤ 450	≥ 30
	1/4 hard	H11	10	"	550-650	450-500	≥ 5
	1/2 hard	H12	10	"	650-750	500-550	≥ 2
	3/4 hard	H13	10	"	700-800	550-600	≥ 1
	4/4 hard	H14	9	"	800-820	550-700	
	spring	H15		"	≥ 820	≥ 700	
AP4	annealed	0	10	"	≤ 550	≤ 500	≥ 30
	1/4 hard	H11	10	"	550-650	500-550	≥ 10
	1/2 hard	H12	10	"	650-750	550-600	≥ 5
	3/4 hard	H13	10	"		600-650	≥ 2
	4/4 hard	H14	9	"	750-850	650-800	≥ 1
	spring	H15	6	"	≥ 800	≥ 800	
AP1D Wire and rod				Ø < 2,5	550-650		≥ 2
				2,5 ≤ Ø < 5	600-750		≥ 2
				5 ≤ Ø ≤ 11*	550-650		≥ 2

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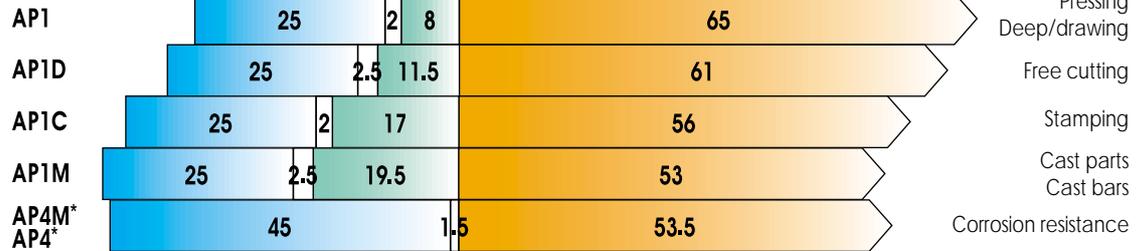
* Rod
 Ø > 12 mm, characterisation by hardness only.
 12 < Ø ≤ 35 mm, minimum hardness for H14 temper : HV 160.
 Ø > 35 mm : please ask our technical department.



CLAL-MSX offers 6 grades of ARCAP® material with specific characteristics for all industrial applications

**NOMINAL
CHEMICAL
COMPOSITION**
(% per weight)

GRADES



Color graphs █ Nickel █ Remainder █ Zinc █ Copper

* Please indicate if required for electronic application.

**PHYSICAL
PROPERTIES**

AP1-AP1C-AP1D-AP1M
AP4-AP4M

Color	Density (g/cm ³)	Melting point (°C)	Modulus of Elasticity Gpa	Coefficient of linear expansion X 10 ⁻⁶ /°C		Optical reflection index (Ag = 100%)	Thermal conductivity W/(m°C)		Resistivity μΩ · cm	Temperature Coefficient K-1	Electrical conductivity % IACS	Non Magnetism (OERSTED **)
white bluish	8.80	1150-1170	163 to 170	16	17	70 %	22	25	35 to 40	0.00025	4.3 to 4.9	10 ⁻⁶
white	8.91	1225-1285	145	16	17	70 %	22.5	23	49	0.00004	3.5	10 ⁻⁶

Typical values for reference only.

** The non magnetism measurements of ARCAP have been carried out by the Paris Physical Institute of the Globe.

**PRODUCT
FORM**



Rod, wire, coil, tube, profiles...

... available from stock.



Cast parts
and cast bars
on request

- HYDROCHLORYDE ACID
- EXTREMELY PERFORMANT RESISTANCE TO CORROSION.
- WASHING POWDERS
- PHOSPHORUS TRICHLORYDE
- CHLORIDES
- ALUMINUM CHLORIDE
- ALUMINUM ALLOYS
- GAZ OF LACQ

Corrosion tables
available on request

Machining conditions for rods

The table below gives the main machining parameters for grades AP1D, AP1C and AP1. They should be considered as bases and

can be modified by the users according to the parts they produce.

TURNING	Cutting speed m/minute		Feed mm/rev	
	HSS tool	carbide tool	HSS tool	carbide tool
AP1D	125	150/170	0,04	0,06
AP1C - AP1	65	80	0,04	0,06

DRILLING	HSS drill	carbide drill with drill bush	HSS drill	
			Ø 1,5 to 12	carbide drill with drill bush Ø 6 to 12
AP1D	120	150	0,012 to 0,080	0,025 to 0,120
AP1C - AP1	60	80	0,012 to 0,080	0,025 to 0,120

Recommended tip angle : 160 to 164°.

CUTTING ANGLE	AP1D and AP1C 7 to 8°.	
TOOL SHARPENING	Compared with stainless steel the frequency of tool sharpening can be divided by 12	for the AP1C and AP1 grade and by 45 for the AP1D grade.
CUTTING OIL	AP1D : all good quality soluble oils.	AP1C : preferably cutting oil for special alloys.

Processing

SHEET METAL WORK, SPINNING, SWAGING	AP1, AP1C, AP4 , in annealed temper have similar formability as brasses and mild steel AP1 and AP1C can only be cold worked.	AP4 can be hot worked. AP1D is suitable for some cold-working operations.
ANNEALING	In neutral or reducing atmosphere, temperature about 750° C, duration 15 minutes to 1 hour according to the quantity.	
STRESS RELIEVED HEAT TREATMENT	Cold rolled, drawn or stamped parts may be stress relieved at 250°C, preferably in neutral or reducing atmosphere.	
PICKLING	After annealing in air, remove the scale in a bath of 10% of sulphuric acid and 2 to 3% of nitric acid, then pickle in a bath with 80%	water, 9% sulphuric acid and 11% sodium bichromate, preferably at 50 to 60°C.
WELDING AND BRAZING Grade AP1 - AP1C AP4 - AP4M	Brazing, soldering, resistance welding, TIG welding can be carried out without difficulty.	
Grade AP4 - AP4M	The less conventional welding methods such as plasma, micro plasma, electron beam	welding, capacitor discharge, high frequency, laser... give very good results.
Grade AP1D - AP1M	These grades are sensitive to high temperature. Therefore soldering is the only process that we recommend.	



Coaxial plug for telephone industry in AP1C



Parts for armament in AP1D



Parts for clocks