Ualloy-4J29 (Expansion alloy)

Common Name: Kovar, Nilo K, KV-1, Dilver Po, Vacon 12

Ualloy-4J29 also known as Kovar alloy. it was invented to meet the need for a reliable glass-to-metal seal, which is required in electronic devices such as light bulbs, vacuum tubes, cathode ray tubes, and in vacuum systems in chemistry and other scientific research. Most metals cannot seal to glass because their coefficient of thermal expansion is not the same as glass, so as the joint cools after fabrication the stresses due to the differential expansion rates of the glass and metal cause the joint to crack.

Kovar is a nickel–cobalt ferrous alloy compositionally identical to Fernico, designed to be compatible with the thermal expansion characteristics of borosilicate glass (~5 × 10^{-6} /K between 30 and 200 °C, to ~10 × 10^{-6} /K at 800 °C) in order to allow direct mechanical connections over a range of temperatures. It finds application in electroplated conductors entering glass envelopes of electronic parts such as vacuum tubes (valves), X-ray and microwave tubes and some lightbulbs.
The name Kovar is often used as a general term for Fe–Ni alloys with these particular thermal expansion properties. Note the related particular Fe–Ni alloy Invar which exhibits minimum thermal expansion.

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Ualloy-4J29 not only has thermal expansion similar to glass, but its nonlinear thermal expansion curve can often be made to match a glass, thus allowing the joint to tolerate a wide temperature range. Chemically, it bonds to glass via the intermediate oxide layer of nickel oxide and cobalt oxide; the proportion of iron oxide is low due to its reduction with cobalt. The bond strength is highly dependent on the oxide layer thickness and character. The presence of cobalt makes the oxide layer easier to melt and dissolve in the molten glass. A grey, grey-blue or grey-brown color indicates a good seal. A metallic color indicates lack of oxide, while black color indicates overly oxidized metal, in both cases leading to a weak joint.

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Information presentation property of Ualloy

Mainly used in electric vacuum components and emission control, shock tube, igniting tube, glass magnetron, transistors, seal plug, relay, integrated circuits lead, chassis, brackets and other housing sealing.

Normal composition%

Ni	28.5~29.5	Fe	Bal.	Co	16.8~17.8	Si	≤0.3
Mo	≤0.2	Cu	≤0.2	Cr	≤0.2	Mn	≤0.5
C	≤0.03	P	≤0.02	S	≤0.02		

Tensile Strength, MPa

Code of condition	Condition	Wire	Strip
R	Soft	≤585	≤570
1/4I	1/4 Hard	585~725	520~630
1/2I	1/2 Hard	655~795	590~700
3/4I	3/4 Hard	725~860	600~770
I	Hard	≥850	≥700

Typical Physical properties

Density (g/cm^3)	8.2
Electrical resistivity at 20℃(Ωmm^2/m)	0.48
Coefficient of linear expansion（20℃~200℃）X10^{-6}/℃	3.7~3.9
Curie point T_c/ ℃	430
Elastic Modulus, E/ Gpa	138

Coefficient of expansion

θ/℃	$\alpha_1/10^{-6}$℃$^{-1}$	θ/℃	$\alpha_1/10^{-6}$℃$^{-1}$
20~60	7.8	20~500	6.2
20~100	6.4	20~550	7.1
20~200	5.9	20~600	7.8
20~300	5.3	20~700	9.2
20~400	5.1	20~800	10.2
20~450	5.3	20~900	11.4

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Thermal conductivity

θ/℃	100	200	300	400	500
λ/ W/(m*℃)	20.6	21.5	22.7	23.7	25.4

The heat treatment process	
Annealing for stress relief	Heated to 470~540℃ and hold 1~2 h. Cold down
Annealing	In vacuum heated to 750~900℃
Holding time/h	14 min~1h.
Cooling rate	No more than 10 ℃/min cooled to 200 ℃

Style of supply

Alloys Name	Type	Dimension	
Ualloy-4J29	Wire	D= 0.1~8mm	
Ualloy-4J29	Strip	W= 5~250mm	T= 0.1mm
Ualloy-4J29	Foil	W= 10~100mm	T= 0.01~0.1
Ualloy-4J29	Bar	Dia= 8~100mm	L= 50~1000

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