# A-286 (UNS K66286, S66286) HIGH PERFORMANCE ALLOY

Electralloy's A-286 is a precipitation hardening iron base alloy containing nickel, titanium, and molybdenum as major alloying elements. It is a popular high temperature metal for jet engine and gas turbine applications with moderately high strength up to 1300°F and oxidation resistance to 1500°F.

## CHEMICAL COMPOSITION (Nominal Analysis, weight percent)

| | | | |
|---|---|---|---|
| **Carbon** *(max)* | **0.08** | **Aluminum** *(max)* | **0.35** |
| **Manganese** *(max)* | **0.35** | **Titanium** | **1.90 / 2.35** |
| **Silicon** *(max)* | **0.30** | **Vanadium** | **0.10 / 0.50** |
| **Chromium** | **13.50 / 16.00** | **Boron** | **0.003 / 0.010** |
| **Molybdenum** | **1.00 / 1.50** | **Iron** | **Balance** |
| **Nickel** | **24.00 / 27.00** | | |

## TYPICAL APPLICATIONS

Typical applications include gas turbine disks, blades, shafts, etc. **A-286** is attractive for elevated temperature fastener and spring applications. This alloy has also shown satisfactory cryogenic service to -423°F. High strength, non-magnetic applications are common because it remains essentially non-magnetic even after severe cold work.

Electralloy's **A-286** can be supplied to meet all the requirements of the following specifications, and more…

**AMS 5731, 5732, 5734, 5737, 5895**
**ASTM A638, A453**
**NACE MR0175**

Electralloy's **A-286** is available in a wide variety of sizes and forms, including ingot, billet, bar, and coil rod.

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## PHYSICAL PROPERTIES

| | |
|---|---|
| **Melting Range:** | 2500°F to 2600°F (1290°C to 1350°C) |
| **Density:** | 0.286 lb./in$^3$ (7.91 gm/cm$^3$) |
| **Magnetic Permeability:** | (H=200 Oersteds) |
| Solution treated | 1.006 |
| Cold worked and aged | 1.015 |
| **Specific Heat:** | (70 to 1300°F) 0.11 Btu/lb./°F |

**Coefficient of Thermal Expansion**

| Temperature °F | Temperature °C | In./in./°F |
|---|---|---|
| 70 to 212 | 21 to 100 | 9.37 x 10$^6$ |
| 70 to 1200 | 21 to 650 | 9.67 x 10$^6$ |

**Thermal Conductivity**

| Temperature | | |
|---|---|---|
| °F | °C | Btu/ft$^2$/ft./hr./°F |
| 70 | 21 | 88 |
| 120 | 650 | 172 |

**Modulus of Elasticity :**

| Temperature | | Tension | | Shear | | Poisson's Ratio |
|---|---|---|---|---|---|---|
| °F | °C | 10$^3$ksi | MPa | 10$^3$ksi | MPa | |
| 75 | 24 | 28.8 | 198 | 11.0 | 76 | 0.30 |
| 1300 | 704 | 21.1 | 146 | 7.9 | 55 | 0.33 |

## MINIMUM MECHANICAL PROPERTIES

**Tensile Data:** *1800°F solution anneal & aged*

| Test Temp. | | UTS | | YS | | El | RA |
|---|---|---|---|---|---|---|---|
| °F | °C | ksi | MPa | ksi | MPa | % | % |
| 70 | 21 | 130 | 896 | 85 | 586 | 15 | 20 |

**Typical Hardness:** 248 to 341 BHN

**Tensile Data:** *1650°F solution anneal & aged*

| Test Temp. | | UTS | | YS | | El | RA |
|---|---|---|---|---|---|---|---|
| °F | °C | ksi | MPa | ksi | MPa | % | % |
| 70 | 21 | 140 | 965 | 90 | 655 | 12 | 15 |

**Typical Hardness:** 277 to 363 BHN

**Stress Rupture:** *1800°F solution anneal & aged*

| Test Temp. | | Axial Stress | | Time | El |
|---|---|---|---|---|---|
| °F | °C | ksi | MPa | Hrs. | % |
| 1200 | 650 | 70 | 483 | 23 | 38 |



## HEAT TREATMENT

A-286 heat treatment consists of two parts; solution treating at 1800°F or 1650°F (985°C or 900°C) followed by aging at typically 1325°F (720°C). Higher solution temperature provides optimum stress rupture properties and the lower solution temperature gives increased room temperature tensile strength and higher stress rupture ductility.

## HOT WORKING

Recommended hot working temperature range for this alloy is 2100°F down to 1700°F (1150°C to 925°C).

## CORROSION RESISTANCE

Electralloy A-286 has shown good resistance, without special coatings, in jet engine and supercharger applications up to 1300°F. Above 1500°F, A-286 does not compare favorably with type 310 stainless. It does demonstrate excellent performance in 20% salt spray corrosion tests. The high nickel content makes it more resistant than type 304 in cool sulfuric acid solutions, but not as good in some strong selective oxidizing environments. The alloy is susceptible to intergranular corrosion in the aged condition.

## WELDING

A-286 is weldable using most fusion techniques. Conditions must be carefully controlled to avoid cracking in the weld and HAZ, particularly in large sections, as the alloy passes through a low ductility region upon cooling. Material should be welded in the solution treated condition.

## MACHINING

The alloy can be machined using techniques & equipment similar to 300 series stainless and exhibits the same "gumminess" and work hardening characteristics. It requires slower speeds, sharp tools, and rigid set-ups. The gummy condition is sometimes overcome by machining in a partially aged, fully aged, or overaged condition. Cold working also improves machinability. In the solution treated condition the alloy is rated as 35% as compared to B1112.

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