

ULTIMET® Alloy

Machining Guidelines

Nominal Chemical Composition (wt %)

<u>Co</u>	<u>Cr</u>	<u>Ni</u>	<u>Mo</u>	<u>Fe</u>	<u>W</u>
Bal.	26	9	5	3	2

General

ULTIMET® alloy can be successfully turned, drilled and milled providing appropriate tooling and parameters are employed. The alloy possesses high strength (and therefore resists metal removal). It also work hardens rapidly (from a hardness of approximately HRc 30, in the solution annealed condition, to approximately HRc 40, after 10 percent cold reduction). The alloy is most easily machined in the solution annealed condition.

Tensile Properties

<u>Condition</u>	<u>Ultimate Tensile Strength (Ksi)</u>	<u>Yield Strength at 2% Offset (Ksi)</u>	<u>Elongation in 2 in. (%)</u>
Annealed	149	82	35.5
Annealed + 1000°F	151	77	44.2
Annealed + 1200°F	152	76	45.1
Annealed + 1400°F	144	75	26.6
Annealed + 1600°F	144	75	29.5
Annealed + 1800°F	149	74	39.8

*100 hours aging time at temperature prior to room temperature tensile test

Hardness vs. Cold Reduction

<u>Condition</u>	<u>Hardness (Rc)</u>
Annealed	30
Annealed + 10% cold reduction	40
Annealed + 20% cold reduction	43
Annealed + 30% cold reduction	47
Annealed + 40% cold reduction	49

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Machines and Tooling

With regard to machines and tooling, the following advice is offered:

Capacity: The machine should be rigid, modern, and as much overpowered as possible. The best practice is to use the machine well below its rated capacity.

Rigidity: The work piece and tool should be held rigid. Tool overhang should be minimized and extra support used when possible.

Tool Sharpness: One of the most important factors is to make sure that all tools are sharp at all times. Change to sharpened tools at regular intervals rather than out of necessity. A 0.4 mm (0.015 in) wear land is considered a dull tool.

Tools: Use positive rake tools. Use square inserts with a 15 degree or 45 degree side cutting edge angle (SCEA) whenever possible. Triangular tools are weaker but should be used when square shoulders are required.

Positive Cuts: Machining ULTIMET alloy requires that all possible effort should be made to achieve heavy, constant feeds to maintain a positive cutting action. If the feed slows and the tool dwells in the cut, work hardening (glazing) occurs, tool life deteriorates, and close tolerances are impossible to achieve if this occurs. The prime rule, when machining the alloy, is "get in and get out" as fast as possible with all tools.

Lubrication: A good lubricant is desirable. Soluble oils are recommended especially when using carbide tooling. If tapping or threading is being performed, or if heavy cuts and relatively slow feeds are being used, sulfo-chlorinated oils are recommended.

Parameters

The following machining parameters are recommended for ULTIMET alloy:

Turning:

- Carbide (not high speed steel) tools are recommended
- Surface Speed: 0.30 to 0.35 m/s (60 to 70 sfm)
- Feed Rate: 0.13 to 0.25 mm (0.005 to 0.010 in.)
- Depth of cut for roughing: 1.3 to 2.5 mm (0.05 to 0.10 in.)
- Depth of cut for finishing: 0.25 to 0.38 mm (0.010 to 0.015 in.)

Drilling:

- Carbide tipped or high speed steel drills are recommended
- Surface Speed:
 - High Speed Steel Drills: 0.04 to 0.05 m/s (8 to 10 sfm)
 - Carbide Tipped Drills: 0.15 to 0.18 m/s (30 to 35 sfm)
- Feed Rate: 0.1 mm (0.004 in.) per rev. 6.4 mm (0.25 in.) diameter and greater
- 1350 Included angle on point

Milling:

- Carbide (not high speed steel) end mills are recommended
- Carbide End Mill Surface Speed: 0.13 to 0.15 m/s (25 to 30 sfm)
- Feed Per Tooth
 - Cutter diameter below 19mm (0.75 in.): 0.05 mm (0.0002 in.) feed
 - Cutter diameter above 19mm (0.75 in.): 0.08 mm (0.003 in.) feed

ULTIMET alloy contains, in varying concentrations, the following elemental constituents: Al, Co, Cr, Cu, Fe, Mn, Mo, Ni, W. Inhalation or exposure to metal dust or fumes generated from cutting, grinding, melting, or welding of these alloys may cause adverse health affects. For specific concentrations of elements present in any particular product, refer to Material Safety Data Sheet H2071 (MSDS) supplied by Haynes International, Inc.