

ISO 9001:2000 and AS 9100 CERTIFIED



TUNGSTEN HEAVY ALLOY PRODUCTS



ATI Firth Sterling

Allegheny Technologies



INTRODUCTION

ATI Firth Sterling is a leading manufacturer of tungsten heavy alloys. Since the inception of our heavy alloy production in 1958, we have continued to acquire advanced technology and state-of-the-art equipment to meet the ever increasing demands of the marketplace. To guarantee a highly skilled work force, we provide technical training to our employees on an on-going basis. Along with our technical capabilities, our company-wide commitment is to our customers.

ATI Firth Sterling markets its heavy alloys under the product trademarked name of Densalloy™. Densalloy provides the unique properties required in applications ranging from therapeutic medical radiation shielding to aircraft counterbalancing. Its nominal tungsten content ranges from 89% to 97% with the balance primarily of nickel and iron. By adding alloying elements to tungsten, Densalloy has greater ductility and better machinability than pure tungsten.

HEAVY ALLOY MANUFACTURING PROCESS

Tungsten Powder Production

All the tungsten powder used by ATI Firth Sterling is produced at our facility in Huntsville, Alabama. This minimizes cost fluctuations and helps to insure an uninterrupted supply of tungsten powder.

Tungsten powder is initially made from tungsten ore (Wolframite/Scheelite) which is chemically processed into ammonium paratungstate (APT). APT is then converted into tungsten oxide and subsequently reduced to pure tungsten powder. The tungsten powder is then mixed with the alloying powders to produce a homogenous blend of Densalloy. Each lot of powder is identified and tested for sound metallurgical properties.

Pressing

Blended tungsten powder (Densalloy) is cold pressed under controlled conditions to insure uniform compaction throughout the green compact. A variety of presses are used including dry and wet bag isostatic presses which are capable of compaction pressures in excess of 25 KSI and mechanical and hydraulic presses ranging in capacity from 15 to 1,000 tons. Also hundreds of dies and press toolings are available for use.

Green Shaping

A variety of methods including CNC waterjet cutting are used to shape green compacts prior to sintering. Green shaping produces parts which are closer to the desired size thereby minimizing cost and reducing machining of the final product. Sintering Densalloy is accomplished by a liquid phase sintering process in closely controlled hydrogen furnaces at temperatures between 2500°F and 3000°F. Sintering causes the green compacts to shrink 15% to 20% resulting in a fully dense product. Sintered material can then be machined by a large variety of conventional methods.

Machining

We have a wide range of advanced CNC turning and milling centers, wire EDM, centerless grinders as well as access to processes such as plunge EDM, metal stamping, gun drilling, double disc and blanchard grinding. We have both hot and cold rolling mills with the capability to roll tungsten heavy alloy sheet to a thickness of 0.020 inch. All of these capabilities equip us with the flexibility to satisfy the most demanding jobs regardless of size.



Engineering Services

To help enhance our customers' design process and reduce cost, we have available experienced design engineers to discuss the material selection, blank configuration, and machining ideas. Among the tools at our disposal is a state-of-the-art CAD system with full 3-D solid modeling capability for concept evaluation, mass property calculation, and complex surface machining. With this CAD system, we can work directly with our customers through their Unigraphics Operations System or auto CAD base files.

Machining Guidelines

Densalloy is similar to machining gray cast iron because the material is highly abrasive and the chips are discontinuous. Carbide tools are used for milling, turning and drilling; however, cobalt is recommended for tapping. The use of coolant is suggested for roughing but is not required for finish cutting. Cutting speeds should be in the range of 100 to 300 SFPM, and feeds should be set to maintain approximately .006" to .010" chip load. Depth of cuts for

roughing can be as much as .125" and for finishing as much as .030".

Fastening and Joining

Densalloy can be joined to itself and other materials using brazing and conventional mechanical methods. Brazing is most effectively done using nickel or copper in a reducing atmosphere.

Densalloy can also be very effectively joined to itself using a sinter bond technique. Sinter bonding essentially causes diffusion of material across the joint interface resulting in an almost indiscernible joint in the finished part.

Finishes - Corrosion Resistance:

Although Densalloy possesses relatively good corrosion resistance, slight corrosion will occur in high humidity atmospheres. Various finishes can be applied to improve its corrosion resistance. This includes cadmium and nickel plating as well as acrylic and epoxy paints.

Densalloy products are offered as machinable blanks or as finished parts, precision-machined to the customer's specifications and used in many different applications as indicated below.

Bar and Sheet Stock

ROTF (rough oversize to finish) Blanks

Counterbalance Weights/ Vibration Dampening

For industrial applications, such as:

- aircraft control surfaces
- helicopter rotor systems
- ship ballasts
- engine components
- automotive suspension systems
- computer disc drives
- golf club weights
- racing industry

Radiation Shielding Components

- collimators
- shielding blocks
- oil well logging instrumentation
- nuclear testing equipment

Machine Tools

- Densbore™



QUALITY ASSURANCE

ATI Firth Sterling is registered to ISO 9001 and embraces a commitment to total customer satisfaction. As this can only be achieved by producing products which conform to customer requirements, we rely heavily upon all employees to assure these processes are complete and compliant. Our quality department's services are shared throughout the Company to insure product compliance at all stages of the

manufacturing process. These services include originating and distributing quality manuals, operating procedures, and Work Instructions which are based on ISO 9000 standards. Through the use of advanced computerized analytical techniques, quality department personnel perform statistical trend analyses to track, correct and prevent the occurrence of non conformance during the manufacturing operation. We begin

by testing each powder lot to verify its density, tensile strength, elongation and hardness. Photomicrographs are utilized to check for grain structure. State-of-the-art inspection equipment such as optical comparators and coordinate measurement machines offer three dimensional inspection of close tolerance and complex geometric shapes.

| ALLOY TYPE | SD170 | SD175 | SD180 | SD185 | DENS 21 | DENS 23 | DENS 25 |
|----------------------------------------|---------|---------|---------|---------|---------|---------|---------|
| MATERIAL SPECIFICATIONS | | | | | | | |
| MIL.-T-21014 Rev.D | Class 1 | Class 2 | Class 3 | Class 4 | Class 1 | Class 2 | Class 3 |
| SAE-AMS-T-21014 | Class 1 | Class 2 | Class 3 | Class 4 | Class 1 | Class 2 | Class 3 |
| AMS 7725 C | 7725C | — | — | — | 7725C | — | — |
| ASTM B777-87 | Class 1 | Class 2 | Class 3 | Class 4 | Class 1 | Class 2 | Class 3 |
| TYPICAL DENSITY (g/cc) | 17.1 | 17.6 | 18.1 | 18.5 | 17.1 | 17.6 | 18.1 |
| TYPICAL DENSITY (lbs/in ³) | .618 | .636 | .654 | .669 | .618 | .636 | .654 |
| NOMINAL W CONTENT (wt. %) | 90 | 92.5 | 95 | 97 | 90 | 92.5 | 95 |
| MAXIMUM MAGNETIC PERM | N/A | N/A | N/A | N/A | <1.05 | <1.05 | <1.05 |
| TYPICAL HARDNESS (HRC) | 28 | 28 | 29 | 29 | 28 | 28 | 29 |
| MODULUS OF ELASTICITY (x106psi) | 45 | 48 | 50 | 52 | 45 | 48 | 50 |
| ULTIMATE TENSILE STRENGTH MIN (ksi) | 120 | 120 | 120 | 110 | 110 | 110 | 110 |
| 0.2% OFFSET YIELD STRENGTH MIN (ksi) | 80 | 80 | 80 | 80 | 75 | 75 | 75 |
| MINIMUM % ELONGATION (1" GAGE LENGTH) | 10 | 8 | 6 | 2 | 4 | 3 | 3 |

NOTE: The above chart is for reference only. Higher properties can be achieved on a custom-made basis.



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