Advanced Solutions for Space Applications

Aluminum, Titanium, Superalloys, Special Steels

Enhancing your performance
Aubert & Duval: a supplier of choice for space industry

Process flow

Melting
- HPS
- Ti
- NiSA

Remelting

Powder atomization
- PM

Conversion
- HPS
- Ti
- NiSA
- Al

Forging and/or rolling
- HPS
- Ti
- NiSA
- Al

Forging

Closed-die Forging

Heat treatment

Machining

Non destructive testing

Bars
Rotative and static parts
Powders for additive manufacturing

HPS
High Performance Steels:
A range of alloyed steels with tightly controlled characteristics offering optimum value for customers.

NiSA
Nickel-base Superalloys:
Nickel-based superalloys: materials keeping high surface integrity while withstanding severe mechanical stress in a high temperature and corrosive environment.

PM
Powder metallurgy:
Metal Powders (steels, superalloys, titanium) for additive manufacturing.

Ti
Titanium:
Pure or alloyed titanium, combining mechanical properties and corrosion resistant with light weight.

Al
Aluminum:
For specific applications combining resistance with light weight.

Aubert & Duval: a supplier of choice for space industry
Since the dawn of the 20th century, Aubert & Duval has been manufacturing products for the most stringent industries: aerospace, power generation, nuclear.

Propellant tanks, engines, boosters, structural parts... everywhere Aubert & Duval contributes to the safety of launchers and to the life of spacecraft. For more than 30 years, Aubert & Duval has been proud to face up to the technological challenges of space industry with our customers, starting with the Ariane 4 launchers and continuing with the new generation of spacecraft.

With full vertical integration from melting to remelting, powder atomization, hot converting and machining (rough machining through to near-net-shape parts), Aubert & Duval offers wide-ranging cutting edge capabilities for launch vehicles, satellites and other spacecrafts: structure and propulsion parts, helium tanks, components and fasteners.

We have also put in place over many years dedicated skills and modern simulation capabilities to co-design and re-engineer metallurgical solutions in close cooperation with the main original equipment manufacturers.

Today, we are leveraging this knowledge to help our customers in their strategic projects, from R&D to industrial-scale production, providing high-value metallurgical solutions with close technical support.

Let’s take up the new Space challenges together!

As a specialist in upscale metallurgy Aubert & Duval operates several closed-die forging facilities, such as its 22,000 MT, 40,000 MT and 65,000 MT hydraulic presses. Closed-die forging is the process of forming complex-shaped parts from a metal semi-product between two engraved tools (dies) by pressing with a closed-die forging press.
Forged parts and bars for Space applications

**Main materials**

- **Aluminum Alloys**
  - A2000 series
  - A7000 series
  - 5083
  - 6061
  - Aluminum-Lithium

- **Titanium Alloys**
  - TA6V
  - TA6V ELI
  - Ti1023

- **Superalloys**
  - AD730®
  - NY276
  - PER3
  - PER625
  - PER718
  - XSH

- **High performance steels**
  - B19B
  - GH®
  - M5ONL
  - Marval®18
  - ML340
  - MLX®17
  - MLX®19
  - MG6ACW
  - SCV®
  - X15USW
  - X18PA
  - XD15NW®
  - XD80
  - XN26TW

**Main data**

- **Closed-die forgings:**
  - Diameter up to 2 m / 79 in
  - From 20 kgs / 44 lbs
  - up to 13,000 kg / 28,600 lbs

- **Open-die forgings:**
  - up to 30,000 kg / 66,000 lbs

**Structure parts**

- Cone
- Dome
- Bracket
- Bulkhead

- Up to 30 tons, up to 7 meters long

**Propellant/Helium Tanks**

- Spherical Tanks

- Up to 2 meters diameter
Thanks to unrivalled melting and forging capabilities, Aubert & Duval provides aluminum, superalloy and titanium bars as well as open-die and closed-die forgings, from small parts to very large components, meeting new spatial requirements for flying longer, lighter and at lower cost.

With a recognized metallurgical expertise and decades of experience as a safety-critical forging supplier for the aerospace industry, Aubert & Duval is delivering fully integrated solutions from designing and material choice through to machined parts, with the best performance / cost compromise. We support our customers throughout their strategic development projects to meet the current space sector’s requirements more closely and anticipate future challenges.

Propulsion parts

- Compressor disc
- Impeller
- Shaft
- Turbine disc

Up to 4 meters long

Up to 1,4 meters diameter

Bars

<table>
<thead>
<tr>
<th>Main sizes</th>
<th>mm</th>
<th>inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>Round Bars</td>
<td>Ø 7.5-500</td>
<td>Ø 0.30-20</td>
</tr>
<tr>
<td>Flat &amp; Square Bars</td>
<td>T ≤ 310</td>
<td>T ≤ 12</td>
</tr>
<tr>
<td>Sheets</td>
<td>0.6 ≤ T ≤ 150</td>
<td>0.2 ≤ T ≤ 6</td>
</tr>
</tbody>
</table>

Surface conditions

- Black
- Peeled
- Ground
- Others

Heat treatment conditions

- Annealed
- Hyperquenched
- Normalized
- Heat solution treated
- Heat treated
- Aged

Innovation

Aubert & Duval continuously develops new processes and grades able to face space challenges.

**HPS ML340**

This duplex hardening grade is specifically adapted for turbine shafts operating at high temperature (450°C/840°F), and requiring 2230 MPa/323 Ksi resistance. This allows savings in weight, together with engine efficiency improvement, hence lower gas consumption.

**NiSA AD730®**

Is a fully innovative nickel-base superalloy. It withstands higher temperatures (750 °C / 1,382 °F), while reserving strength, creep and fatigue resistance at a competitive cost.

**Al Aluminum-Lithium alloys**

Aluminum Lithium grades allow weight gain up to 4%. Their static properties are equivalent or higher than 7010/7050 and fatigue and rigidity properties improved more than 10%.
A complete metal powder offer for additive manufacturing

The performance of our powders at the heart of your additive manufacturing success

Thanks to our long-standing experience in the space industry, we can offer tailored metal powder, designing the chemical and mechanical properties according to space requirements.

We help our customers in the definition of metal powder specifications in order to develop suitable solutions for space applications: propulsion, structure parts and components.

Pearl® Micro metal powders are designed for the full range of additive manufacturing processes:

**Powder Bed**
- Laser Beam Melting
- Electron Beam Melting
- Binder jetting & sintering

**Blown Powder**
- Laser Metal Deposition
- Cold Spray
Over the years, Aubert & Duval has acquired a very thorough knowledge of design and optimization of metal powders in order to meet customers’ most stringent requirements, particularly for aircraft and space applications. We support space equipment manufacturers to achieve success in their development and series production made by additive manufacturing.

Our research centers and development teams are dedicated to developing new alloys and optimizing powder characteristics to achieve the best material performance and processability for all additive manufacturing technologies.

Our Atomization Processes

With 40 years of experience in high quality gas-atomized powders, Aubert & Duval has a high level of expertise and also dedicated laboratory equipment ensuring the highest quality for Pearl® Micro powders:

- Powder size distribution: sieving and laser diffraction
- Morphology: SEM pictures
- Chemical composition: X-Ray, Optical
- Emission Spectrometer (OES) and Atomic
- Absorption Spectrometer (GFAAS)
- Other physical properties: density, flowability

Key Benefits of our Atomization Equipment

- Melting in VIM furnace or with ESH technology
- N- or Ar-atomization
- High cleanliness level
- Highly spherical powder morphology
- Fully controlled low oxygen and carbon levels
- Minimize satellites & internal porosities
- High stability and reproducibility
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