ASTM F75 CoCr Alloy

General characteristics
Cobalt-based alloys have been used in demanding applications for as long as investment casting has been available as an industrial process. Arcam's Electron Beam Melting technology competes directly with investment casting and is a viable choice for manufacturing complex parts in cobalt-based alloys.

The majority of investment castings made from the cobalt super alloys are cast in an open atmosphere. With Arcam’s Electron Beam Melting process the vacuum atmosphere provides a controlled environment and enables superior material properties in the manufactured parts.

CoCrMo alloys are widely used for medical prosthetic implant devices. The alloys are especially used where high stiffness or a highly polished and extremely wear-resistant material is required. CoCrMo alloys are the materials of choice for applications such as knee implants, metal-to-metal hip joints and dental prosthetics.

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Special characteristics
The Arcam ASTM F75 CoCr alloy is also suitable for Rapid Manufacturing of production tools for injection moulding of plastic parts. The high hardness of the material and the excellent material qualities allow polishing components to optical or mirror-like finishes, and ensures long tool life.

Tools can be built with complex geometries, and the conformal cooling channels further enhance the tool’s life and increase productivity, part and surface quality.

Applications
CoCr is typically used for:
– Gas turbines
– Orthopaedic implants
– Dental implants

Powder specification
The Arcam ASTM F75 CoCr alloy powder for EBM is produced by gas atomization and the chemical composition complies with the ASTM F75 standard’s specification. The particle size is 45–100 microns. This limitation of the minimum particle size ensures safe handling of the powder. Please refer to the Arcam MSDS (Material Safety Data Sheet) for more information about the handling and safety of the powder.

Applications
Arcam ASTM F75* is a non-magnetic cobalt, CoBalance BalanceCoCr steel. In general characteristics, variations are required. CoCrMo alloys are the materials of choice for applications such as knee implants, metal-to-metal hip joints and dental prosthetics.

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Arcam ASTM F75 CoCr alloy. Hip stem implant.

Post-processing
Heat treatment
The following heat treatment program is recommended.
1. Hot isostatic pressing (HIP) in a shared cycle, with the following parameters:
   – 1200 °C
   – 1000 bar argon
   – 240 minutes.
2. Homogenisation (HOM) heat treatment, with the following parameters:
   – 1220 °C
   – 0.7–0.9 mbar argon
   – 240 minutes.

As rapid quench rate as possible, from 1220 °C to 760 °C in 8 minutes maximum. The purpose is to dissolve carbides and improve the isotropy of the microstructure, reducing the brittleness of the as-built EBM material.

Machining
Parts manufactured in the EBM process feature good machinability. Parts produced using the Arcam EBM process demonstrate excellent results when using any conventional machining process.

The excellent properties displayed by the parts manufactured with EBM allow polishing of the parts to a mirror or optical finish for use in dies and other applications requiring a superior surface finish.
Microstructure

Manufacturing CoCr parts with EBM results in fully dense parts without weld lines in the material before or after heat treatment (HIP+HOM).

The as-built material consists of elongated grains containing carbide precipitation. Heat treatment transforms the microstructure into an isotropic structure with a substantial reduction of visible carbides.

HIP+HOM completely transforms the microstructure into an isotropic state. The carbides are dissolved, leading to the increased ductility and reduced hardness demonstrated in the after heat treatment specifications. There is no porosity in the as built or in the HIP+HOM material.

As-built microstructure, etched cross-section along the Z-direction, 50x

Microstructure after HIP+HOM, etched cross-section along the Z-direction, 50x

As-built microstructure, etched cross-section along the Z-direction, 100x

Microstructure after HIP+HOM, etched cross-section along the Z-direction, 100x