CARPENTER
Powder Products

Special Products

BioDur® CCM Plus® Alloy

CCM Plus alloy is a non-magnetic, cobalt-chromium-molybdenum alloy exhibiting high strength, corrosion resistance, and wear resistance. It was originally developed for use in the orthopedic industry for joint replacement and fracture fixation devices, such as total hip, knee, and shoulder replacements, especially when wear or fatigue properties are of major importance, or where intricate high-strength forgings are required.

CCM Plus alloy for the medical implant market is a wrought powder metallurgy product produced by vacuum induction melting, followed by gas atomization and hot isostatic pressing yielding 100% dense billets. These billets provide superior machining characteristics than material produced by traditional cast and wrought processes.

More recently, CCM Plus has been used in the tooling area for hot working applications, such as die casting, forging, and glass forming. It is often used in bi-metallic tooling as the outer layer to take advantage of its exceptional corrosion or wear resistant capabilities.

U.S. Patent Number 5,462,575

Nominal Analysis	
Carbon	0.2-0.3%
Chromium	26-30%
Molybdenum	5.0-7.0%
Cobalt	Balance
Nitrogen	0.15-0.2%

Specific alloy chemistry available upon request.

Product Attributes:

- Homogenous chemistry and microstructure
- Small, uniformly distributed carbides
- Fine austenitic grain size, typically ASTM E112 grain size number 12 and finer for hot rolled material
- Excellent wear and corrosion resistance

Forms manufactured: Bars, Rounds, HIP'd Shapes, Billets, and Powder.

Micro-Melt® NeutroSorb PLUS® Alloys

NeutroSorb PLUS alloys are similar to conventional Type 304 stainless steel, except that they contain a boron addition, which imparts a significant thermal neutron absorption cross-section. These alloys are available with boron levels up to 2.5% as specified by customer requirements. Increasing boron content also increases hardness, tensile strength, and yield strength, while maintaining good formability, impact toughness, and corrosion resistance. Through controlled special processing, NeutroSorb PLUS alloys and ASTM A887-89 Grade "A" alloys provide increased ductility and impact toughness as boron content increases, when compared to traditional cast and wrought borated stainless steel alloys.

The boron addition can consist of natural boron or the enriched boron 10 isotope, which offers a higher neutron absorption cross-section at a given boron content. This enables the use of less total boron, which provides improved ductility and impact toughness. These alloys have been used in the nuclear industry for spent fuel storage racks and cask baskets, control rods, burnable poison rods, and shielding.

U.S. Patent Numbers 4,891,080 & 5,017,437

Nominal Analysis	
Manganese	2.00%
Chromium	18-20%
Nickel	12-15%
Boron-Max	2.5%
Iron	Balance
Others	Less than 1%

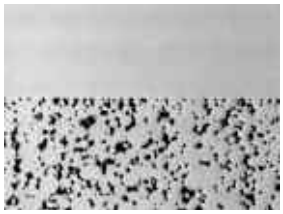
The neutron absorption of NeutroSorb Plus® alloy with about 0.4% boron 10 is approximately the same as when the alloy contains 2.0% natural boron.

Specific alloy chemistry available upon request.

Forms manufactured: Bars, Rounds, Plate, Strip, HIP'd Shapes, Sheets, and Wire.

Porous Tooling

Two major issues that prevail with current plastic injection molds include the venting of gasses generated during the molding process and thermal management of the molding process itself. Trapped gasses cause quality problems, such as burning and short shots. Manufacturers struggle with uniformly removing the heat from all areas of the die cavity during the process cycle. Combining powder metallurgy technology with the Dynaforge process produces a porous tooling material which can minimize or eliminate the venting problem in plastic injection molding. In addition, this material, when combined with an advanced cooling concept, has allowed manufacturers to compress cooling cycles by as much as 50%. Plastic injection molders have found that porous tooling can increase productivity and improve quality with significant cost reductions.



Porous/Solid Tooling Microstructure

Product Attributes:

Porous injection molds up to 5" diameter x 8" tall can be manufactured from a variety of alloys. Porosity can be controlled with average interconnected pore sizes ranging from 4 to 50 microns. Since the cores are connected to one another, gas can flow throughout the tool. While the tools and molds are porous, they can be tailor-made with high strength and/or corrosion resistance. Bi-metallic/composite tools can be produced along with a wide range of near-net shapes. The products made can be used as inserts or as whole tools.

Commonly Used Alloys

Commonly processed alloys include among others:

- 410
- 420
- 718
- 17-4

Dynaforge Process

The Dynaforge process produces advanced tooling for use in hot forming applications, such as forging, die casting, and glass forming. This process uses gas atomized powders of many metallic alloys, including tool steels, stainless steels, and cobalt/nickel base alloys. The screened powder is enclosed in a shaped container, degassed, sealed, and quickly consolidated by a unique quasi-isostatic hot forging process. Functionally graded tools consist of a standard tool steel core with an appropriate heat, wear resistant or other alloy on the outside, as required by the application. The speed of the process produces metallurgical bonds between the two materials with minimal diffusion, avoiding brittle areas and similar problems with slower consolidation processes.

This process can be used to make fully dense parts as described above with the CCM Plus® alloy. Other alloys with superior high temperature hardness and strength can also be used in monolithic and functionally graded tooling materials with improved tool lives of 5 - 10 times or even greater in many applications.

Product Attributes:

Products up to 5" diameter x 8" tall can be manufactured from virtually any alloy. Controlled forging pressures and temperatures appropriate for the specific alloy(s) are used to manufacture the tool or mold.

Commonly Used Alloys

Commonly used alloys for either monolithic or functionally graded products include among others:

- CCM Plus
- CCW
- DM21
- H13
- PD#5
- T15

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