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News Release

SANYO SPECIAL STEEL

NOVASHAPE® Series – Advanced Metal Powders for Additive Manufacturing

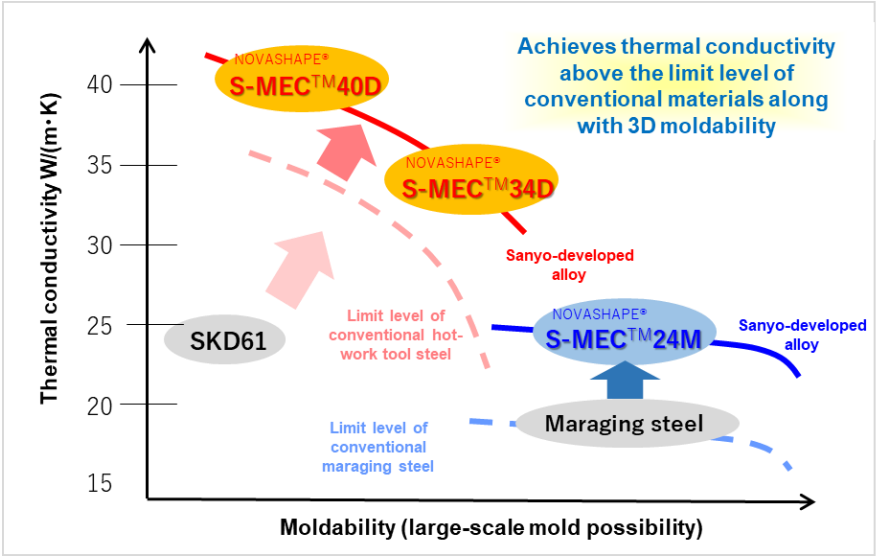
Metal Powders for Die Casting Molds with Higher Thermal Conductivity

— Reducing cycle time of die casting and enabling additive manufacturing of large molds —

Sanyo Special Steel has released a new metal powder lineup enabling formation of high-thermal-conductivity die casting molds by additive manufacturing, thereby reducing the cycle time for die casting and enabling additive manufacturing of large molds.

When these new metal powders are used with 3D printers to produce die casting molds, effective cooling of the molds during die casting can be achieved. Besides raising productivity by reducing cycle time, use of these powders can be expected to extend the life of molds. Moreover, the combination of high thermal conductivity and excellent moldability makes them suitable for additive manufacturing of large molds.

Sanyo will be exhibiting these new powders at the 10th METAL JAPAN Tokyo Expo to be held from October 4 to 6 at Makuhari Messe in Chiba. They will also be introduced at the Autumn Meeting of the Japan Society of Powder and Powder Metallurgy, 2023, to be held from October 19 to 20 at Doshisha University in Kyoto, and will continue to be actively promoted with a view to expanding their adoption.



Positioning of developed materials

Technical challenges relating to additive manufacturing of die casting molds

Large-size molding and high thermal conductivity

SKD61* has a tendency to crack during additive manufacturing, making it difficult to achieve large-size molding.

Maraging steel has low thermal conductivity, leading to insufficient mold cooling.

Difficult to overcome both these challenges with conventional materials

*EU equivalent X40CrMoV5-1

Features of additive manufacturing

Rapid melting and solidifying in each micro area

- Comprehensive hardening effectiveness
- Inhibition of embrittlement by rapid solidifying

It should be possible to reduce alloy elements compared to conventional materials

Development concept

Alloy design that utilizes features of additive manufacturing

S-MEC™40D: Improve thermal conductivity by reducing alloy elements required to ensure hardenability of casted JIS-SKD61

S-MEC™34D: Improve moldability by modifying alloy design from S-MEC™40D to control deformation during additive manufacturing

S-MEC™24M: Improve thermal conductivity by reducing alloy elements required to prevent embrittlement of maraging steel

(Technical introduction)

Technical issues of conventional materials

Die casting is a process of forming metal parts by forcing high-temperature molten aluminum alloy into a mold at high pressure. Die casting molds have internal water-cooling channels for control of mold surface temperature and mold cooling that are critical to productivity and product quality. Making the molds by additive manufacturing greatly increases the degree of freedom in design of the water-cooling channels, enabling effective cooling of the mold during die casting. However, the hot-work tool steel JIS-SKD61 (EU equivalent X40CrMoV5-1) widely used for die casting molds has a tendency to crack during additive manufacturing. Moreover, maraging steel with excellent moldability has low thermal conductivity, leading to insufficient mold cooling during die casting. Various manufacturers have been seeking to develop new alloys that overcome these technical issues. However, since the thermal conductivity and structure of the mold greatly affect the productivity and quality of die cast products, there has continued to be a need for new materials with high thermal conductivity that also have outstanding 3D moldability.

Development concept

In addressing this challenge, Sanyo focused on the processes for rapid melting and solidifying of materials during additive manufacturing. Various alloy elements have been conventionally added as casting materials to maintain quality, and by optimizing the necessary quantities of such elements for additive manufacturing, we have developed new alloy powder that achieves both thermal conductivity exceeding the limit levels of conventional materials and excellent 3D moldability.

Modified JIS-SKD61

S-MEC^{TM}40D: As a general rule, the thermal conductivity of steel materials declines when they contain greater quantities of alloy. However, in JIS-SKD61, widely used in die casting molds, large amounts of hardenability-enhancing alloying elements are added to achieve the hardness necessary in mold use.

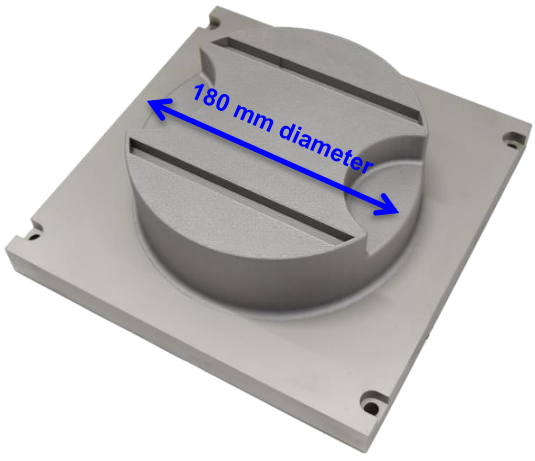
Sanyo noted that it should be possible to reduce the quantity of alloy elements compared to the amount added to JIS-SKD61 as a result of the hardening effectiveness achieved by rapid melting and solidifying in each micro area during additive manufacturing. While ensuring the hardness necessary for use in molds and 3D moldability, Sanyo then developed new material that achieved the highest level of thermal conductivity among similar materials by reducing alloy elements that impair thermal conductivity.

Development concept	Reducing alloy elements that impair thermal conductivity
Characteristics	Highest level of thermal conductivity among similar materials: 40W/(m・K) 1.7 times greater than JIS-SKD61

S-MEC^{TM}34D: Based on the alloy design of S-MEC^{TM}40, moldability was improved by controlling the martensitic transformation temperature.

This material has thermal conductivity 1.4 times higher than JIS-SKD61 and enables additive manufacturing of large molds of 180 mm diameter.

Development concept	Controlling the martensitic transformation temperature
Characteristics	Enables large molds of 180 mm diameter



Example of mold using S-MEC^{TM}34D

Modified maraging steel

S-MEC^{TM}24M: Maraging steel is advantageous for increasing the size of additive manufacturing. However, its thermal conductivity is significantly inferior to JIS-SKD61 because it contains many alloy elements necessary to prevent embrittlement in aging heat treatment.

Sanyo noted that it should be possible to reduce the quantity of alloy elements compared to the amount contained in conventional maraging steel by inhibition of embrittlement through rapid solidifying during additive manufacturing.

By identifying the alloy design that most efficiently heightened thermal conductivity, Sanyo then succeeded in developing new material that maintains outstanding mechanical properties and 3D moldability while achieving thermal conductivity 1.4 times that of conventional maraging steel and equivalent to that of JIS-SKD61.

Moreover, since maraging steel generally contains cobalt, a specified chemical substance, handling of the powder requires measures to prevent health hazards such as installing dust eliminators, as stipulated in the Ordinance on Prevention of Hazards due to Specified Chemical Substances.

Sanyo has achieved outstanding properties in a material that does not use cobalt.

Development concept	Reducing alloy elements required to prevent embrittlement of maraging steel
Characteristics	Thermal conductivity 1.4 times that of conventional maraging steel

Total support for customers' additive manufacturing development

In addition to gas atomization facilities that can produce high-quality spherical metal powders, Sanyo has two metal 3D printers and a non-destructive inspection system (X-ray CT scan). Besides the alloy powder mentioned above, we are actively working to provide total support for our customers' development, along with providing ideal metal powders for additive manufacturing through the development of alloy composition optimized for additive manufacturing, establishing manufacturing processes that maximize material properties, and utilizing rapid material evaluation systems. We will continue to focus our efforts on developing new products in the NOVASHAPE® Series and new technologies, providing solutions that utilize materials and technology to improve the competitiveness of our customers.