Session Chairperson
HIHARA P.E.Office, Dr. Masahiko Hihara

JD24-01

High toughness steels for gigantic dies and molds of die-casting

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The integral casting to make car bodies is one of the trends of diecasting. The gigantic dies have higher risk of gross cracking due to low toughness at core. The low toughness comes from coarse primary carbides and coarse microstructure. The coarse carbide is made by small solidification rate of a large ingot. In addition, small quenching rate of a large die leads to coarse microstructure given by transformation at higher temperature. The new grades exert higher toughness in a large die are developed. In this paper, the behavior of toughness to quenching rate is mainly shown. And various properties of developed grades compared with conventional grades are shown.

JD24-02

Characterization of high-performance coatings for die-casting molds

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Aluminum die-casting molds necessitate surface treatment that satisfies all requirements for soldering, erosion, and heat-checking resistances. This study explores the feasibility of fulfilling these requirements by combining an AlCrTiSiN composite multilayer coating with a nitriding treatment known for its exceptional toughness. The performance of this combined treatment was compared and assessed against gas-nitrided and other ceramic-coated specimens. To this end, evaluations performed include aluminum soldering tests using mold release agents, corrosion-resistance tests in molten aluminum alloys, room-temperature and high-temperature friction and wear tests, micro slurry-jet erosion tests, and heat-checking tests. Furthermore, this paper presents the practical results of applying the AlCrTiSiN composite multilayer coating to actual aluminum die-casting molds.

JD24-03

Water cooling effectiveness of Ti matrix composite shot sleeve and development for improvement

TYK CORPORATION ●Sadayoshi Takayama, Shinji Kajita, Yukie Kaku, Masamitsu Takai, Akihiro Kato

Our Ti matrix composite shot sleeve features excellent heat retention property. The sleeve contributes to improved quality and yield in aluminum alloy die casting by reducing cold flakes. The most important issues regarding the life of the sleeve are thermal deformation near the pouring port and damage at the impact area of hot metal. This results in erratic operation of the plunger tip, unstable injection speed, roughness of the internal surface of the sleeve, and enlargement of the inner diameter, resulting in replacement of the sleeve. Currently, as a countermeasure for these problems, water cooling is applied to the impact area of hot metal from behind to achieve a certain effect.
This time, based on the results of further experiments on this water-cooled structure, we present the direction for better water-cooling conditions.

JD24-04

Investigation of CO2 reduction effects by utilizing surface treatment technology to improve castability of thin and large die castings

MEC INTERNATIONAL CO., Ltd. ●Katsuhiro Takami, Tetsushi Yamaguchi, Shigeki Tamura, Hiroki Osawa

Recently, from the global environment point of view, regarding die-casting, new function requirement to the product is increasing. Especially for the electric car parts, from the circumstance of the rapidly increasement to the requirement of electrification, the study of further weight savings and thinning product has begun. Conventionally, higher speed, higher pressure and higher temperature are to respond these requirements. We overcame these issues by using our technology for mold surface treatment to anti-molten metal repulsion properties. We also confirmed the CO2 reduction effected by mold life extension, and lower the control of molten metal temperature.

Session Chairperson
SSK DCTech Hideto Sasaki

JD24-05

Residual stress on inner surface of the bent hole in die-casting die material

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Shot peening is expected to improve fatigue strength by work hardening and compressive residual stress induced by plastic deformation when the fine metal particles are impacted on the metal surface. Shot peening is used to prevent stress corrosion cracking in water-cooled holes of die-casting dies. The diameter of the water-cooling hole is a long, narrow, stop hole, but it is a straight line, so it could be peened.
In recent years, die casting dies have been developed using metal additive manufacturing technology. There are high expectations for the possibility of fabricating even complex design surfaces freely with additive manufacturing. Another advantage is that water cooling holes inside the die can be designed in any shape, including curved holes.
The surface after metal additive manufacturing generates tensile residual stress and poor surface roughness. The same is observed on the surface of the water-cooling holes inside the die. Residual stress can be removed by heat treatment, but the surface roughness must be improved.
In this study, we report the results of the new processing method developed for the surface modification on bent holes in die-casting die materials.

JD24-06

Prevention of corrosion on the inner surface of 3D cooling channel of additive manufacturing die by electroless Ni plating

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MAEDA GIKEN Co., Ltd. Kiyoshi Utsumi, Morimi Shirai, Isao Takahashi
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The inner surface of the cooling channel of aluminum die-casting molds is prone to corrosion. Rust and scale on the inner surface of the cooling channels not only reduce cooling efficiency, but also cause mold cracking and water leakage due to corrosion fatigue fracture. In particular, the optimization and maintenance of the inner surface of the cooling channels are more important for laminated molds fabricated by the selective laser melting method, which have a complex three-dimensional cooling structure, because the roughness of the inner surface of the cooling channels is larger. In this development, in order to prevent corrosion on the inner surface of cooling channels in die-casting mold, we focused on the anti-corrosion effect of electroless Ni plating. The roughness of the inner surface of the cooling channel and the film formation behavior of electroless Ni plating were investigated, and practical aluminum die-casting was performed to clarify the effect of electroless Ni plating.

JD24-07

Cooling Performance Improvement for Die-Casting Molds using 3D Printer Fabrication and Future Development

Ryobi Limited Takarayama Yasuhiro, ●Takao Mitsuharu, Kitamura Mitsuaki, Kittaka Teruhiko, Miyake Tatsuya

In recent years, die-casting products are required to be produced with high quality, with complexity shapes, and at the same time, cost reduction is also required.
Since 2014, our company began verifying the applicability of 3D cooling inserts to the die-casting mold, using metal additive manufacturing technology with the cooperation of external companies.
After verification of their effectiveness, we installed powder bed metal 3D printer in 2018 to produce 3D inserts in-house. Initially, there was trial and error in setup methods, forming techniques, and functional evaluations of metal powders.
Moreover, mold design had to be carried out without existing standards or benchmarks.
In this report, we will present case studies regarding the design, manufacturing, and casting of 3D cooling inserts that our company has been working on. Additionally, we will discuss the future development of molds using metal 3D printers.