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Development of Al-Li Alloy Castings Excellent in Formability.

Seiji Saikawa[1], Susumu Ikeno[2] and Koichi Komai[3]

[1] Graduate School of Science and Engineering for Research, University of Toyama, Toyama-shi, Toyama 930-8555, Japan

[2] Hokuriku Polytechnic College, Uozu-shi, Toyama 937-0856, Japan

[3] Tanida Ltd., 28-2, Higashikagatsume-machi, Kanazawa-shi, Ishikawa 920-0209, Japan

The suitability of coated material for a casting mold used for producing Al-Li alloy excellent in formability was investigated. Visual inspections of the casting surfaces of Al-Li alloys indicated that there were large gas bubble defects due to melt-mold interaction when those were cast into conventional molds consist of SiO_2 sand and phenol resin binder. XRD analysis showed that the main product of the interaction was Li_2O and Li_2CO_3. Except metal mold castings, the quality of Al-Li castings was order of CaO, Al_2O_3, TiO_2, BN, MgO and no-coated sand mold. This order mostly agreed with the standard generation free energy of oxide, except in MgO coated mold.

Keywords: Al-Li alloy, casting, mold, reaction, formability

1. Introduction

In the aerospace , automobile and motorcycle fields, high-strength aluminum alloys are widely used for body, structural, and engine components, where weight reduction is needed to improve movement performance and fuel efficiency[1]. Al-Li alloys have excellent characteristic with high specific strength, high modulus and lightweight property, it is used for aerospace-related fields in particular[2].

For casting of high quality Al-Li alloy excellent in formability, it is important to control the process of melting , refining, molding and casting . However, since the Al-Li alloy are highly active and hard to cast, there has been limited research on those process of Al-Li alloy for casting[3, 4].

In this study, the suitability of molds used for producing Al-Li alloy castings excellent in formability was investigated.

2. Experimental procedure

Pure Al and ingots of other elements were melted at 973K in an electrical furnace. When the temperature of molten metal was up to 1003K, pure Li added into molten metal under innert atmosphere. After all elements were melted, molten metal was degassed by argon gas bubbling. Fig.1 shows schematic drawing of the mold for casting. Temperature of molten metal was contorolled to 973K, it was cast into various molds with a Y-shaped cavity.

Table 1 shows detail of molds using for Al-2.5%Li casting. Five kinds of oxide material, such as BN, TiO_2, Al_2O_3, MgO and CaO coated to inner surface of sand molds, and then those molds were heated at 473K for 4.8ks before cast .

The soundness and quality of castings were evaluated by visual inspection of cross section of castings, and amount and kind of reaction products occurred at the surface of the castings using by X-ray Diffraction method(Cu-K,40kV,40mA).

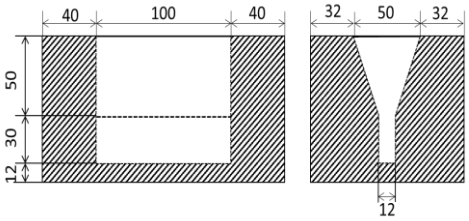

Fig.1 Schematic drawing of the mold for casting.

Table 1 Detail of molds using for Al-Li casting.

Code	Mold Material	Binder	Coated Material	Heating of Mold before casting
Sand-mold	sand	Phenol Resin	---	473K, 4.8ks
BN-Coated			BN	473K, 4.8ks
TiO_2-Coated			TiO_2	473K, 4.8ks
Al_2O_3-Coated			Al_2O_3	473K, 4.8ks
MgO-Coated			MgO	473K, 4.8ks
CaO-Coated			CaO	473K, 4.8ks
Metal-mold	metal	---	BN	453-473K

3. Results and discussion

The sectional appearance of the central part of Al-Li castings are shown in Fig. 2. Many porosity defects occured in the inside of all castings except metal mold one's . MgO coated, sand mold and BN coated mold have lowest casting quality, because those had many porosity defect. CaO, TiO_2 and Al_2O_3 coated molds had relatively slightly good quality, because those defects were rather less.

Fig.3 shows X-ray diffraction result obtained from the castings surface. Peaks from aluminum matrix was detected by all castings. In addition to these, diffraction peaks of reaction products, such as Li_2O, Li_2CO_3, LiOH-H_2O and γ -$LiAlO_2$ peaks were detected in all castings. In reference to peak strength and the kind of the product, we evaluate the soundness of each castings. As above results, the quality of the castings was order of CaO, Al_2O_3, TiO_2, BN, MgO and no-coated sand mold. This order mostly agreed with the standard generation free energy of oxide, except in MgO coated mold.

Fig.4 shows appearance of Al-2%Li-2%Cu -1.5%Mg-0.10%Zr alloy plate hot rolling in 90%. Before of the rolling, slab was cast by ceramic coated mold. The rolling temperature was 473-573K, and rolling passes was 20 times. Because the crack was observed in neither part, it was proved that Al-Li alloy cast by before rolling was superior in a formability.

4. Conclusions

Good quality Al-Li alloy castings are obtained when molten metal are refined by Ar degassing, and then pouring (cast) into molds which surfaces are coated with cermics materials, such as CaO, Al_2O_3 and TiO_2.

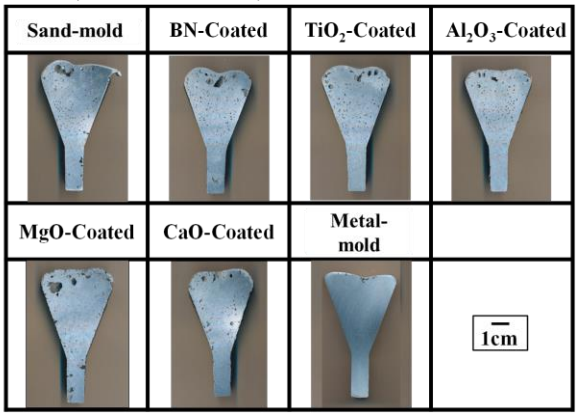

Fig.2 X-ray diffraction result obtained from the casting surface of Al-2.5%Li alloys.

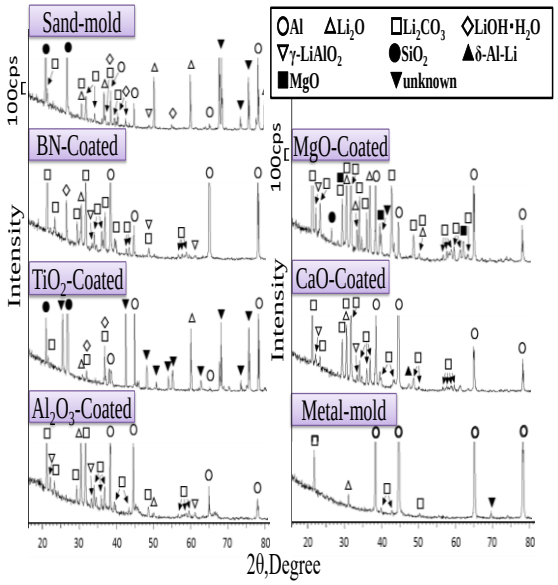

Fig.3 X-ray diffraction result obtained from the castings surface of Al-2.5%Li alloys.

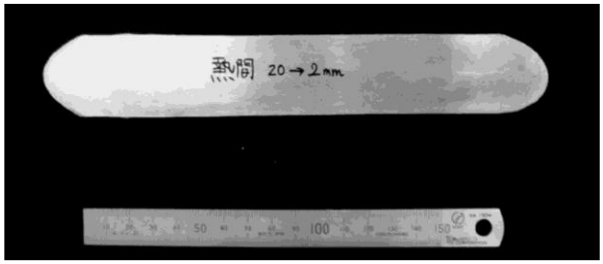

Fig.4 Appearance of Al-2%Li-2%Cu-1.5%Mg -0.10%Zr alloy plate hot rolled in 90%.

Acknowledgements

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References

[1]T.Ishikawa: Japan Institute of Light Metals. 62(2011), 469–474.

[2]T. Nakamura: Japan Institute of Light Metals. 62 (2012), 249–256.

[3]S. Saikawa, S. Sugioka, K. Nakai, Y. Sugiura and A. Kamio: Japan Institute of Light Metals. 41 (1991),596-601.

[4]]S. Saikawa, S. Sugioka, K. Nakai, Y. Sugiura and A. Kamio: Japan Institute of Light Metals. 43 (1993), 630-634.