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Innovation of a roll caster for aluminum alloy

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In this study, we propose three prototypes of roll casters, each with innovative features: a single roll caster equipped with a scraper (SRCS), a vertical type high-speed twin roll caster for aluminum alloy (VHSTRC), and a vertical type tandem twin roll caster (VTTRC). The scraper of the SRCS improves the flatness of the free solidified surface of the strip, and the cast strip exhibits no center line segregation. The VHSTRC can cast Al-11%Si strip at a speed of 60 m/min. Furthermore, a cup test was conducted for this strip, which demonstrated that a limiting drawing ratio of up to 1.9 can be obtained. Finally, the VTTRC can cast three-layer clad strips. In this system, one VHSTRC is mounted on the other VHSTRC to cast the clad strip. The clad strips can be cast without mixing of the two kinds of aluminum alloys.

Keywords: *single roll caster, twin roll caster, clad strip, scraper*

1. Introduction

Although conventional twin roll casters for aluminum alloy (CTRCA) provide advantages such as rapid solidification and a straightforward casting process, their disadvantages are center line segregation and a low casting speed. A single roll caster equipped with a scraper (SRCS) and a vertical type high-speed twin roll caster for aluminum alloy (VHSTRC) were proposed to overcome these disadvantages [1,2]. A straightforward process is critical in the fabrication of clad strips. Therefore, a vertical type tandem twin roll caster (VTTRC) was proposed [2]. In this paper, the characteristics of the three innovative twin roll casters are shown.

2. Single roll caster equipped with a scraper

A schematic illustration of the SRCS is shown in Fig. 1 [1]. Semisolid metal on the free solidified surface is scribed by the scraper, and the scribed surface is shown in Fig. 2. As shown in the figure, the scraper produced a flat free solidified surface. The thickness distribution in the lateral direction of an as-cast 5182 strip is shown in Fig. 3, and was found to be neither convex nor concave. Cross-sections of the as-cast strip and the strip after cold rolling and annealing are shown in Fig. 4. No significant difference was seen in the microstructure between the roll contact surface and the scribed surface. In addition, no center line segregation was observed.

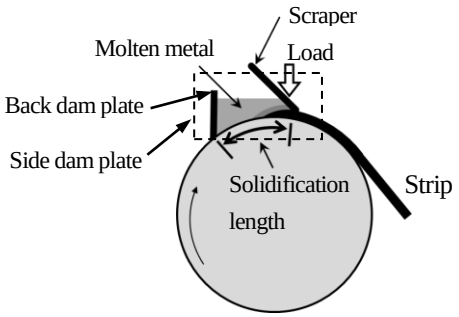


Fig. 1 Single roll caster equipped with a scraper

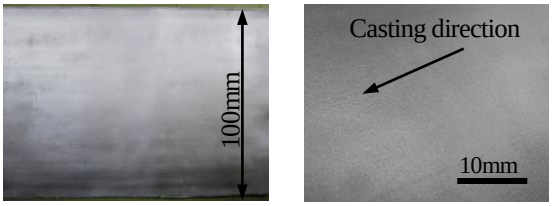


Fig. 2 Scribed surface of as-cast 5182 strip

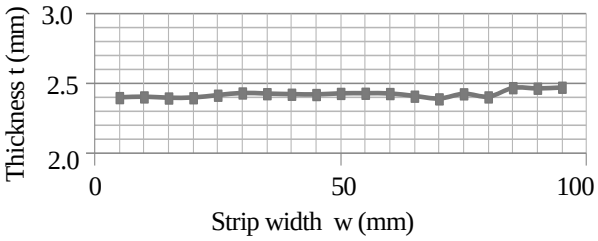
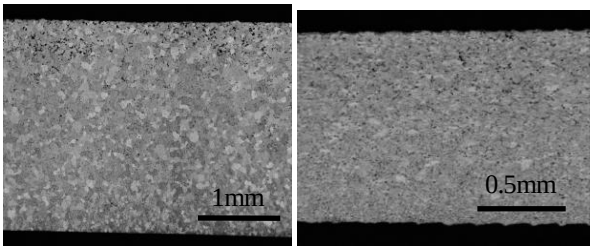


Fig. 3 Thickness distribution of as-cast 5182 strip



(a) as-cast strip (b) cold rolled and annealed

Fig. 4 Cross section of 5182 strip

3. Vertical type high speed twin roll caster

A schematic illustration of the VHSTRC is shown in Fig. 5 [1]. The VHSTRC uses hydrostatic pressure provided by a metal head to improve the contact

between the molten metal and the roll. Additionally, copper rolls are used in this system. A very fine microstructure was observed for an as-cast Al-11%Si strip cast at 60 m/min, as shown in Fig. 6. The eutectic Si was globular and smaller than 2 μm, and rapid solidification was attained. A bending test and a deep drawing test were conducted on the cold rolled and annealed 1-mm-thick plate, and the result is shown in Fig. 7. Loop bending at a 0.5 mm radius of curvature was achieved. Additionally, we performed a deep drawing test, which demonstrated that a limiting drawing ratio (LDR) of 1.9 could be achieved.

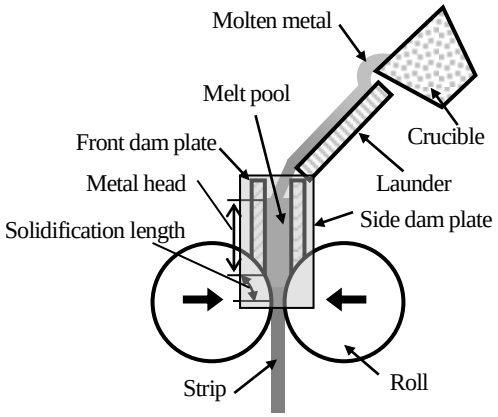


Fig. 5 Vertical type high speed twin roll caster

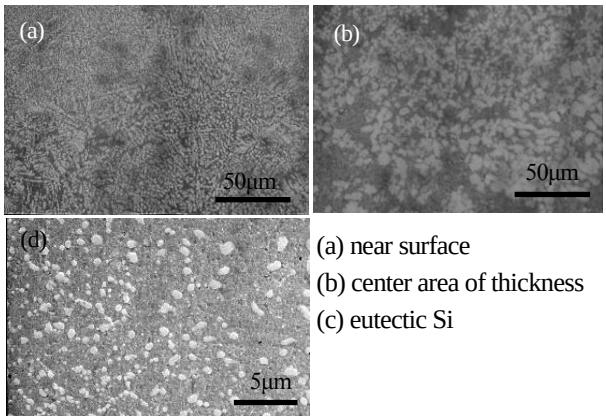


Fig. 6 Microstructure of as-cast Al-11%Si strip

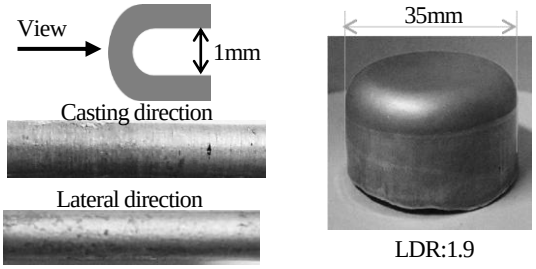


Fig. 7 Result of bending test and deep drawing test.

4. Vertical type tandem twin roll caster

A schematic illustration of the VTTRC for producing clad strips is shown in Fig. 8 [1,2]. A base strip and overlap strips are cast by the upper and lower twin roll casters, respectively. The cross-section of the as-cast three-layer clad strip cast at 30 m/min and the line analysis of Si at the interface are shown in Fig. 9. The interface between the strips was clear, and the Si in 4045 did not diffuse into 3003. A continuous bending test was conducted, as shown in Fig. 10, as an easy investigation method of the bonding conditions. It is clear from Fig. 10 that the overlay strip was strongly bonded to the base strip, because cracks did not occur at the interface between the 4045 and the 3003 alloys.

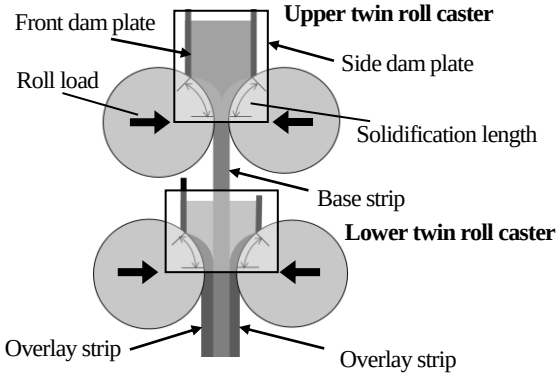


Fig. 8 Vertical type tandem twin roll caster for clad strip

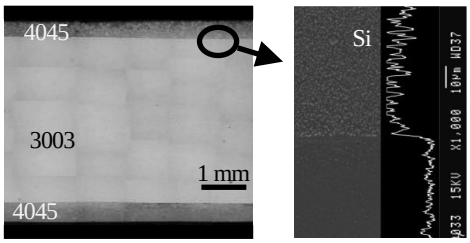


Fig. 9 Cross section of as-cast clad strip and result of line annalysis of Si at the interface

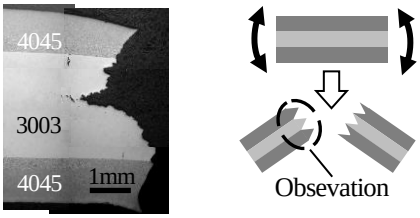


Fig. 10 Broken area after continuous bending test

5. Conclusion

Selected characteristics of innovative roll casters are discussed in this paper. These new characteristics are not features of the conventional twin roll casters typically used with aluminum alloys.

References

[1] T.Haga: Journal of Achievements in Materials and Manufacturing Engineering 43(2010) 393-402.
[2] T.Haga, R.Nakamura, S.Kumai and H.Watari: ibid. 62(2013) 36-44.