Tokyo Institute of Technology School of Materials and Chemical Technology
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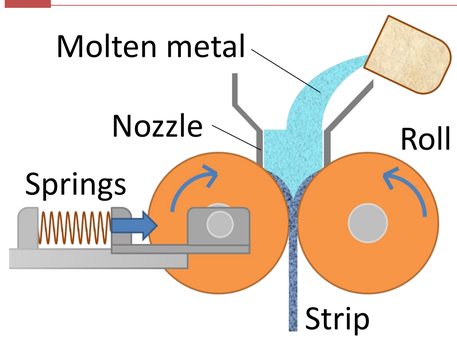
Formation of periodical marks on Al-Mg alloy strip fabricated by vertical type high speed twin roll caster

INTRODUCTION

Vertical type high speed twin roll casting



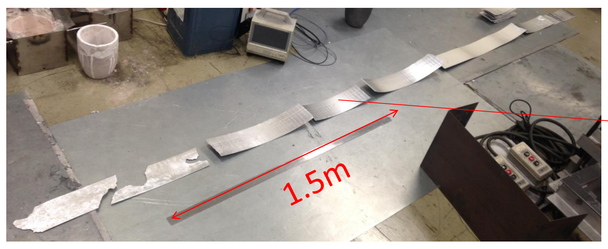
Application: car inner panel

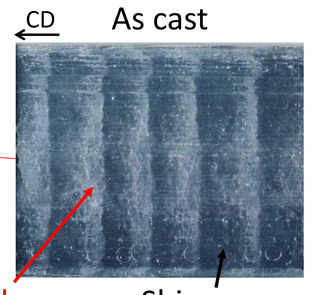

Ref. mitchellnissan.com

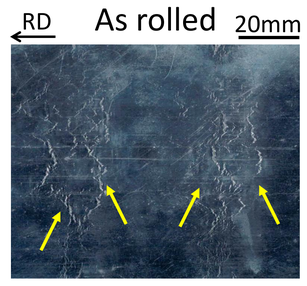

http://www.omronap.co.th

- Hot rolling processes in conventional method are skipped
  - ➡ Lower cost & energy consumption
- Rapid cooling results in finer microstructure
  - ➡ Better mechanical properties

Problem of Al-Mg strip







- Al-Mg alloy has high heat crack susceptibility
  - ➡ Many cracks & fractures even in twin roll casting
- Periodical marks on strip surface
  Muddy zone has many surface cracks unerasable by rolling

OBJECTIVE

What are periodical marks?

- Microstructural observation with SEM/OM
- Chemical analysis with EPMA

How are periodical marks formed?

- Casting with differently shaped nozzle
- Detecting melt temperature at nozzle tip

EXPERIMENTAL PROCEDURE

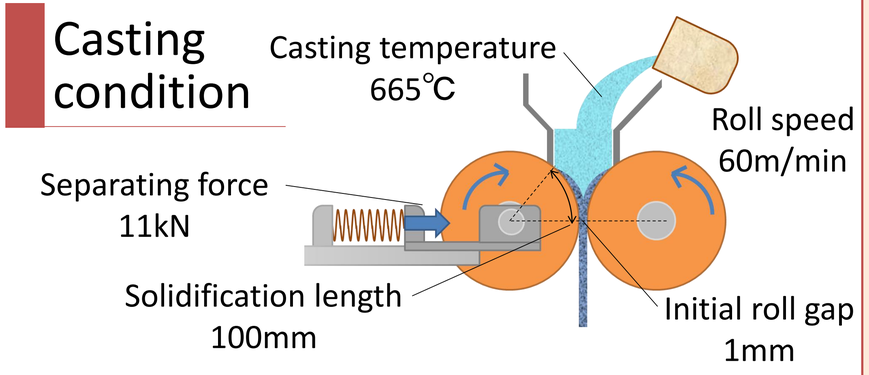
Sample: Al-Mg alloy

Chemical composition [wt%]						
Al	Mg	Si	Ti	Fe	Mn	Cu
Bal.	3.5~4.5	~0.2	~0.2	~0.3	~0.6	~0.1

Microstructural analysis

- Surface: SEM-SEI, EPMA
- Cross-section: OM etched by Weck's reagent, Keller's reagent

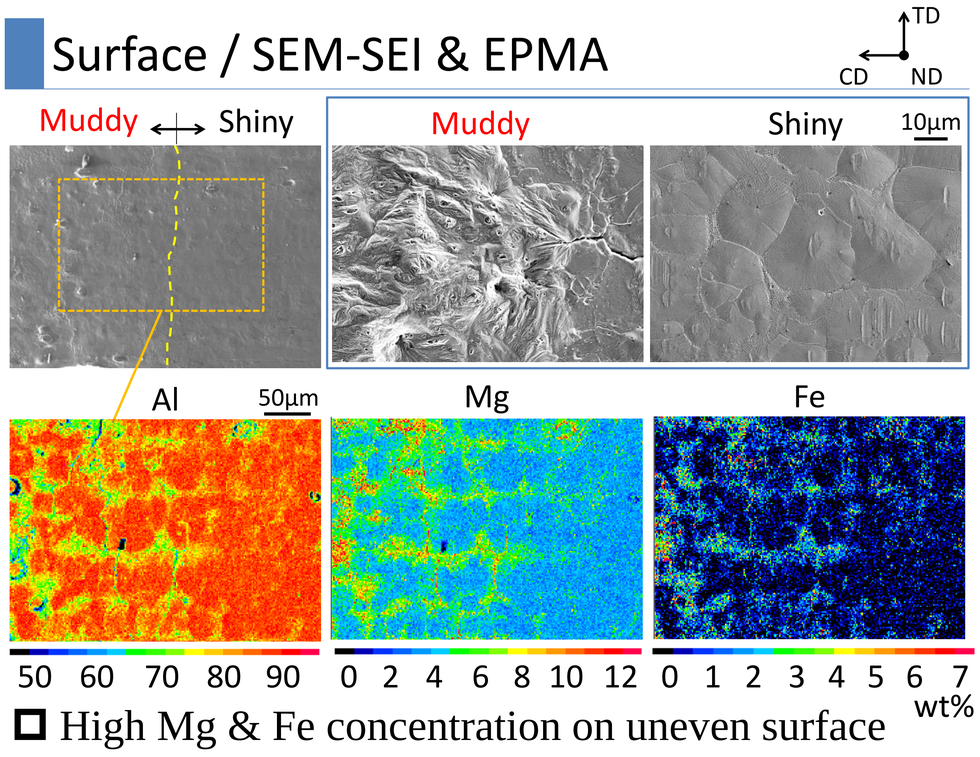
Casting condition



RESULTS & DISCUSSIONS

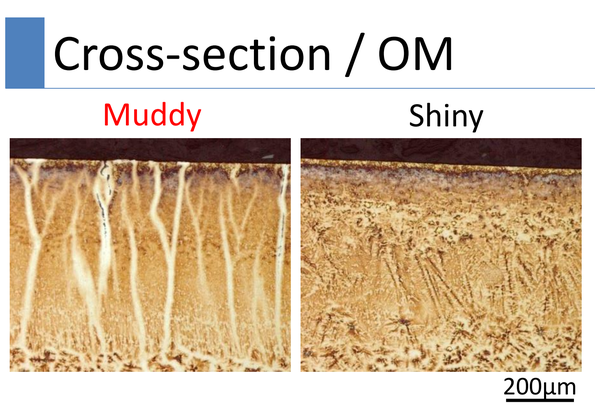
What are periodical marks?

Surface / SEM-SEI & EPMA

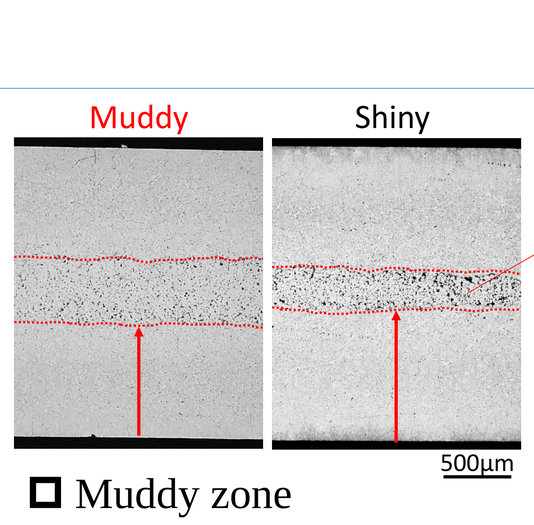


- High Mg & Fe concentration on uneven surface

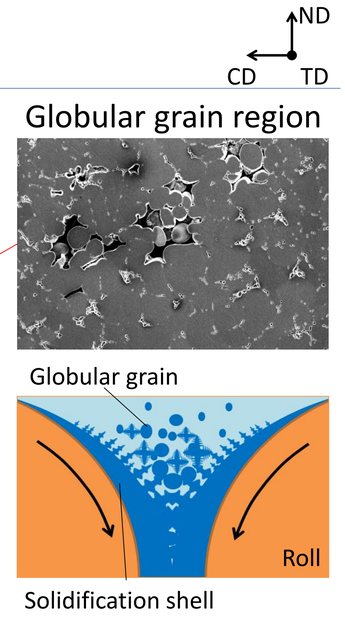
Cross-section / OM



- Muddy zone
  High Mg & crack along grain boundary to surface
  - ➡ Inverse segregation



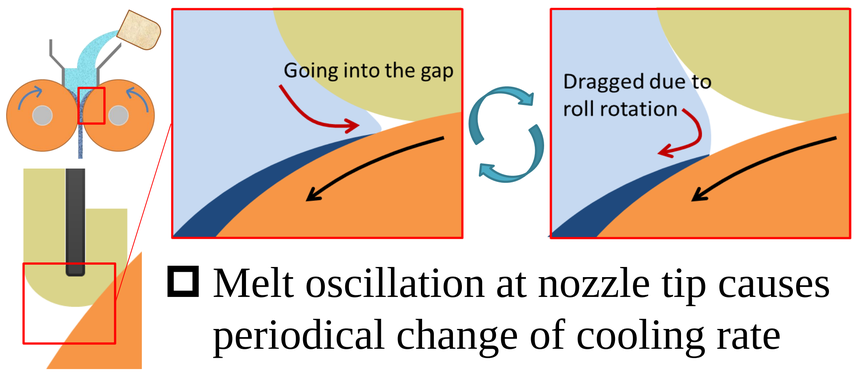
- Muddy zone
  Thinner solidification shell
  - ➡ Lower cooling rate



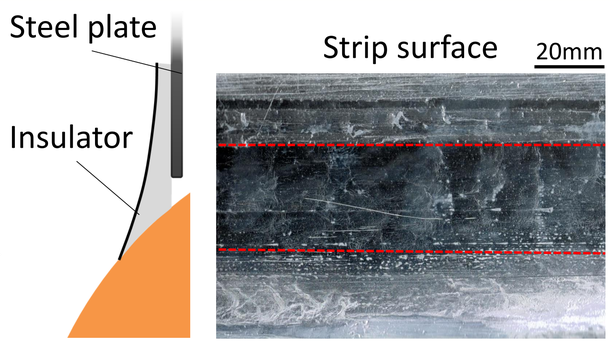
- Lower cooling rate ➡ Residual liquid was squeezed to surface ➡ Muddy zone
- Higher cooling rate ➡ No residual liquid remained ➡ Shiny zone

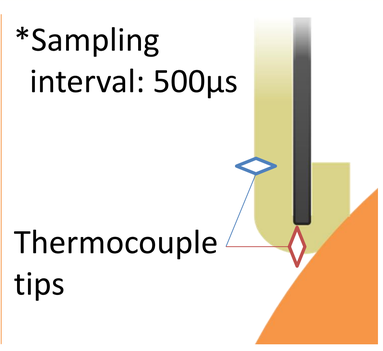
How are periodical marks formed?

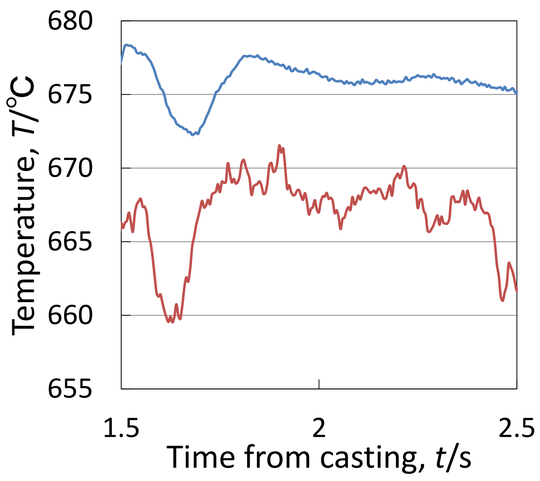
Idea & Validation



- Melt oscillation at nozzle tip causes periodical change of cooling rate







- No gap at nozzle tip erases periodical marks
- Temperature oscillation is detected only at nozzle tip

CONCLUSIONS

- Al-Mg alloy (AC7A) strip can be fabricated by vertical type high speed twin roll casting
- Problem: Periodical marks on the strip "Muddy zone" has many cracks indelible even after rolling
- Periodical marks: Lower cooling rate ➡ Residual liquid was squeezed toward surface ➡ Muddy zone
- Formation of periodical marks: Periodical melt oscillation at the nozzle tips ➡ Periodical change of cooling rate