Magnesium Diffusion and Flux Interactions During Controlled Atmosphere Brazing

By

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Scope:

- Introduction
- Why add magnesium?
- Pre-existing oxide - surface and sub-surface
- Mg Diffusion - braze cycle
- Sumitomo work - core/clad Mg interaction
- Summary
- Future work

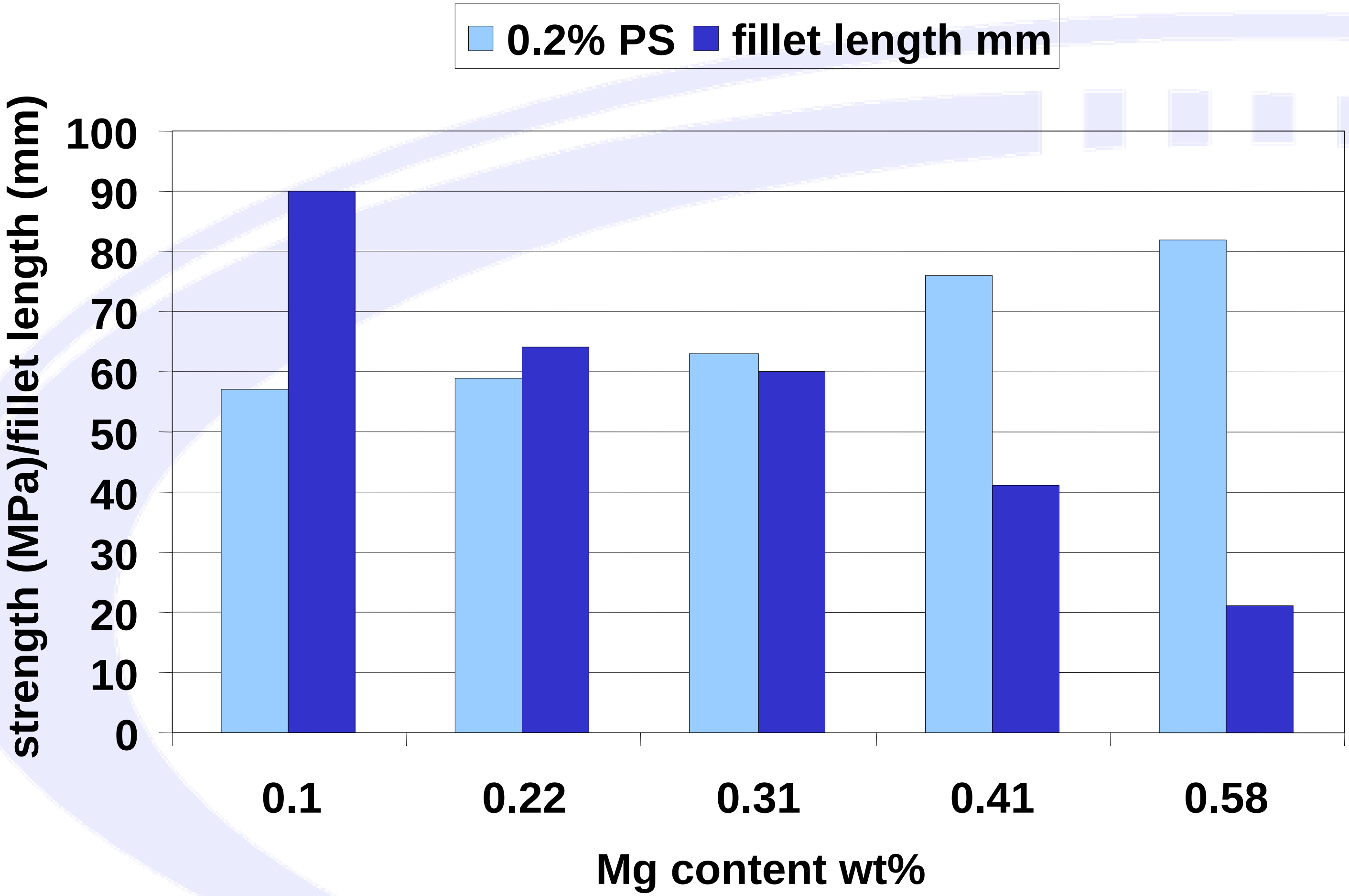
Why Add Magnesium?

- potent solid solution strengthening
- does not limit absorption of process scrap
- no ELV limitations on recycling

………..However:

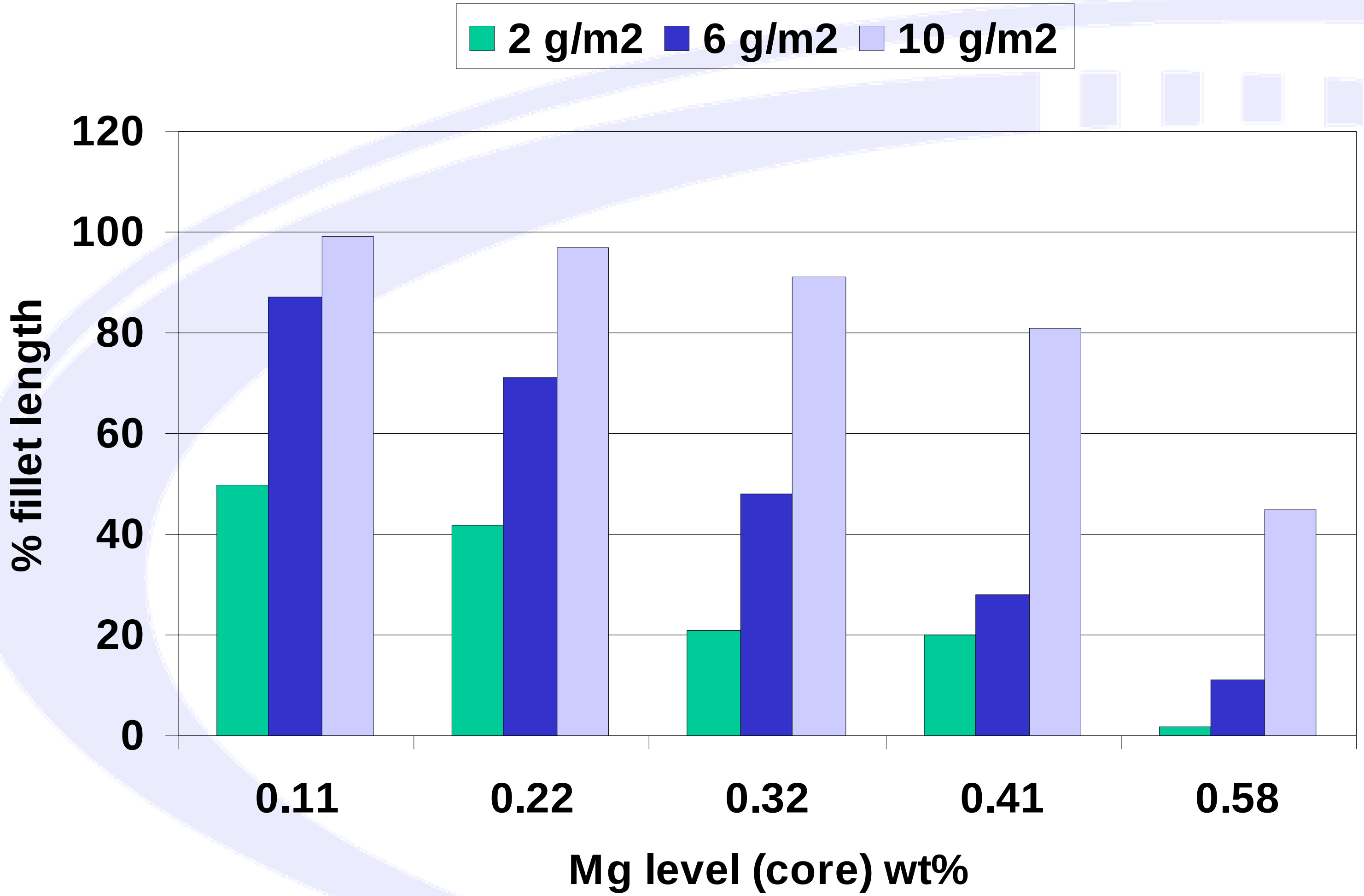
- flux 'poisoning'
- increased flux consumption or
- alternative flux packages

Influence of Mg Additions:



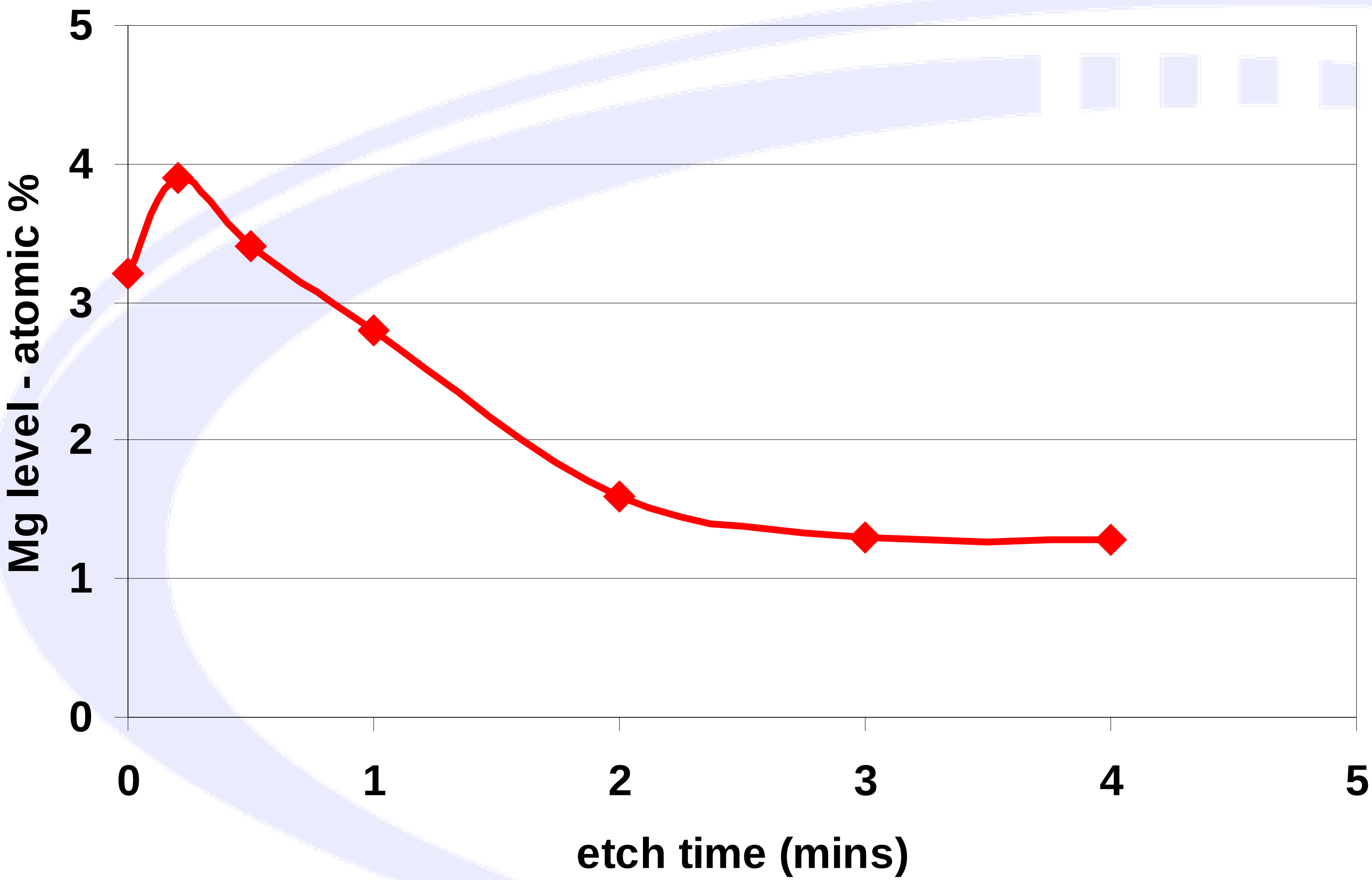
Gray et al, AFC Brazing Seminar October 1998

Influence of Mg Additions:

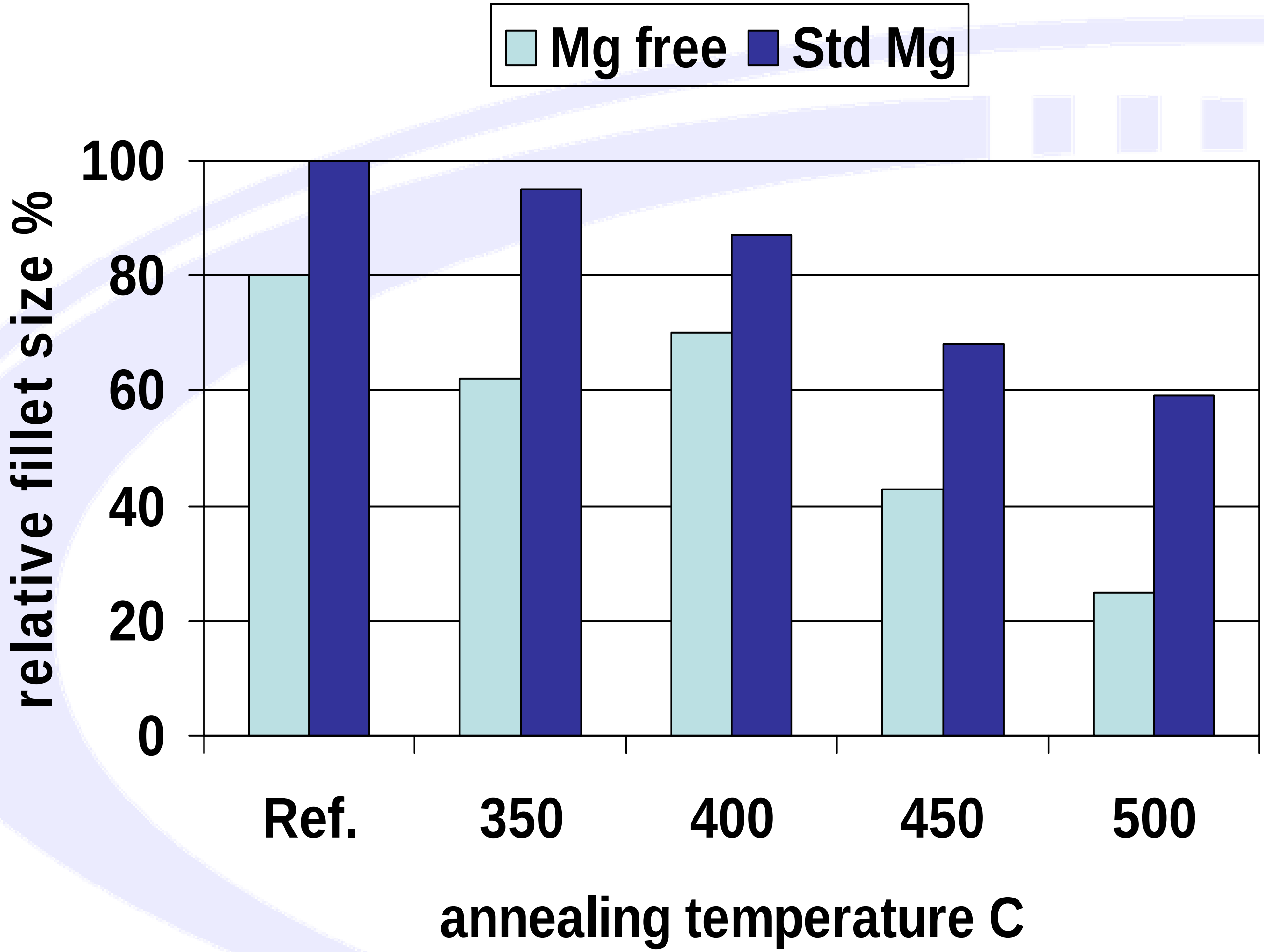


Lauzon et al, AFC Brazing Seminar October 1998

Mg Profile After Batch Anneal



Pre-existing Oxide - VB



Wittebrood et al, Corus
SAE 1971

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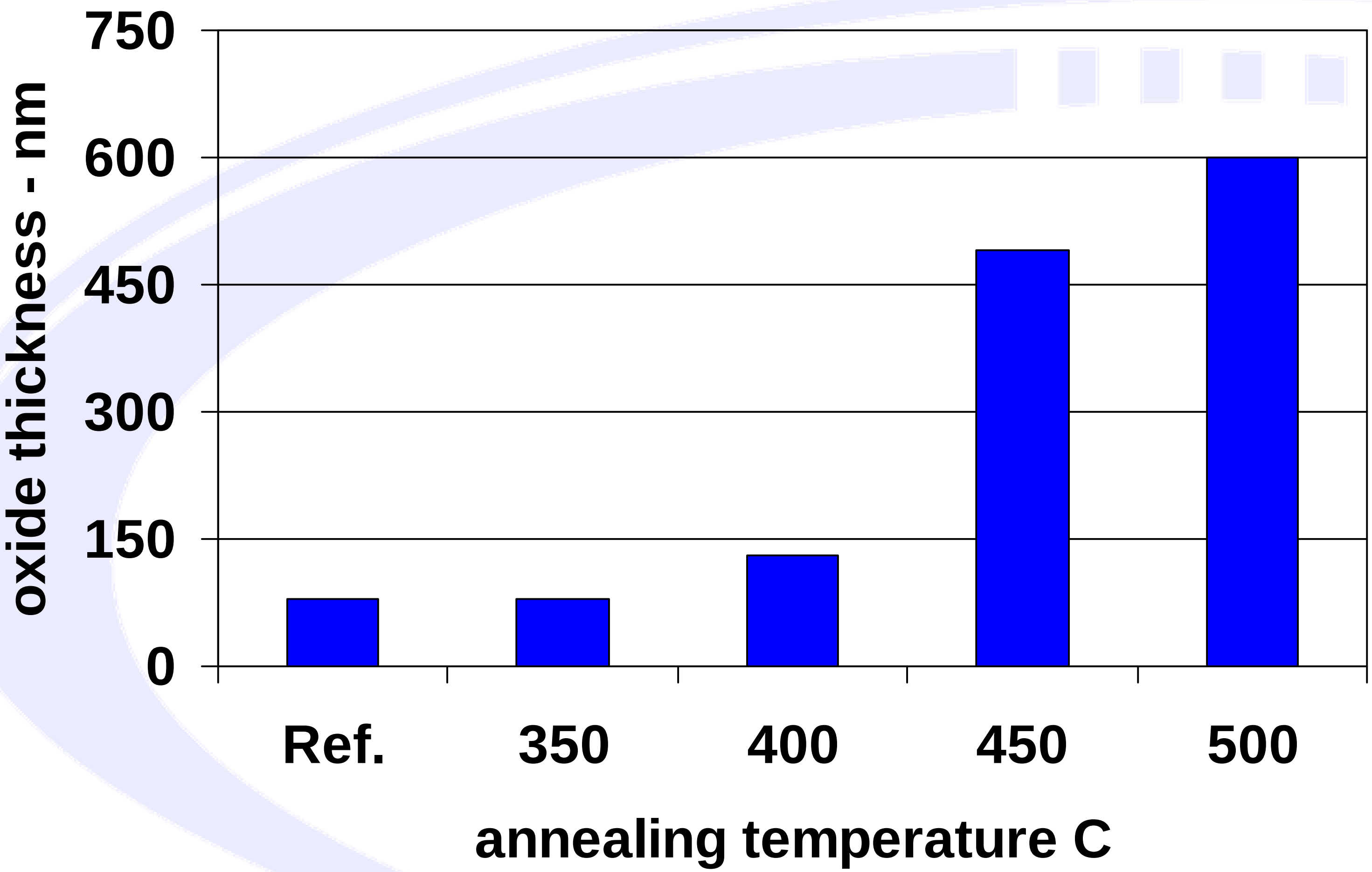

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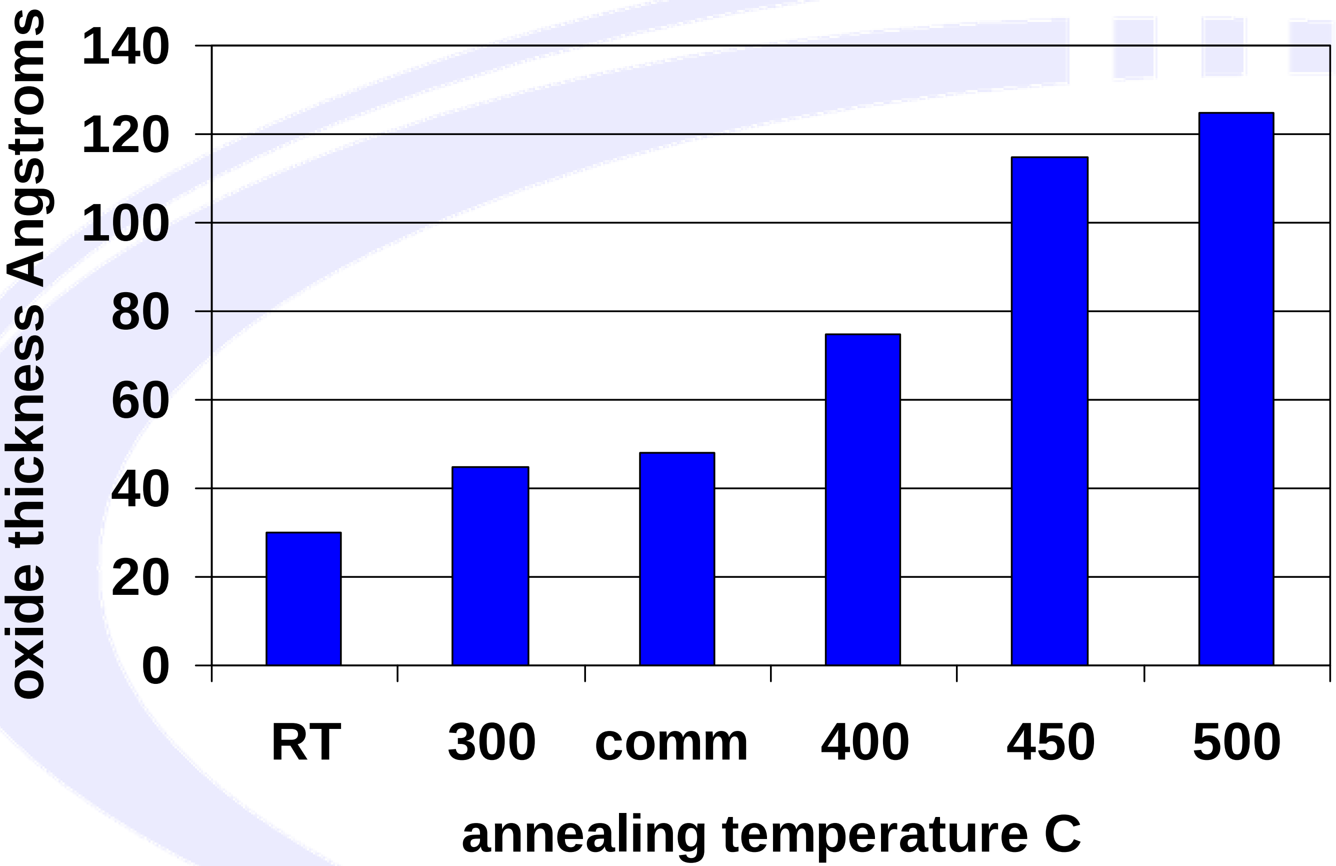
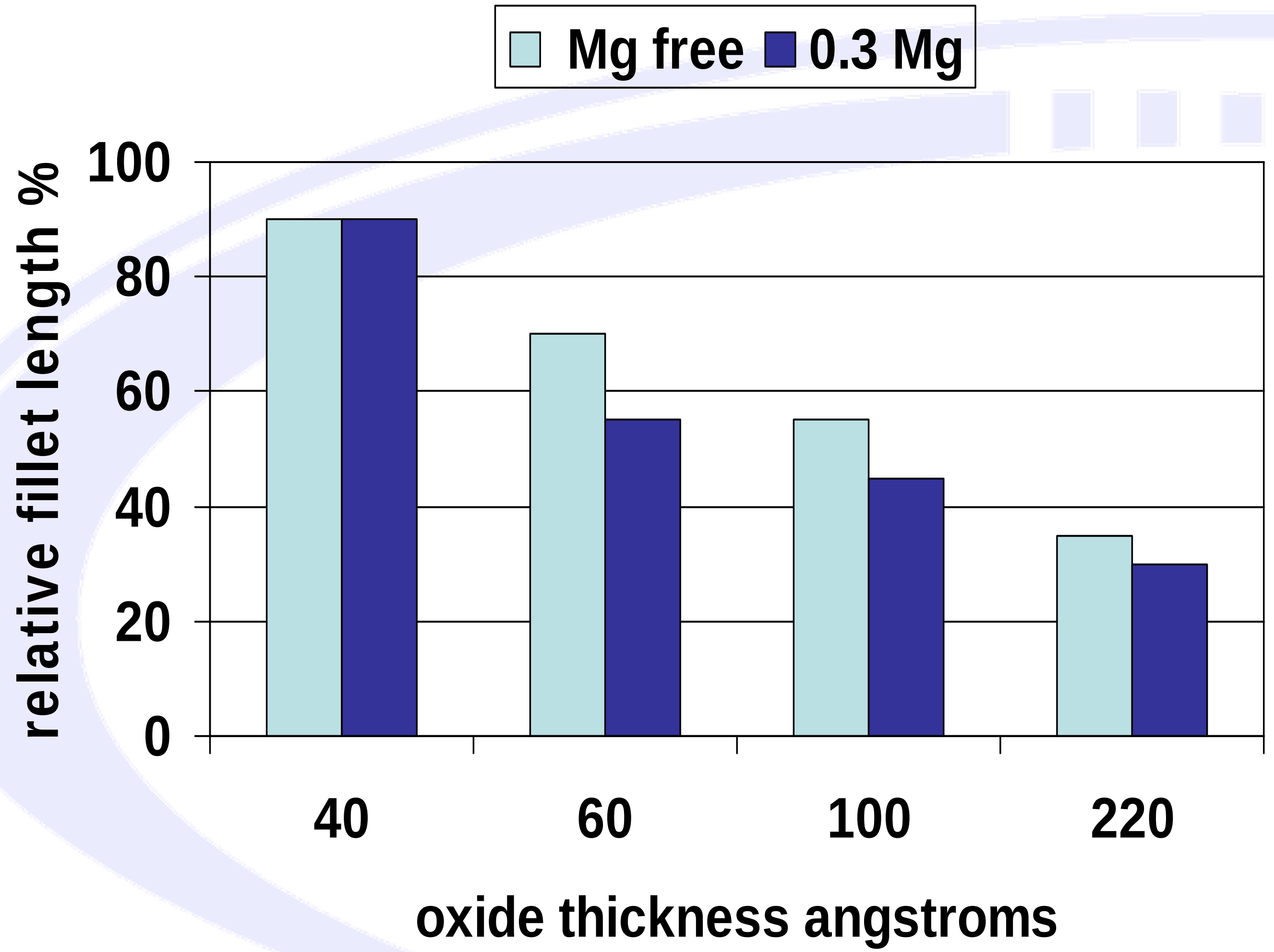


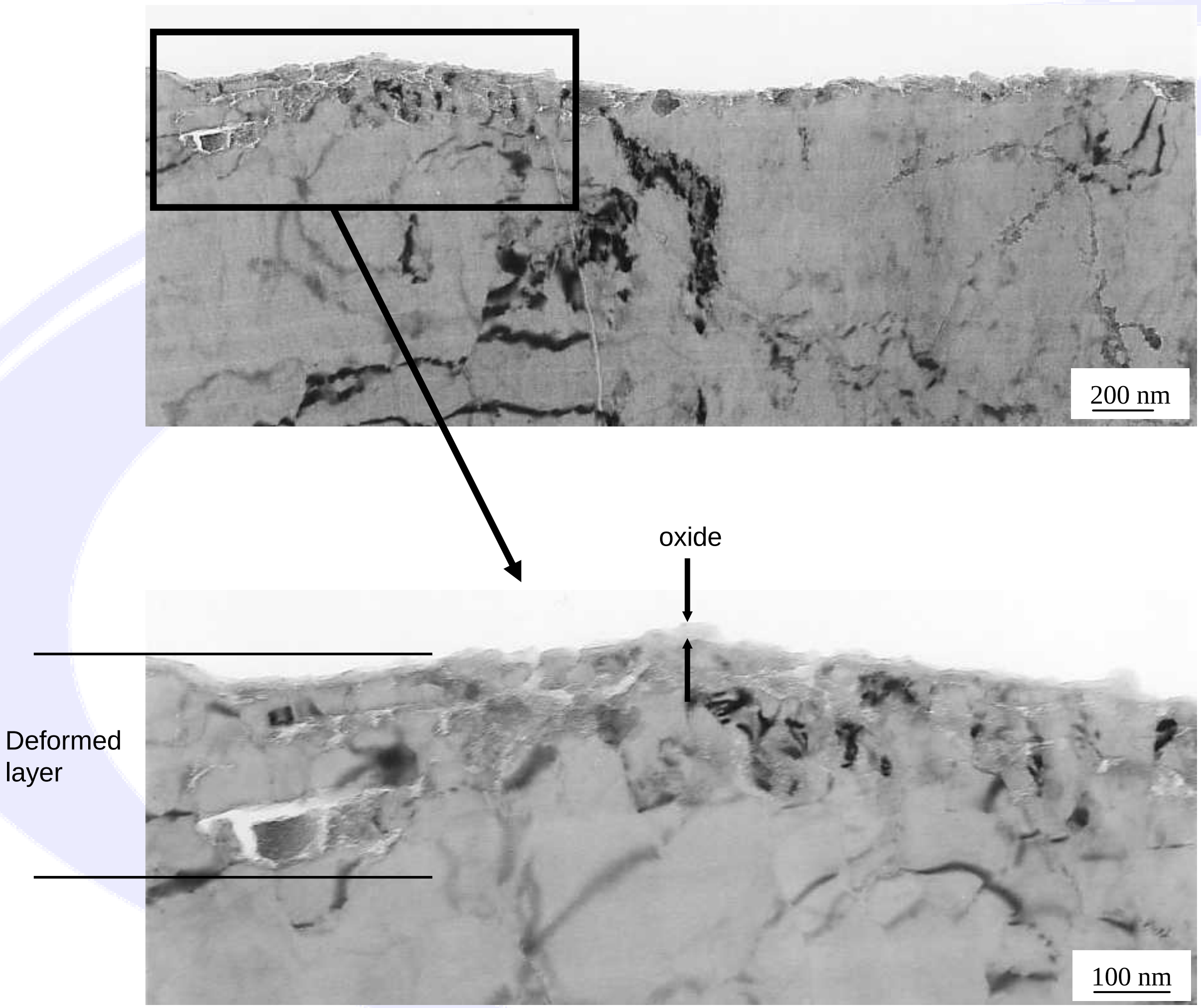
Olefjord et al,
SAPA 4th International Conf. 1994

Pre-existing Oxide - CAB



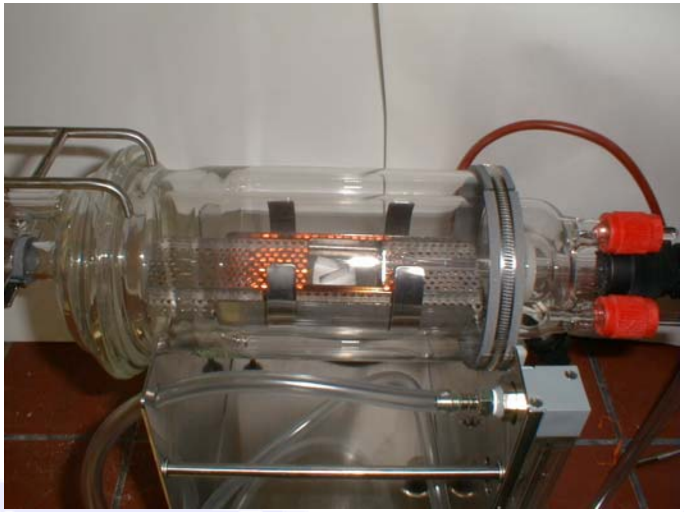
Gray et al, Alcan
VTMS 1999

Sub-surface Oxide – 'disturbed layers'

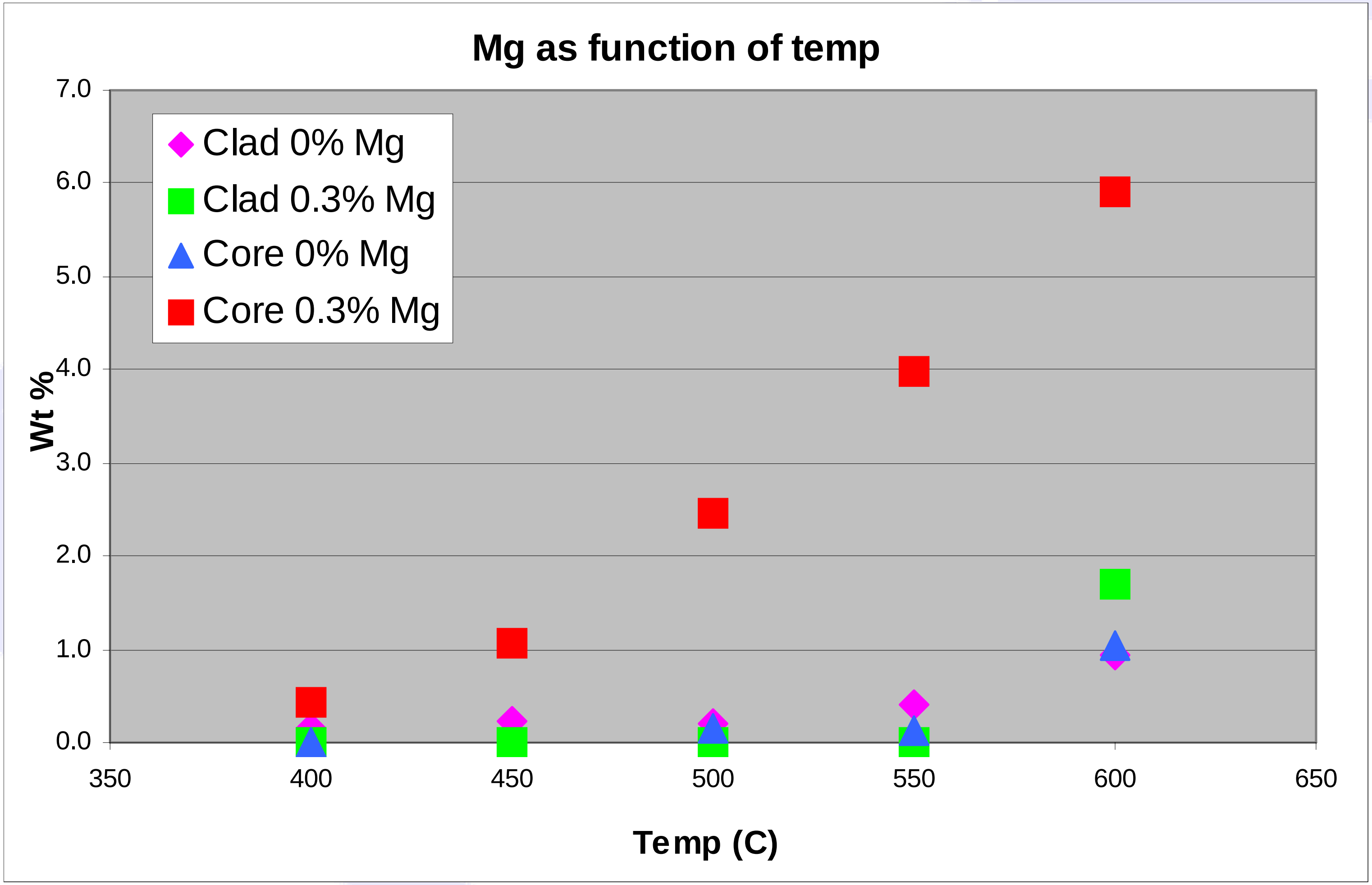


Experimental:

- 3003 core alloys with <0.1 and 0.31 wt% Mg
- Oxidation behaviour - 400, 450, 500 & 550°C
- Brazing cycle - 20 mins to 600°C and 2 min hold
- Flux load - 5 g m^{-2}
- Laboratory tube furnace (Solvay Fluor)



Oxidation Behaviour:



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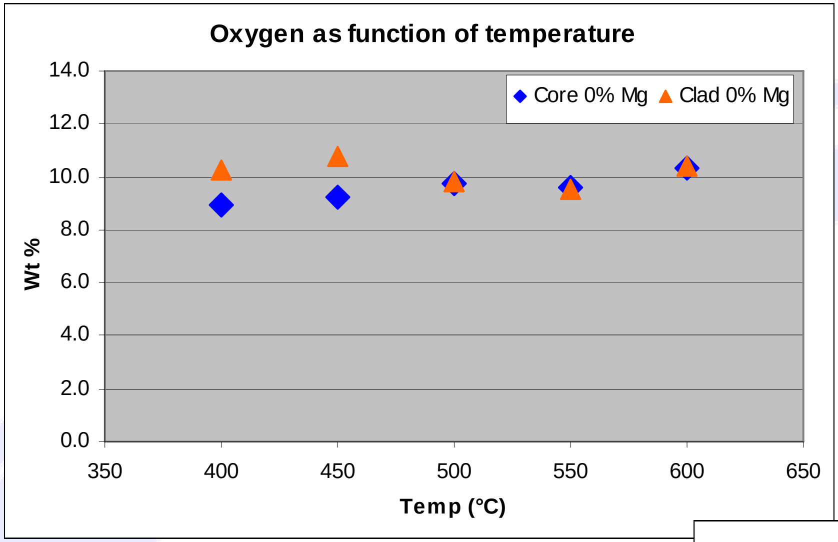
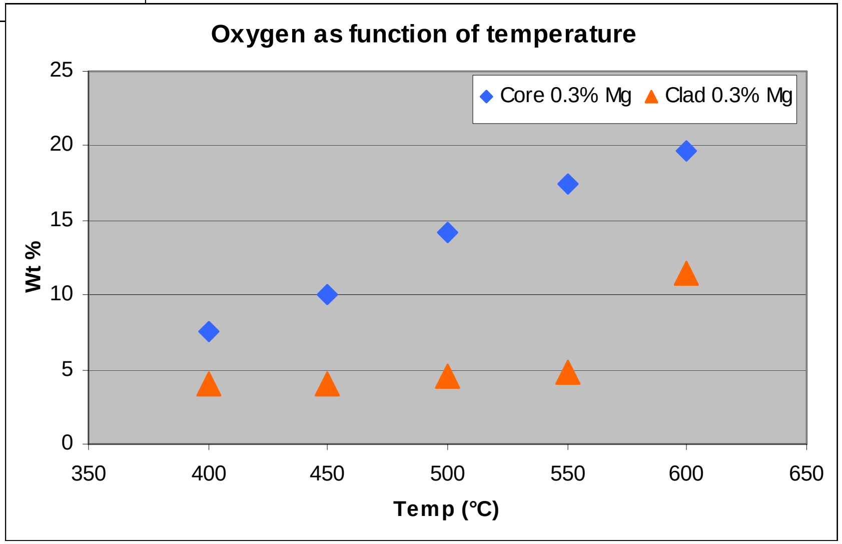
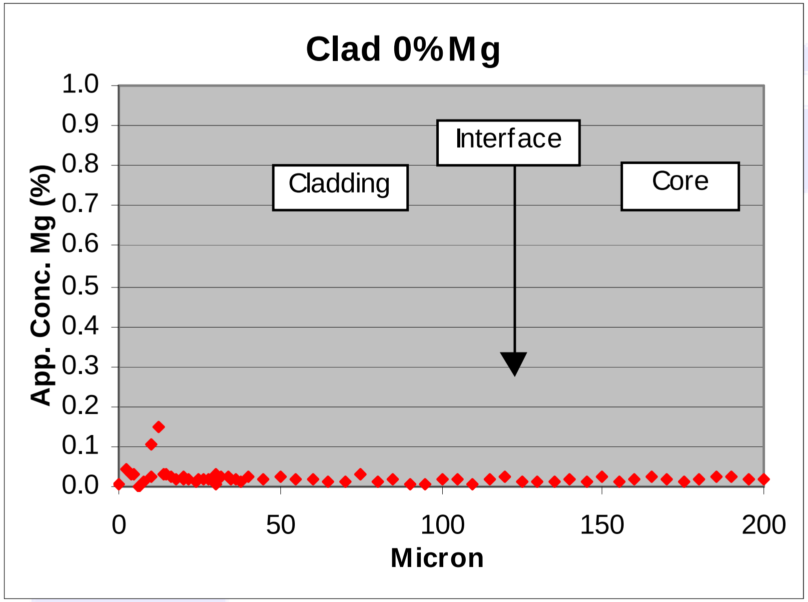
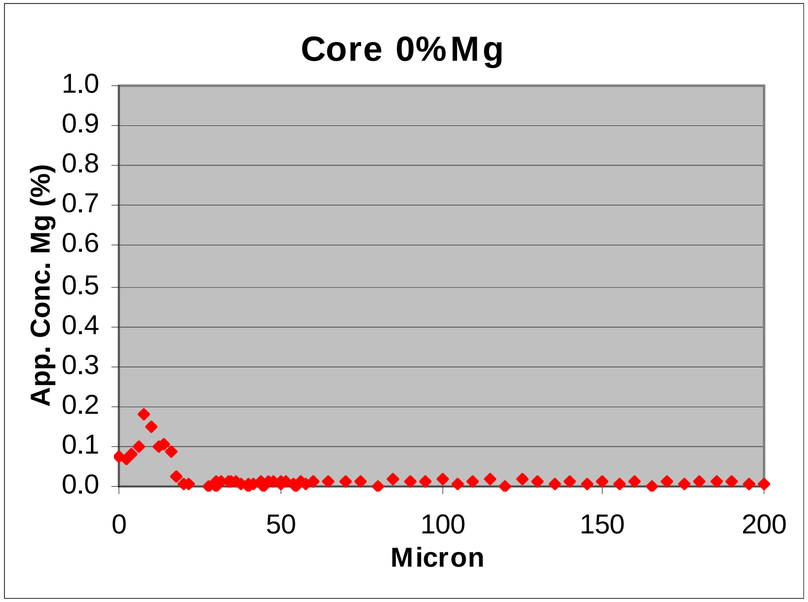




Mg Profiles - Clad/core Interface





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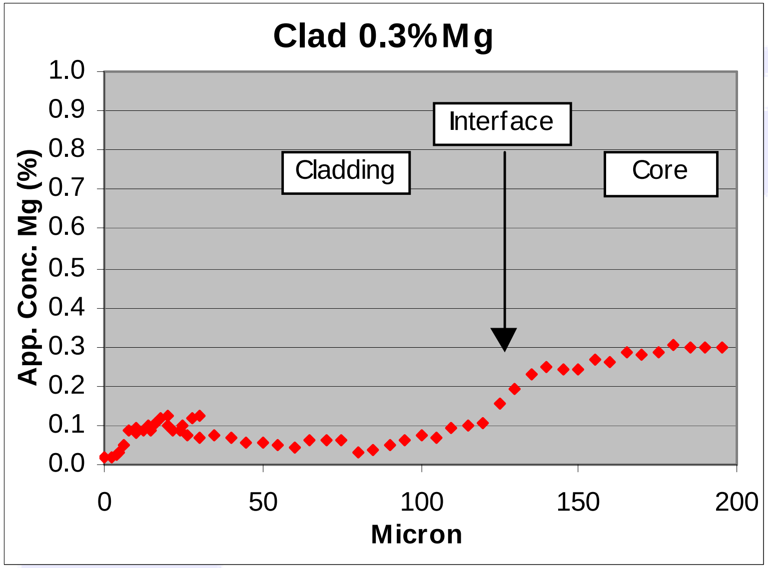
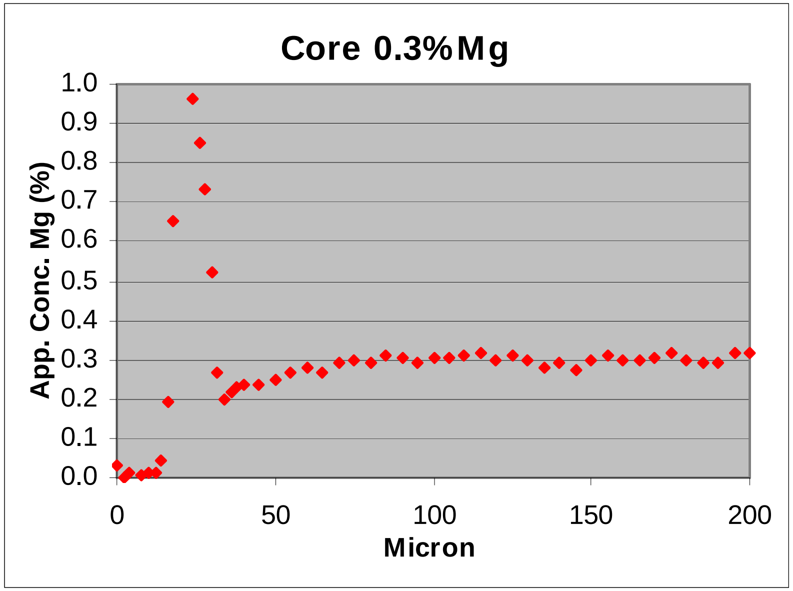
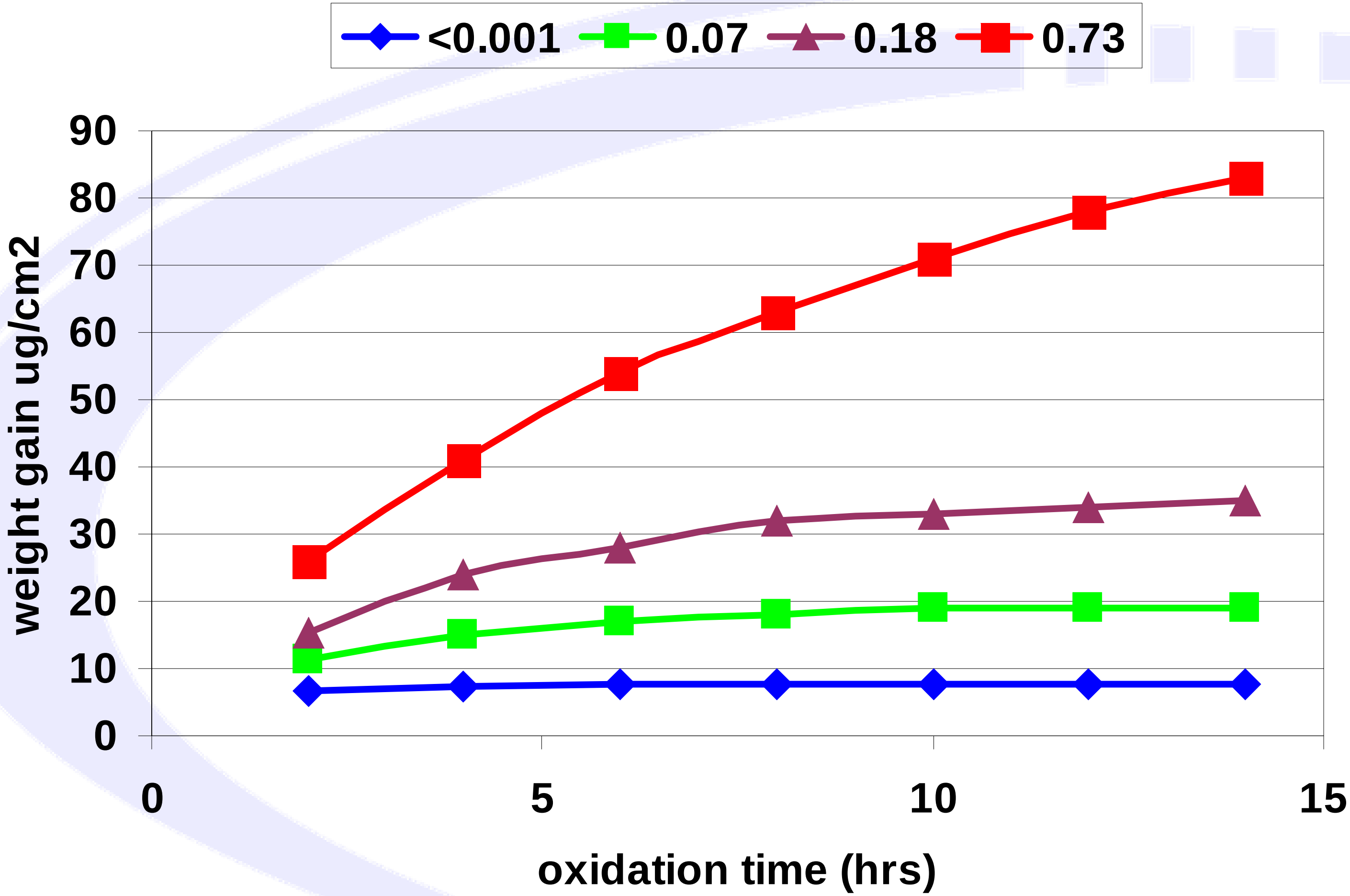
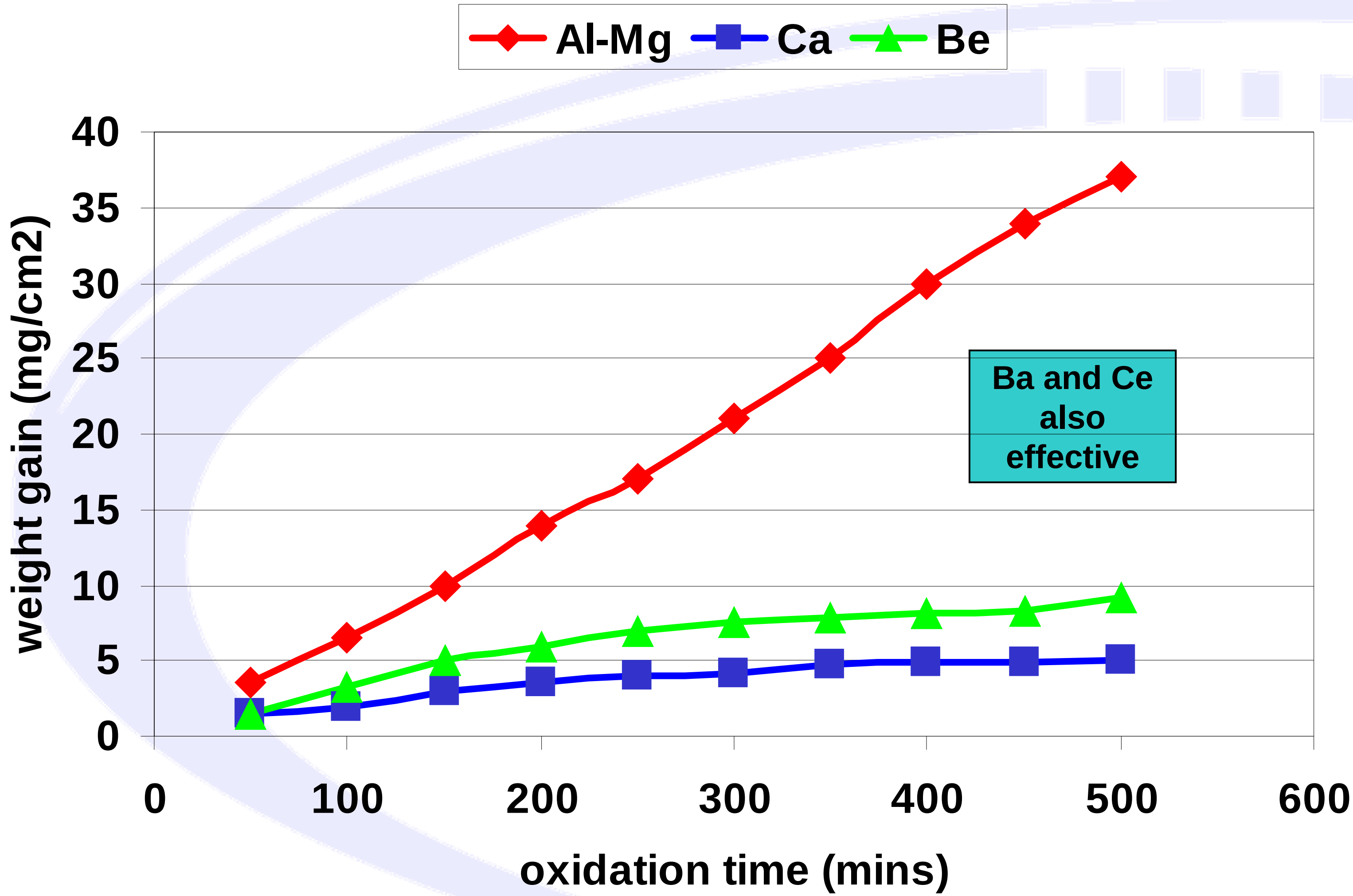




Al-Mg Alloys - Oxidation Rates at 595°C

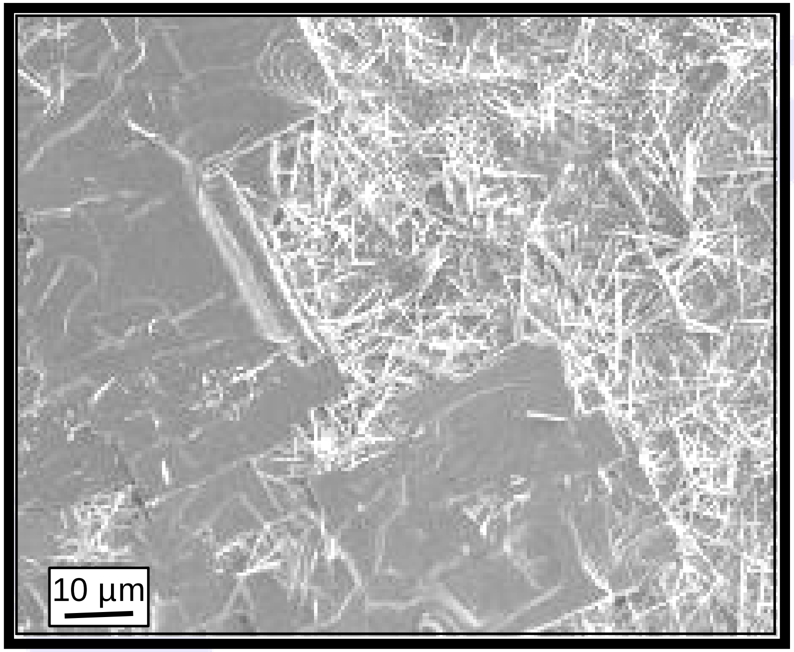


Oxidation Suppressants: 480°C

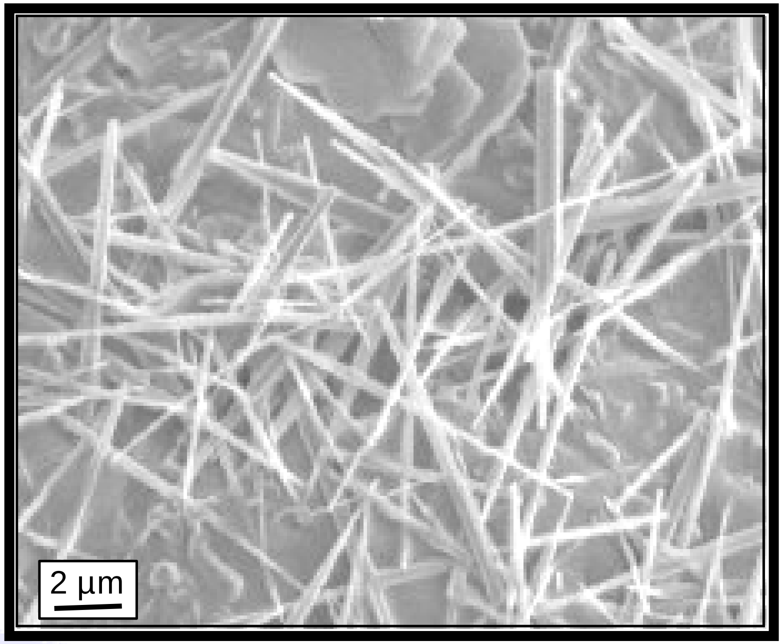


Field et al, Alcan International Ltd

Flux Morphology:



Clad Surface
<0.1 wt Mg core



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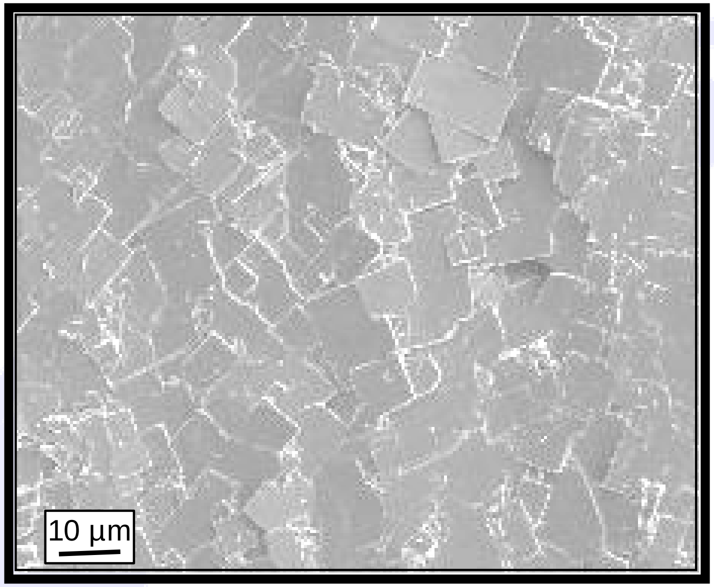
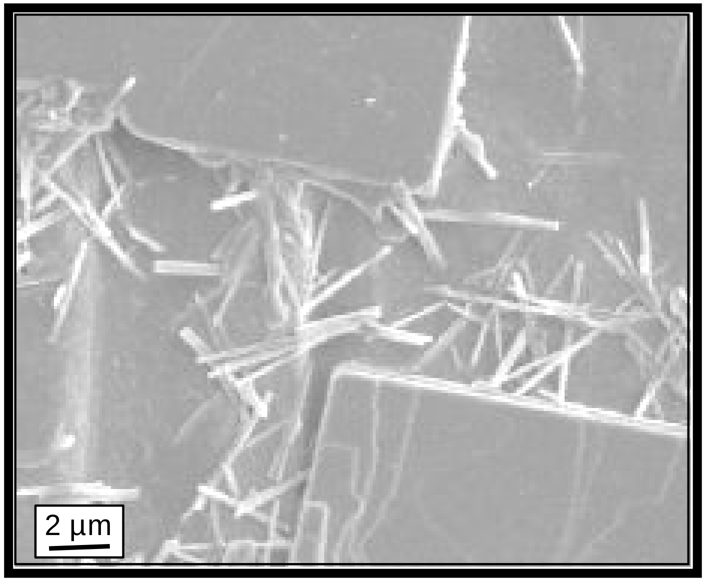


Core surface
<0.1 wt% Mg core



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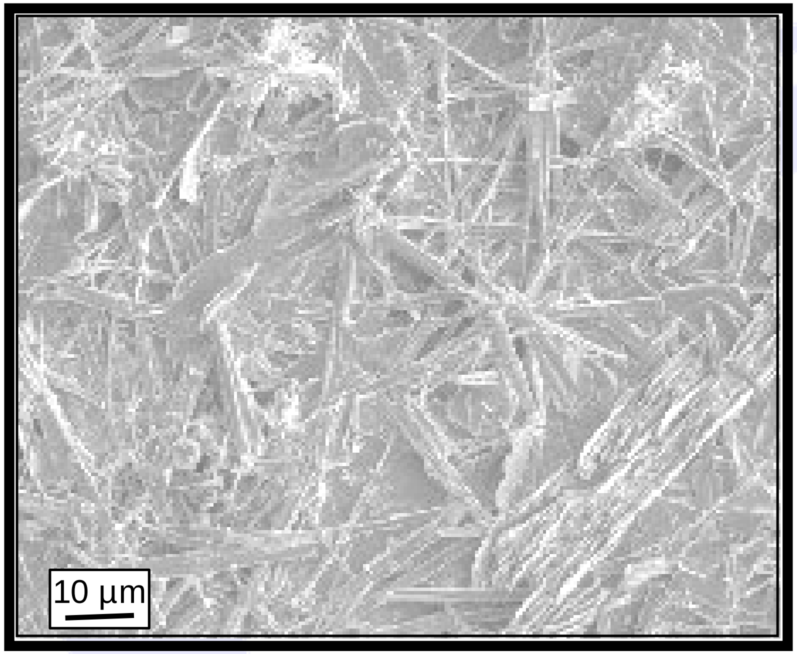
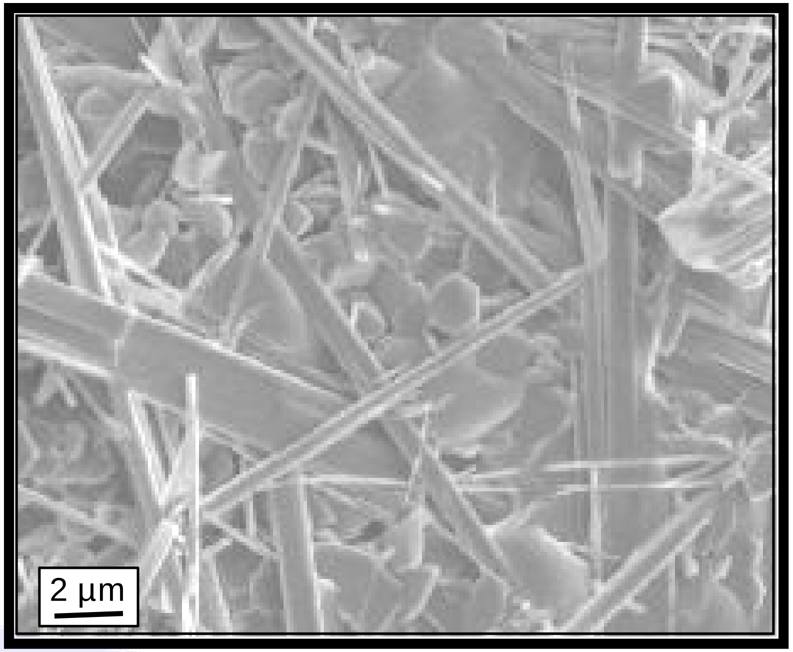


Clad Surface
0.3 wt % Core



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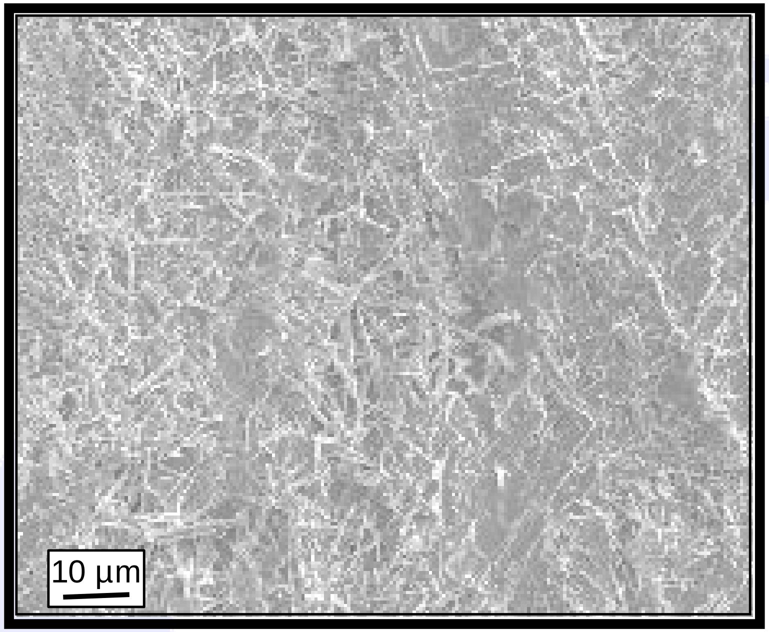
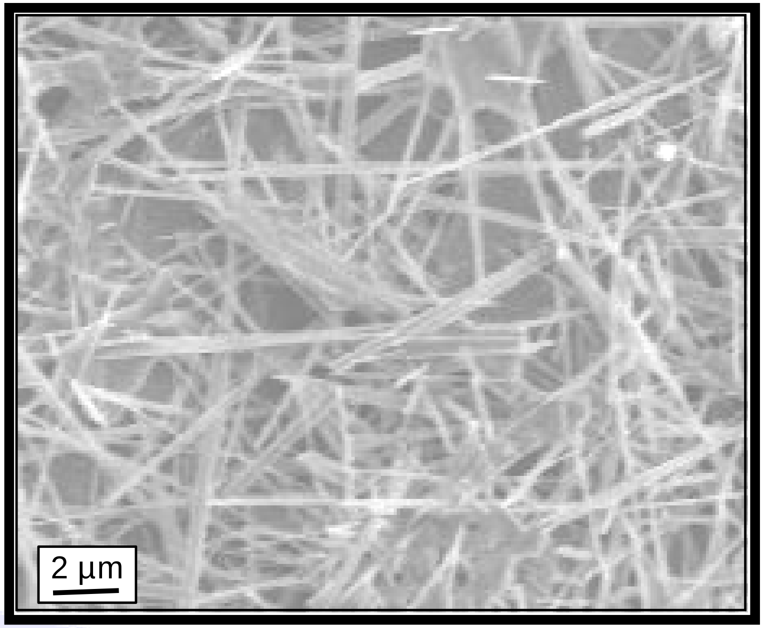


Core Surface
0.3 wt% Mg core

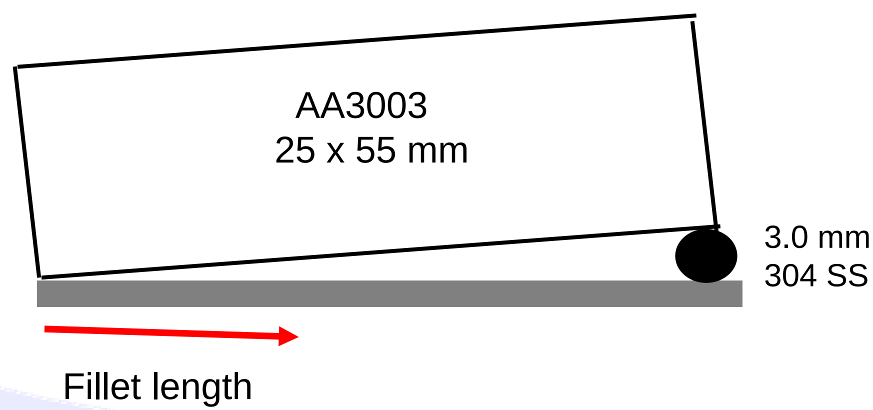


Sumitomo Paper: Material & Test Method

Al-10% Si
Mg = 0.006, 0.016, 0.028 & 0.065 wt%

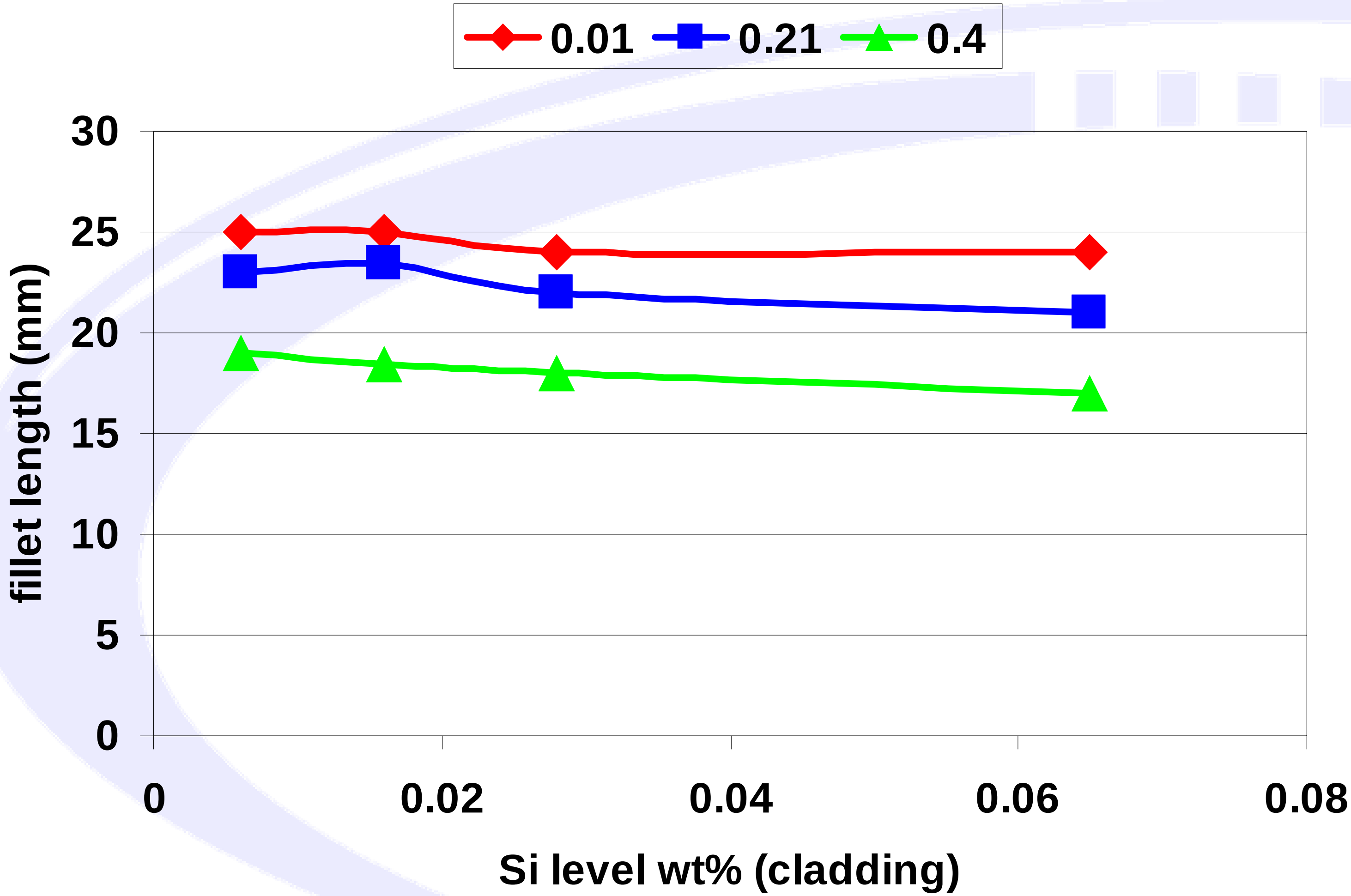
Core alloy Al-1.2Mn
Mg = 0.01, 0.21 & 0.40 wt%

Flux levels:
32 g m^{-2}
8 g m^{-2}
2 g m^{-2}



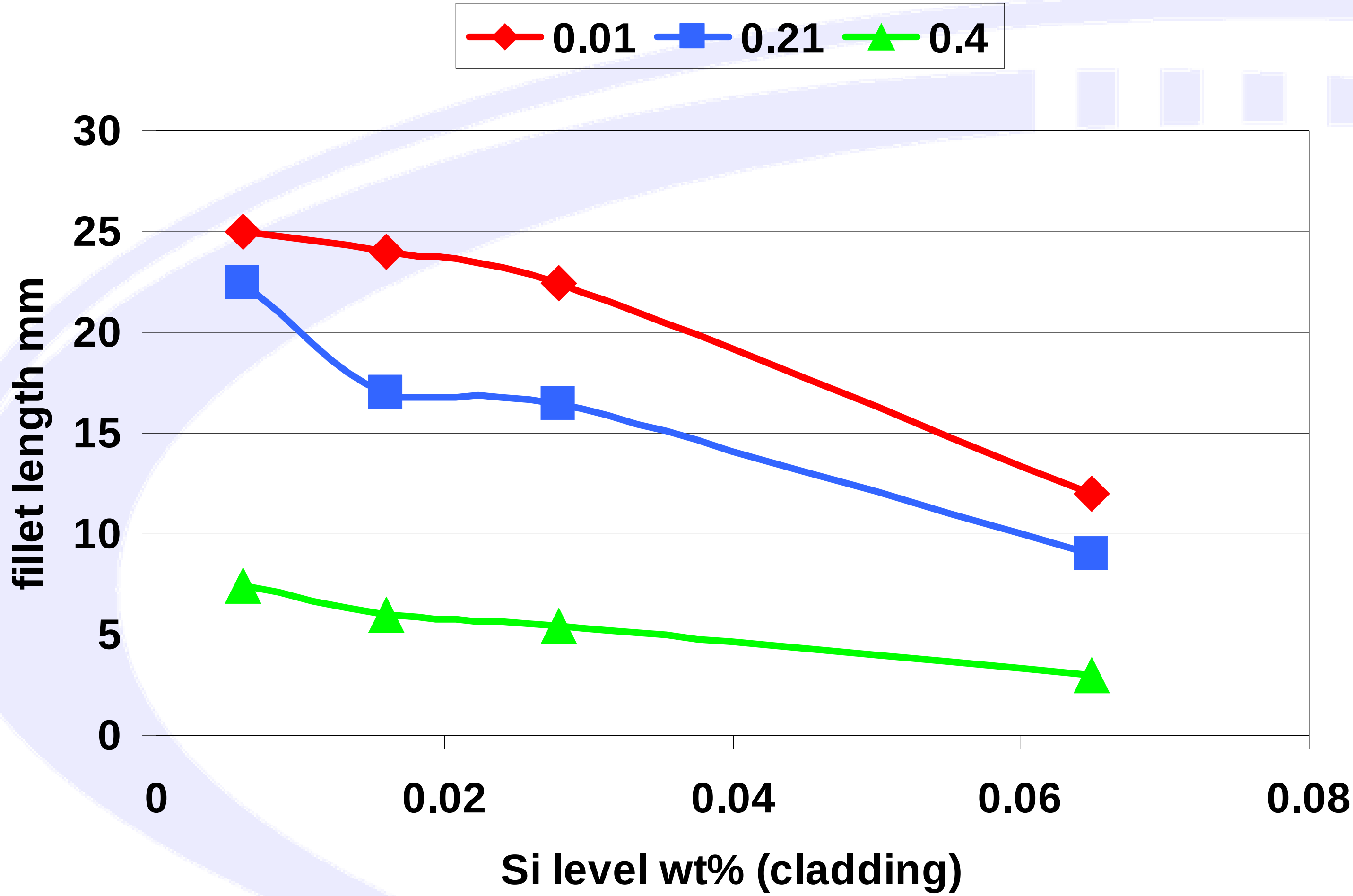
Hisatomi et al,
Jpn Inst. Light Metals 1998

Clad/core Mg Interactions: High Flux



Hisatomi et al,
Jpn Inst. Light Metals 1998

Clad/core Mg Interactions: Low Flux



Hisatomi et al,
Jpn Inst. Light Metals 1998

Summary:

- Pre-existing oxide (surface) reduces clad fluidity
- Influence of sub-surface oxide?
- Increasing Mg level in Al-Si cladding reduces melting point and extends melting range
- Majority of Mg retained in solid solution in the cladding alloy
- Reducing Mg level in cladding increases tolerance in core
- Increasing clad thickness will increase tolerance to Mg

Future Work:

- Oxidation suppressants in clad alloy
- Mg clad/core interactions
- Clad/core with interlayer
- Mg/Flux interactions
- Removal of surface and sub-surface oxide