High-Throughput Experimental Screening of CCAs

Introduction for the experimental part of “High-throughput experimental and Calphad screening of CCAs (Hi-TeCC) – towards new alloys with exceptional mechanical properties”

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Outline

- Motivation
- Methodology
  - Laser Metal Deposition
  - Alloy Selection
- Preliminary Results
  - Mechanical Properties
  - Microstructure
- Outlook

Motivation

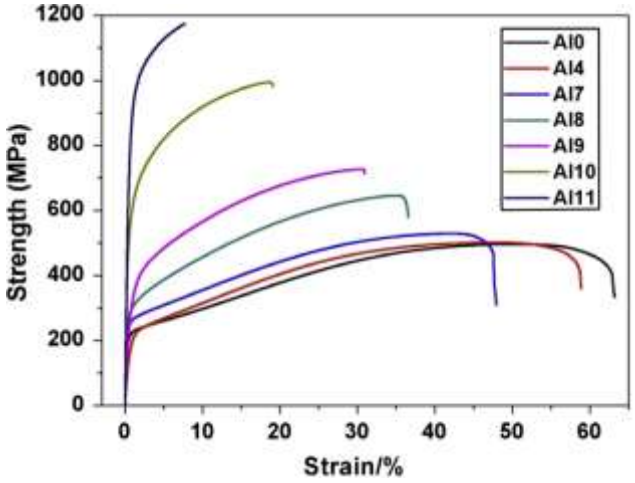
- Comparatively poor mechanical properties of Cantor alloy

  ➔ Can be improved by CCA concept
- But large alloying space makes selection difficult

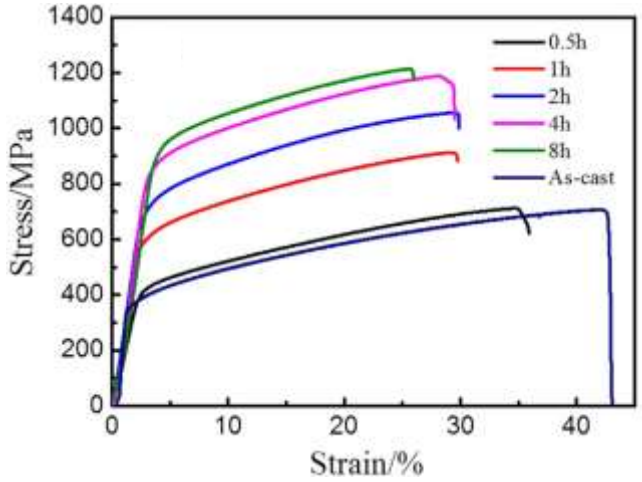
<u>Approach in Hi-TeCC</u>

- Thermodynamic calculation to determine alloying range
- Rapid screening via Laser Metal Deposition
- Focus on Co-Co-Fe-Mn-Ni (+Al +C) system

CoCrFeMnNi +Al (at%) [1]



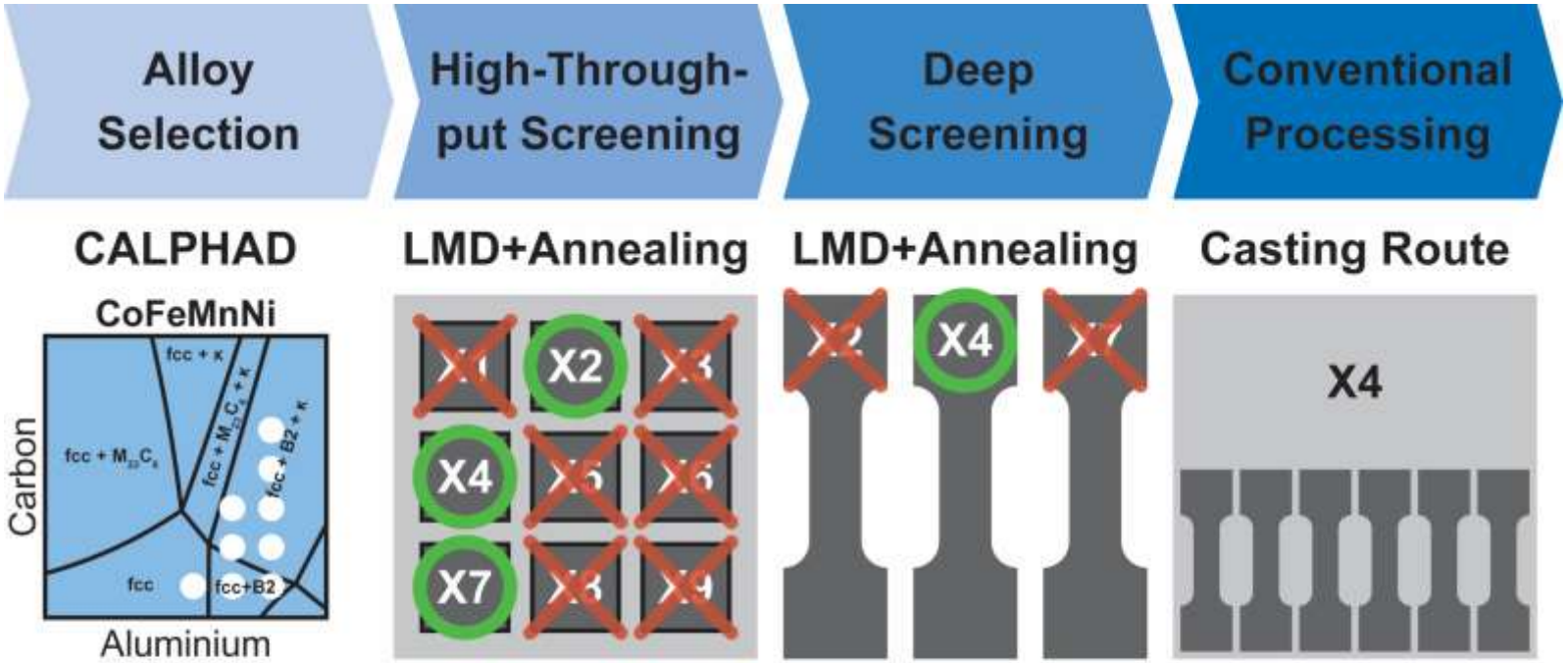
$Al_{0.5}$CoCrFeNi 650 °C annealing [2]



1 [J.Y. He et al., Acta Mater. 62 (2014), pp. 105-113]

2 [S. Niu et al., Mater. Sci. Eng. A 671 (2016), pp. 82-86]

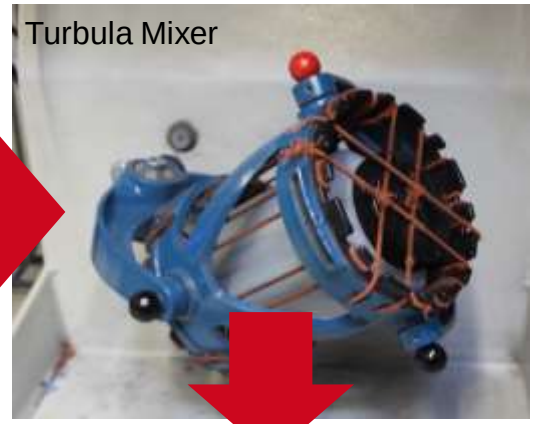
Methodology

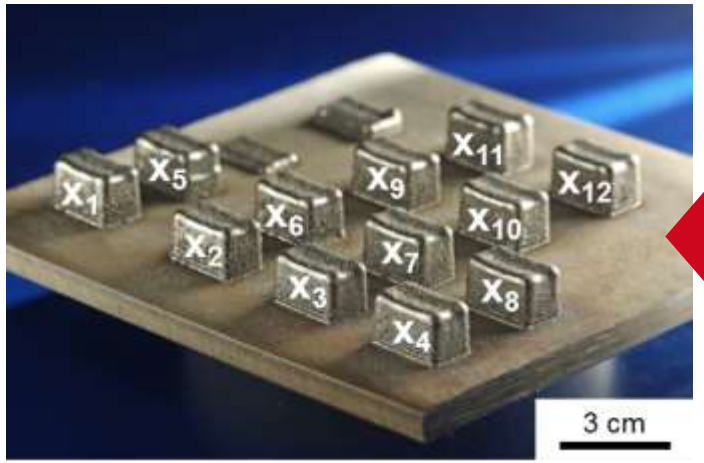


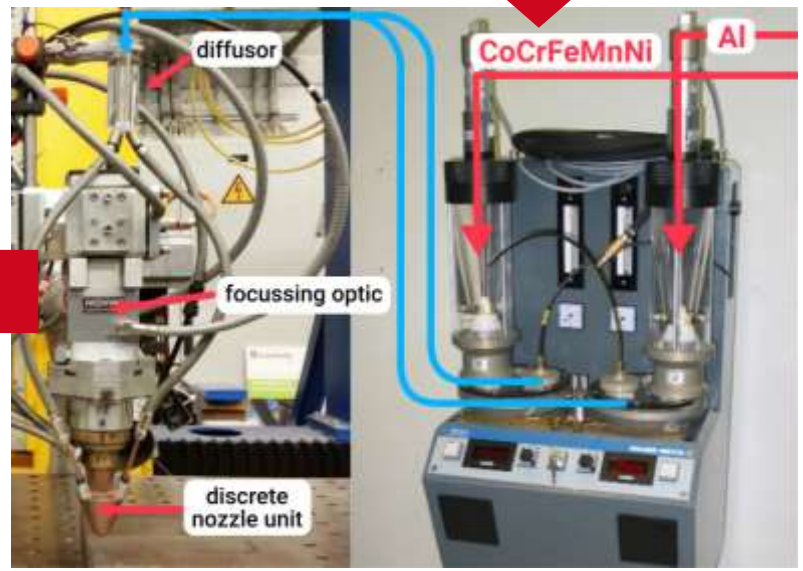
Laser Metal Deposition

- High flexibility and rapid sample production
  - Pre-mixed Cantor powder
  - In-situ alloying
- High cooling rates
- Dendritic Microstructure far from equilibrium

➔ Post heat treatment necessary

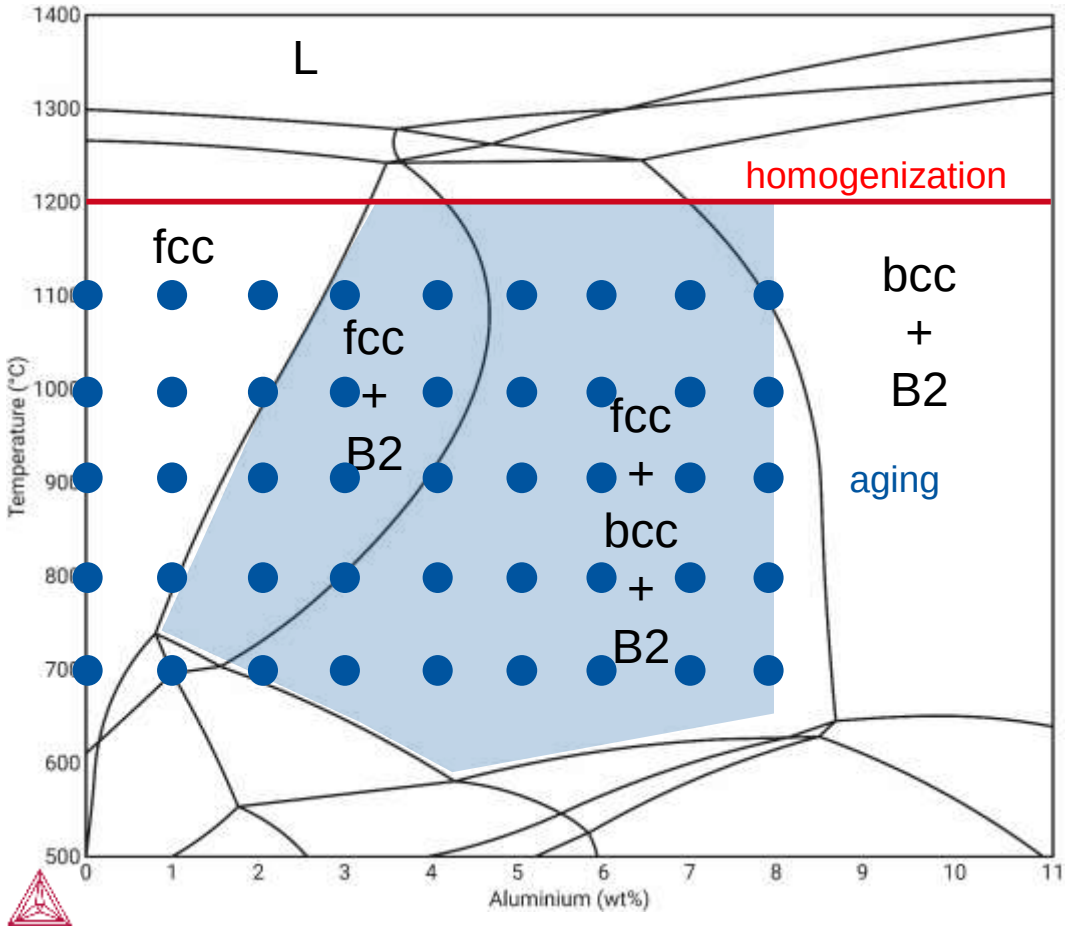




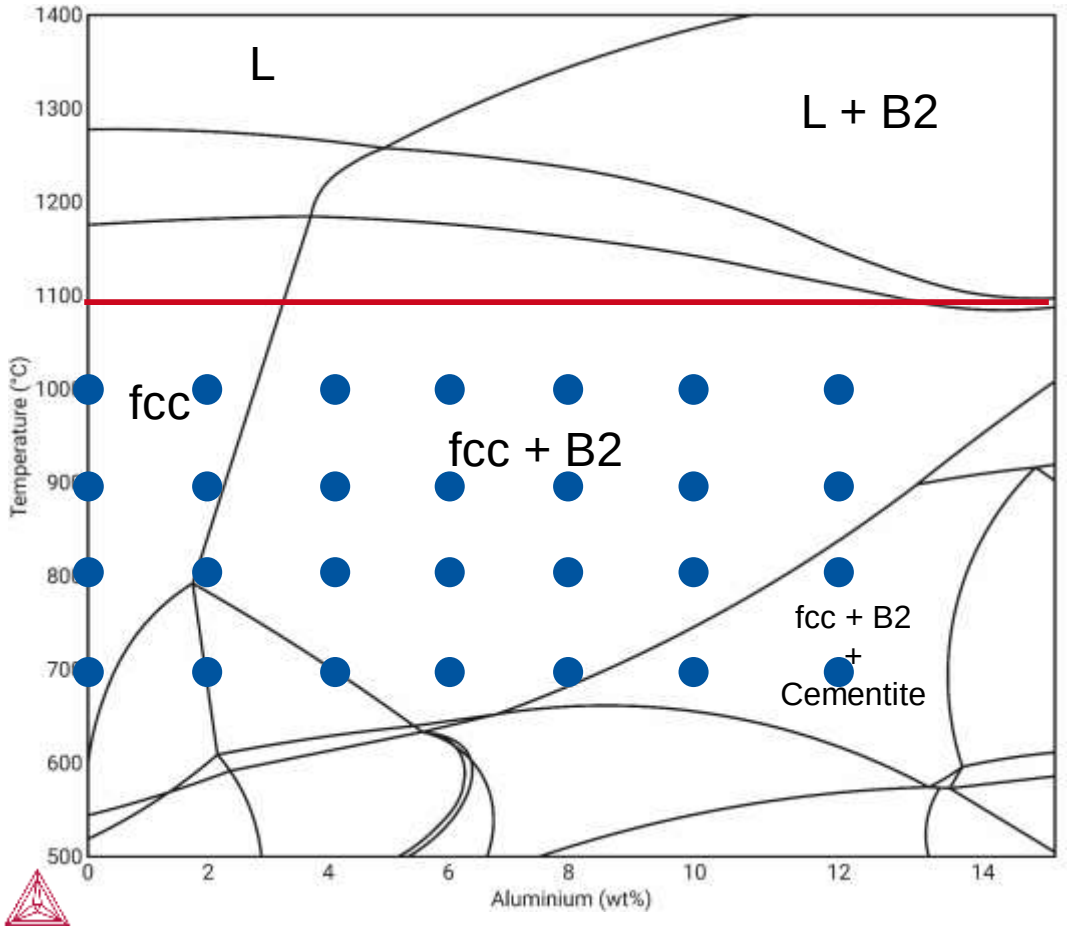


Alloy Selection

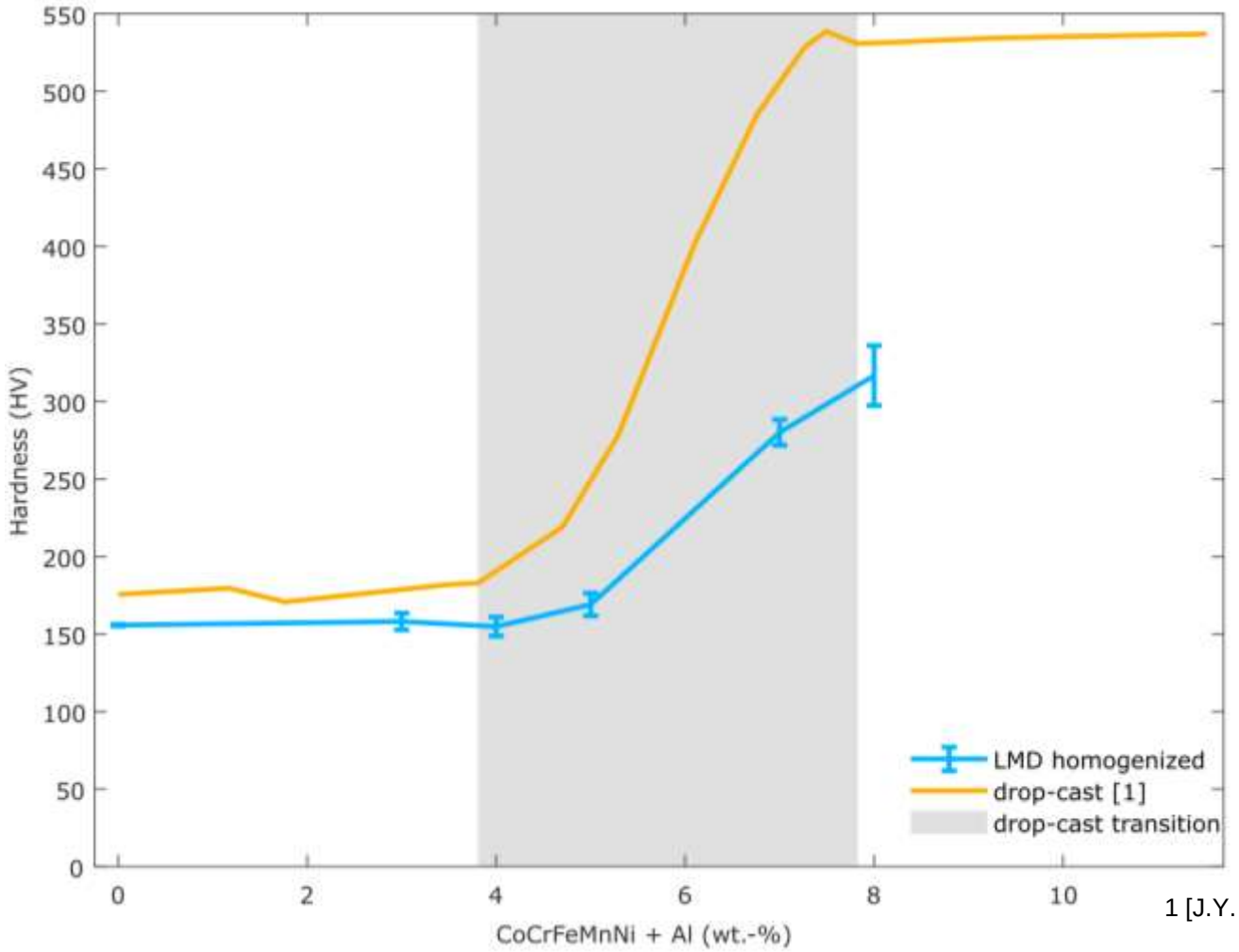
CoCrFeMnNi + Al



CoFeMnNi + 0.3 wt% C + Al

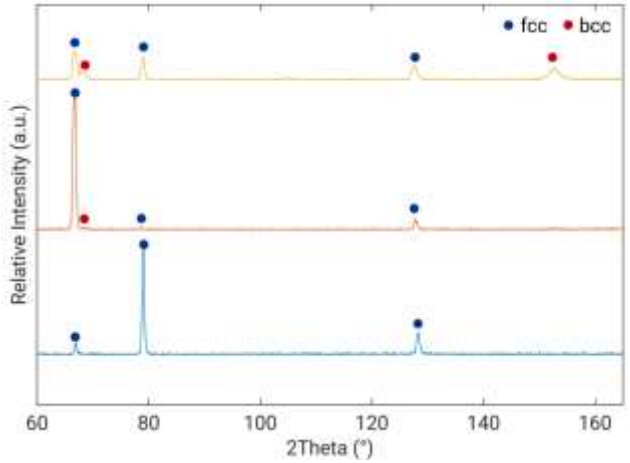


Preliminary Results – Mechanical Properties



1 [J.Y. He et al., Acta Mater. 62 (2014), pp. 105-113]

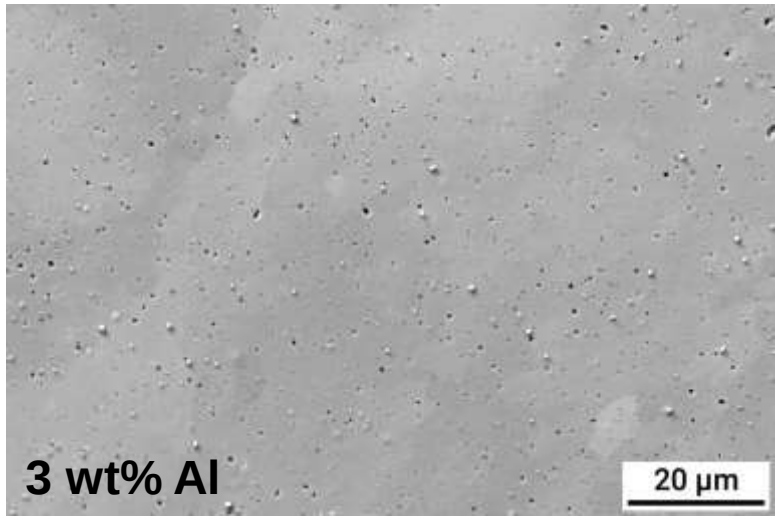
Preliminary Results – Microstructure

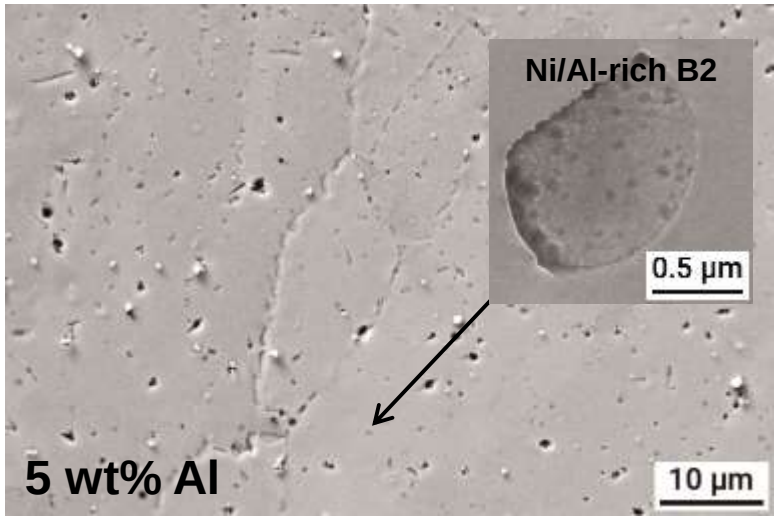


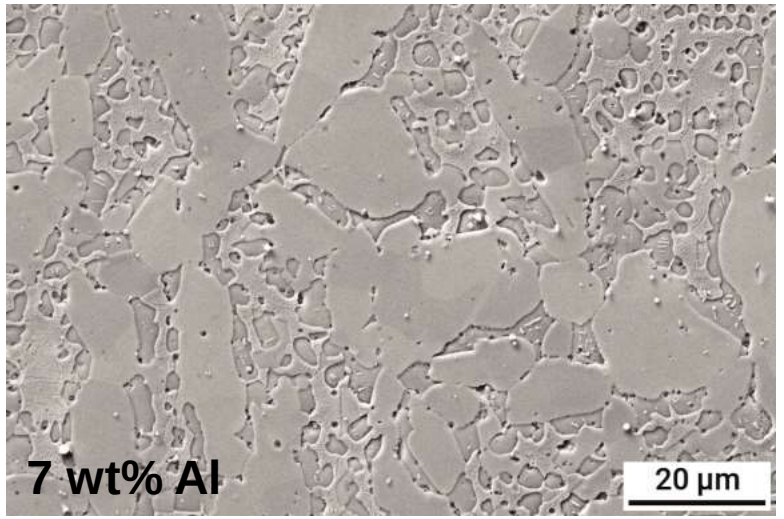
7 wt% Al, 80% fcc, 20% bcc

5 wt% Al, 99% fcc, 1% bcc

3 wt% Al, 100% fcc





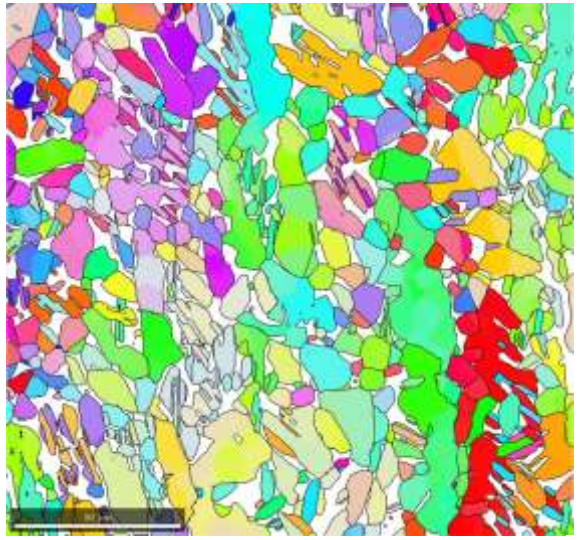


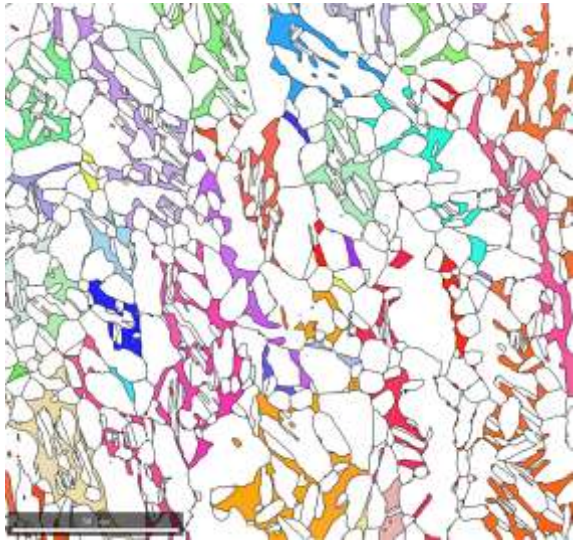
Preliminary Results – Microstructure

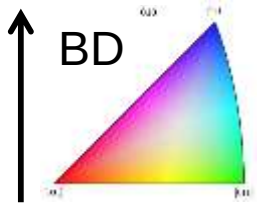
CoCrFeMnNi + 7 wt% Al

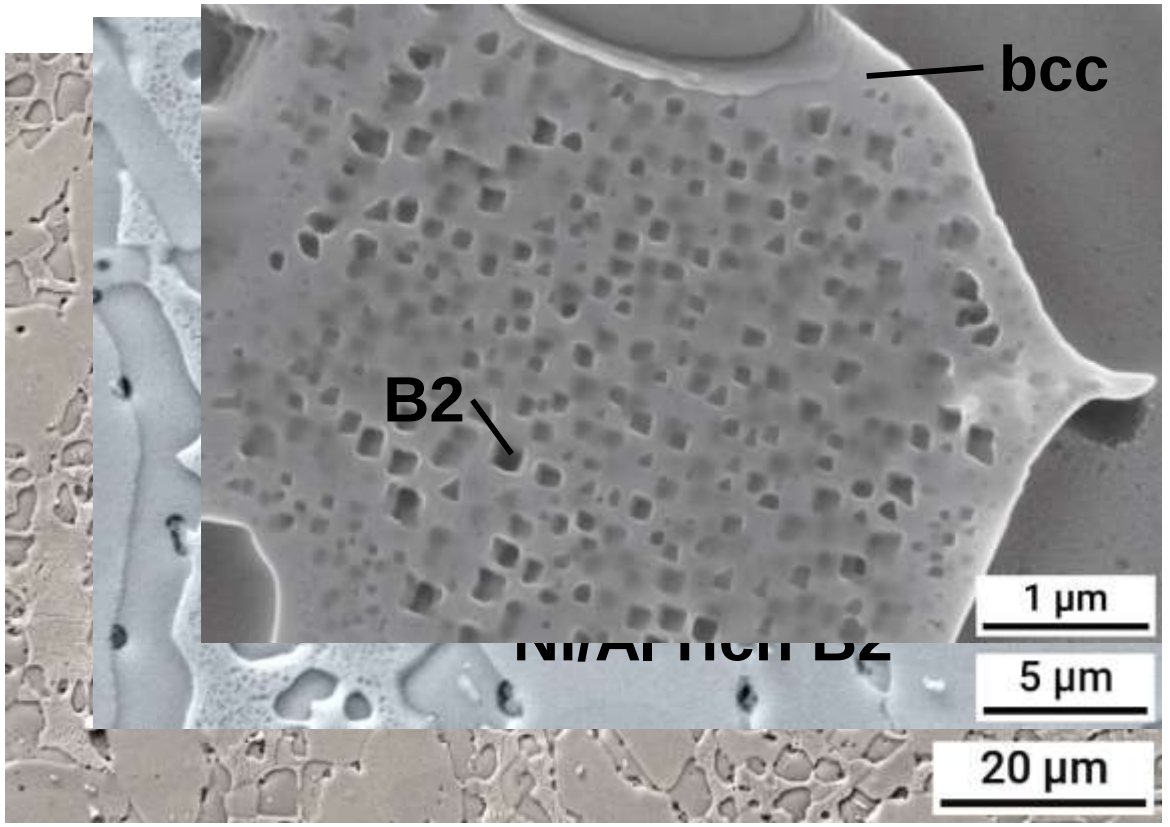
fcc

bcc









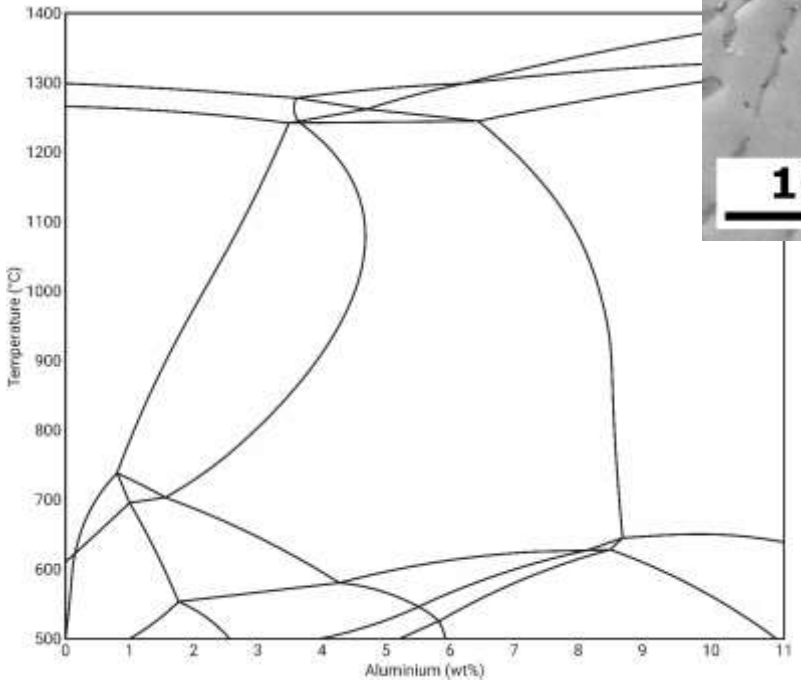
Outlook

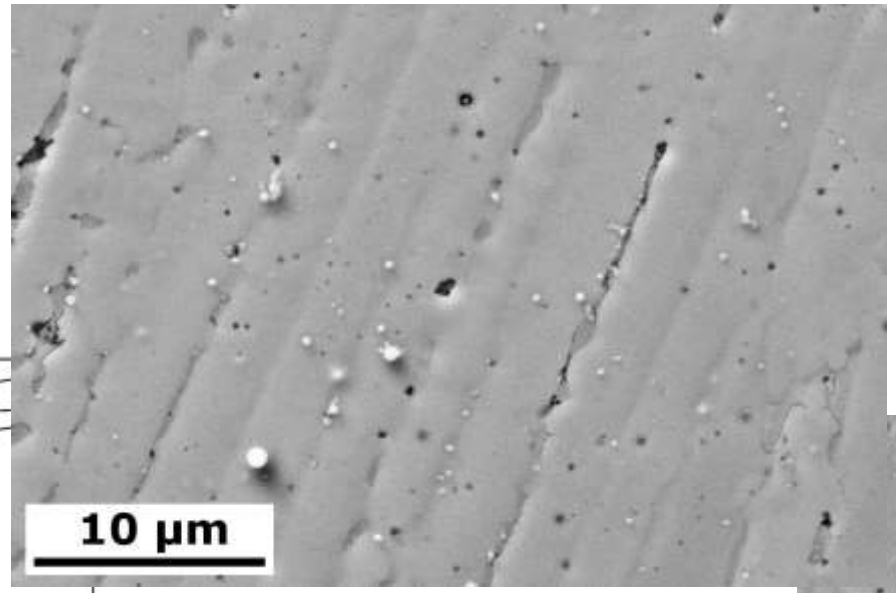
- Thermodynamic predictions validated
- Further validation of thermodynamic data
  - Aging heat treatments
- Further deepen understanding of Cantor + Al system
  - Development of multi-phase microstructures
  - Deformation behavior and mechanical properties
- Screening of Co-Fe-Mn-Ni +Al +C system

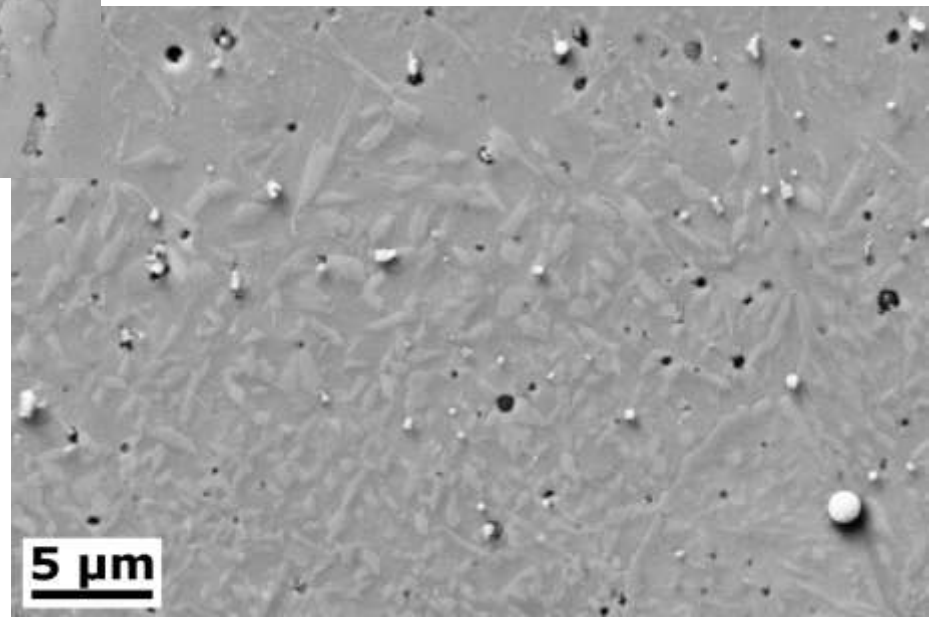
  ➔ Find ideal candidates for conventional processing

Thank you for your attention!
Questions?

As-LMD


1400
1300
1200
1100
1000
900
800
700
600
500
Temperature (°C)
0
1
2
3
4
5
6
7
8
9
10
11
Aluminium (wt%)


10 µm


5 µm