Synchrotron based 3DXRD studies of rolled braze clad aluminum sheets

Uppsala Synchrotronix AB

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The presentation is based on two VINNOVA funded projects: 2019-03268 and 2019-05299 and is a collabortive effort between the partners: Gränges Sweden AB, Lund University and Uppsala Synchrotronix AB

- The first project is a measurement project where Synchrotron based 3D techniques have been employed to study grain orientation effects in braze clad on aluminum sheets used for manufacturing of complex heat exchangers.
- The second project is an analysis and data visualization project to extract information from the 3DXRD data to gain information about grain formation and grain orientations.
- The presentation will show results from the analysis and visualization project.

Bridging the gap between industry and big science…

- Start-up founded in August 2018
- Targeting the heavy industry in Scandinavia
- Aiming at general mediator services
  - → R&D partner & management
  - → Industrial needs and context analysis
  - → Sample prep (scientific and workshop)
  - → Spectroscopy, imaging, scattering
  - → Data analysis
  - → Complementary conventional analyses
- XPS and X-ray instrumentation expertise
- Partnering with scientists, consultants, and labs

Photographs of MAX IV (top), SOLEIL (left) and Uppsala Science Parka by Leif Jansson, Vincent Moncorgé, and Henrik Lundström, respectively.

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Achievements and project participation

- Experiments at SOLEIL, MAX IV, SPring-8, Petra-3
- 3D studies of brazing failure mechanisms (tomography, DCT, 3DXRD)
- Development of 3D analysis routines development
- APPES studies of oxide break-up during brazing
- In-situ studies of hot-rolling steel processes using SAXS/WAXS
- In-house development of HAXPES for industrial chemical depth profiling
- R&D service supplier – Materials Business Centre (cleaning formulations, orthopedic fixation)
- Graphene Round Robin – SEM, Raman, TGA, light DLS
- APPES studies of calcination processes in the formation of catalytic coatings
- Scientific partners at four universities, advisory XPS expert (John Åhlund) recruited

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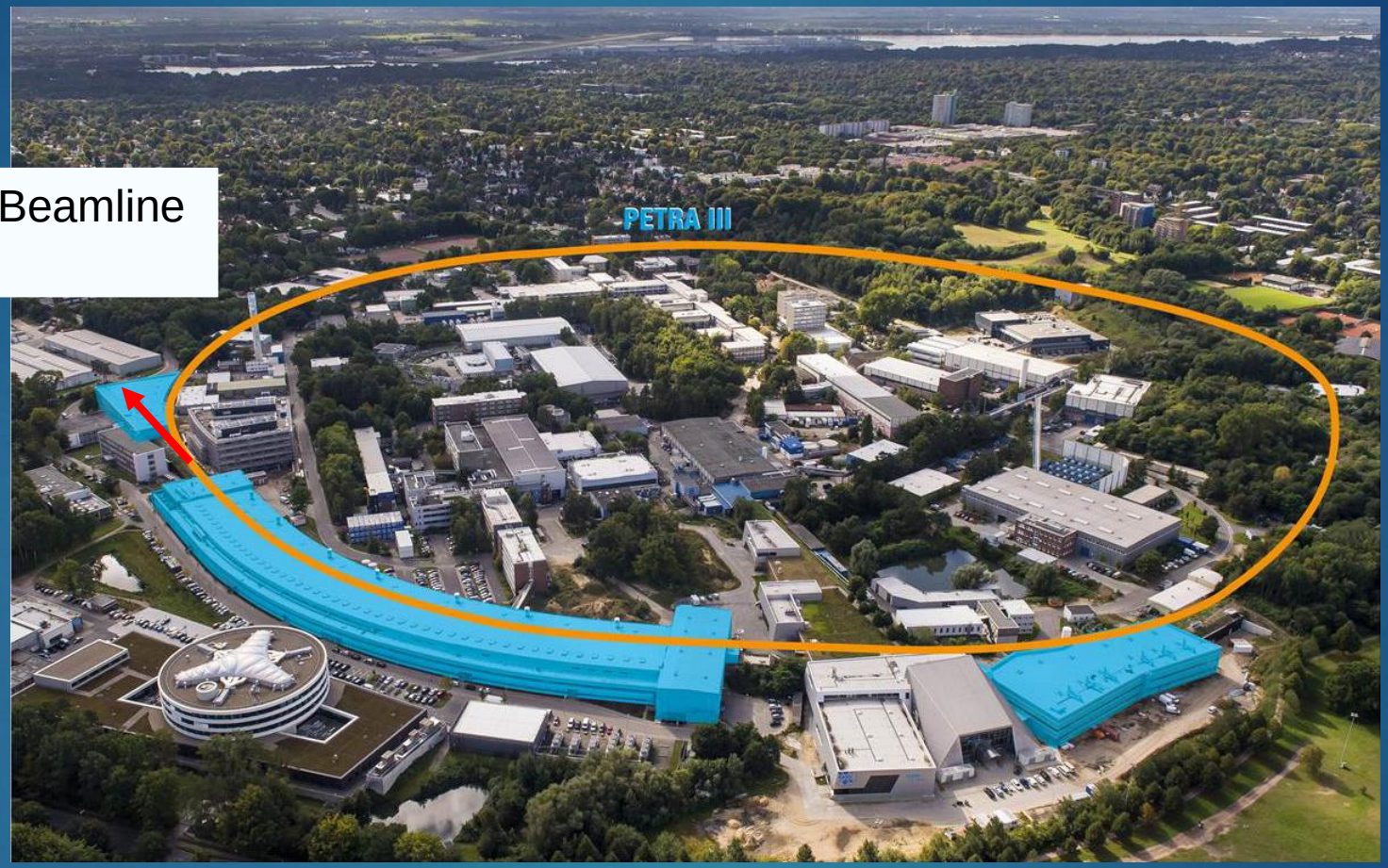
Swedish Materials Science beamline

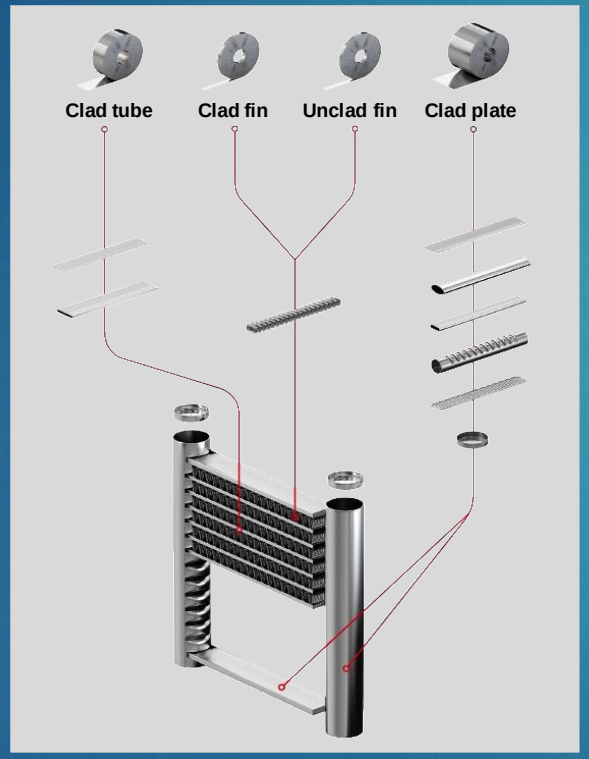
SMS Beamline (P21)



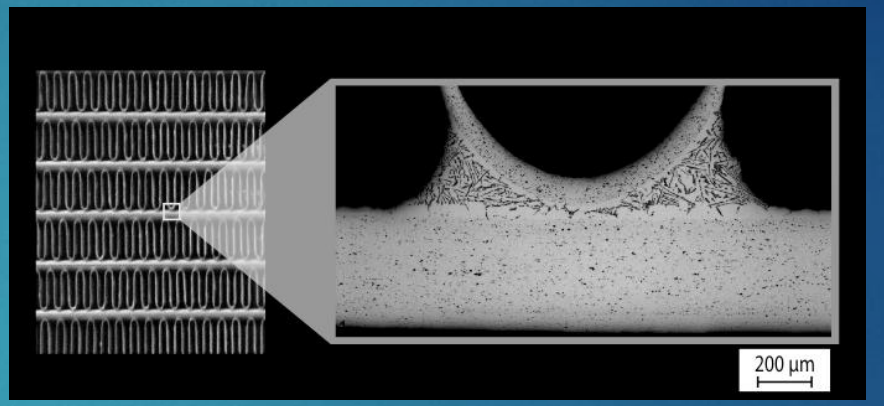
PETRA III at DESY in Hamburg, Germany

Aluminium Heat Exchanger

Several aluminium sheets with different material properties.

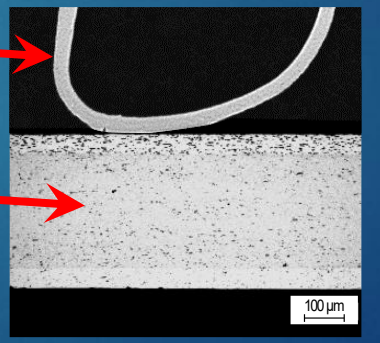


Joined together through brazing.



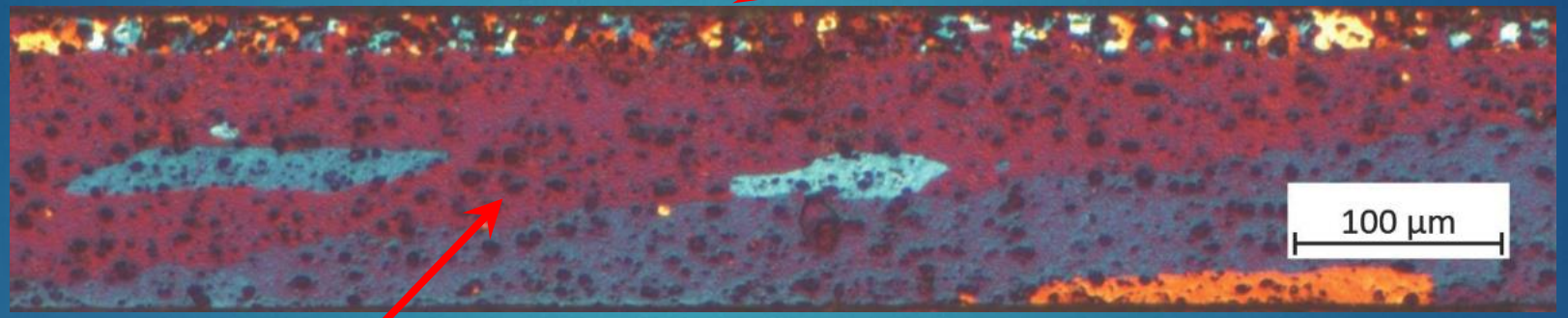
Aluminium fin.

Aluminium sheet with braze clad.



Aluminium Sheet with Braze Clad

20 µm thick aluminium-silicon alloy
with a solidus of 577 °C



Aluminium alloy as core material

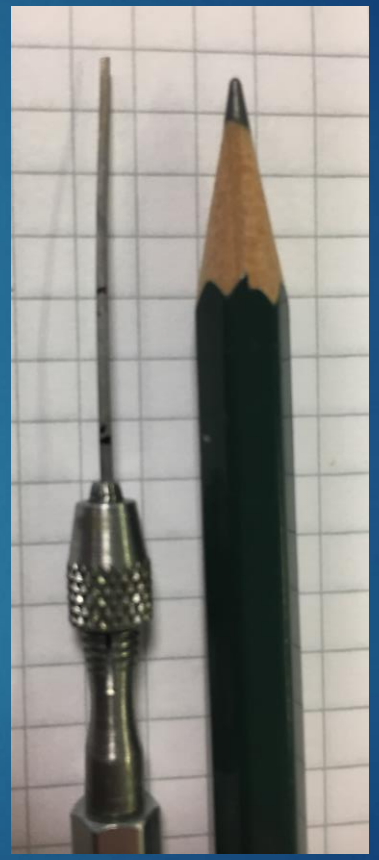
1.6 % manganese, 1.5 % zinc, 0.8 % silicon, 0.25 % iron, and 0.1 % zirconium.

Braze simulation and sample preparation

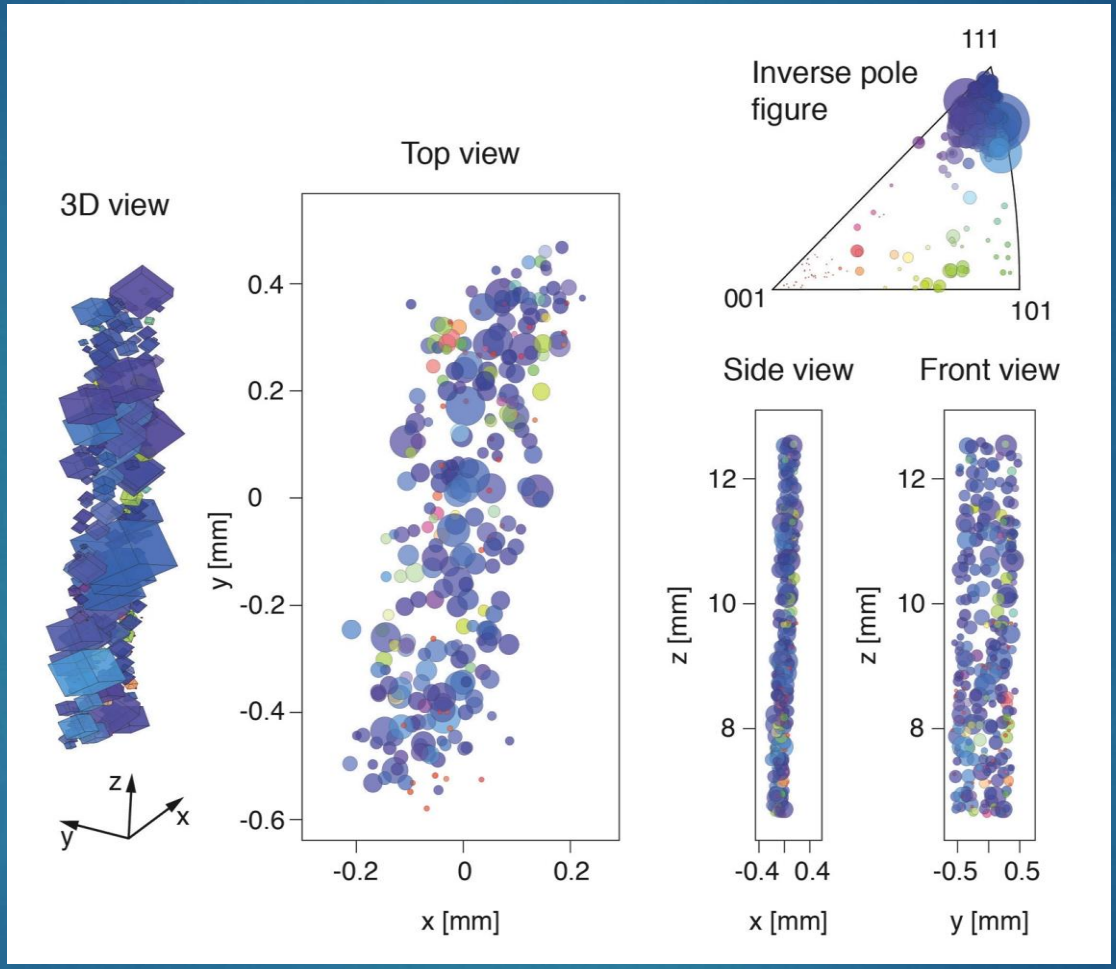
Cooled zone
(T < 570 °C)

Brazed zone
(T > 580 °C)

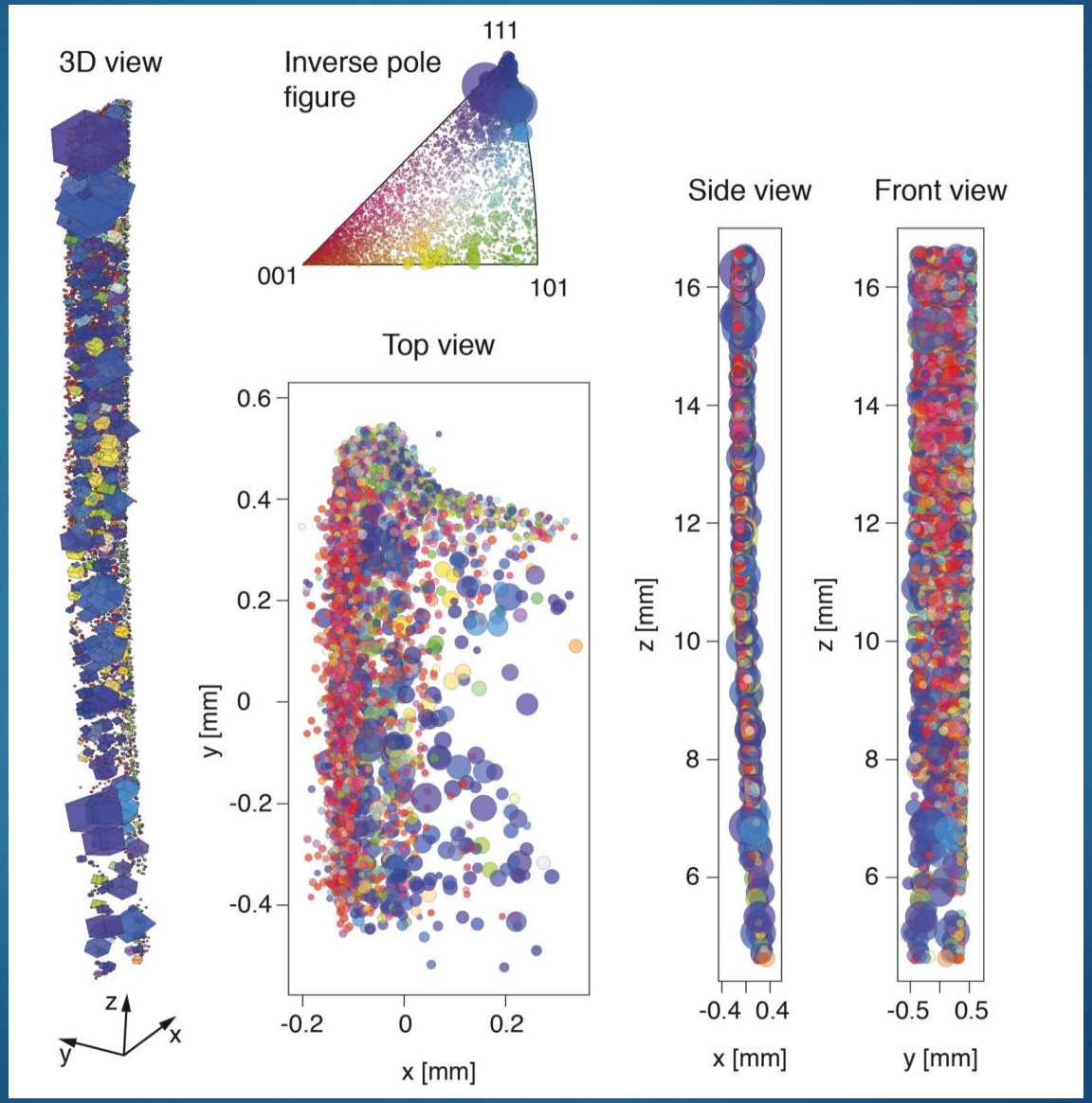
Cooled zone
(T < 570 °C)



The Center-of-Mass Position Maps

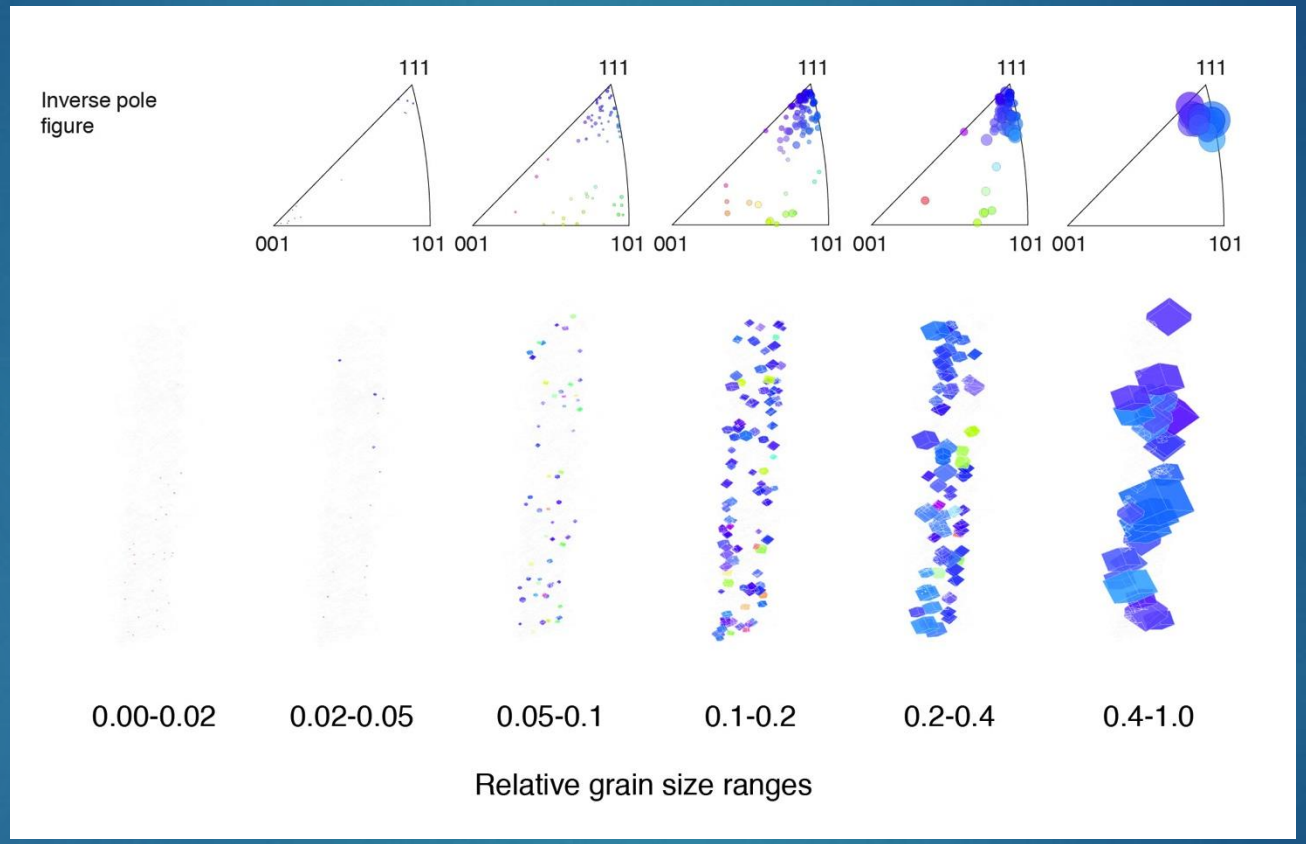


The Center-of-Mass Position Maps



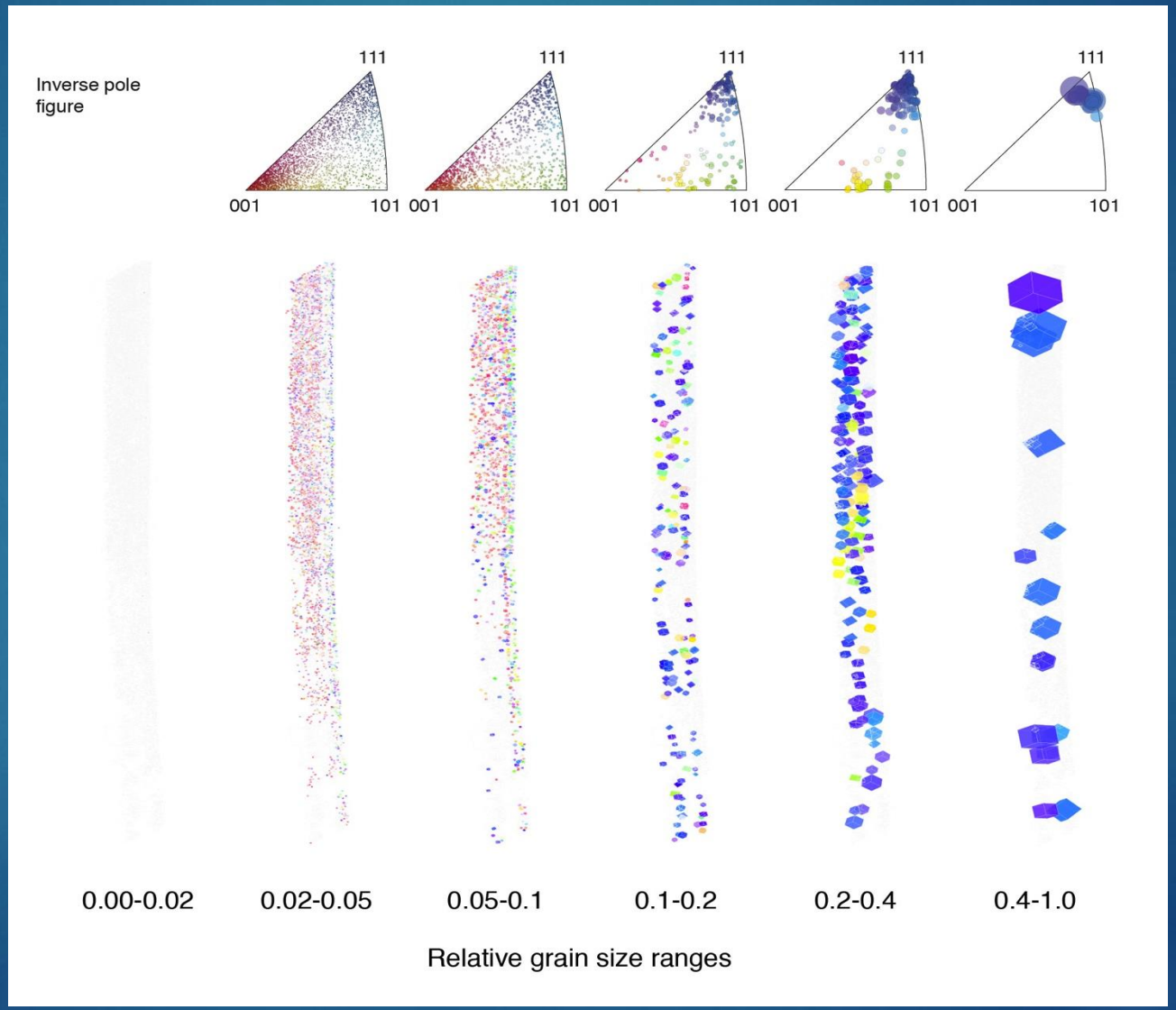
Grain Size Distribution

Before braze simulation



Grain Size Distribution

After braze simulation



Conclusion

- Significant number of grains are formed in the solidification process of the molten Al-Si alloy.
- The new Al-Si grains are oriented along the {001} direction, which is in contrast with the {111} orientation of the grains in the core Al material.
- Local recrystallization occurs in the core material during brazing. The new grains have different orientation compared to the original grains oriented along the {111} direction.
- It is possible to distinguish the three zones: the non-brazed zone, the fully brazed zone, and the transition region between them.

Thank You for your attention!

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