Development of RCCA for high-temperature applications

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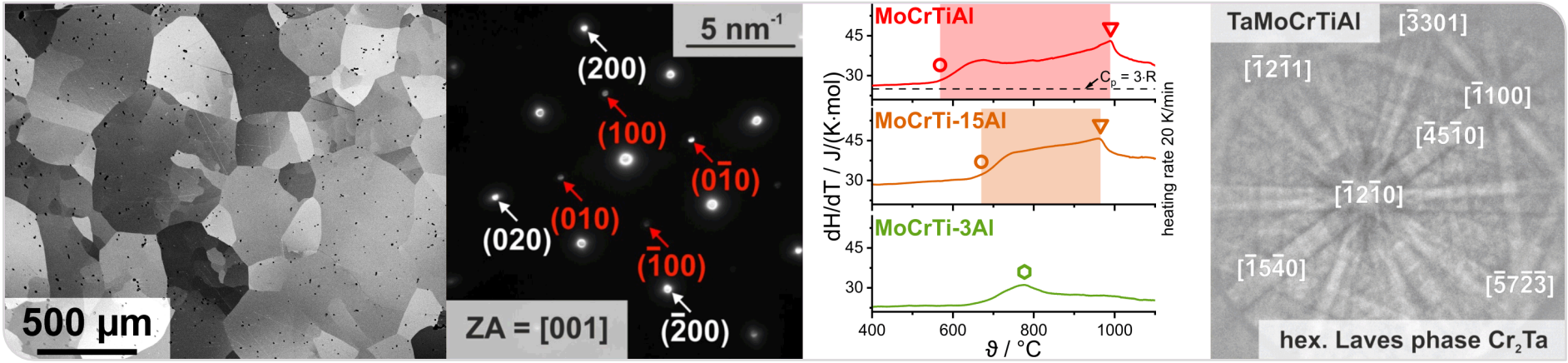


Motivation

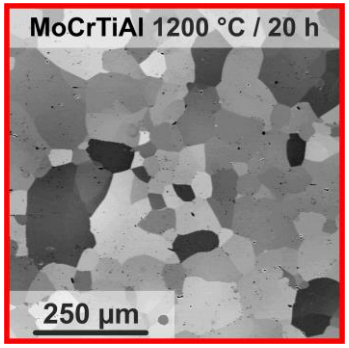
- Material for high-temperature structural applications
  - balanced mechanical properties at RT and elevated temperatures
  - oxidation resistance

- Arc Melting → Homogenization (20 h) → cooling inside the furnace

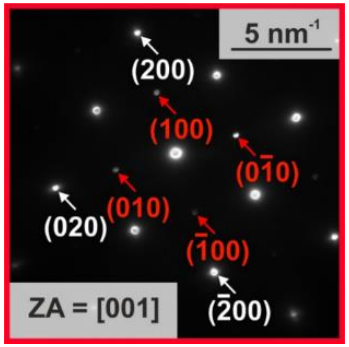
Ta-Nb-Mo-Cr-Ti-Al

Summary of MoCrTiAl

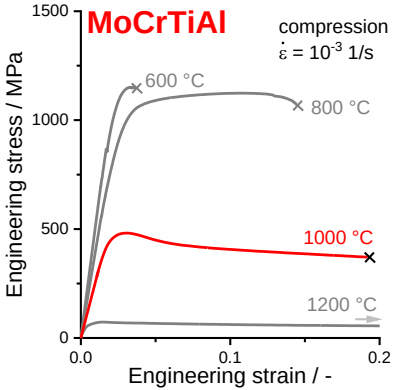
- Avoid the formation of the Laves phase (C15, **Cr_2Ta**) in comparison to TaMoCrTiAl
- **No secondary** phases experimentally observed
- **B2** crystal structure
- **Similar** mechanical properties as **Ta/Nb-MoCrTiAl**
  - Laves phase is not solely responsible for the brittle behavior
- How to stabilize the **A2** crystal structure until room temperature?



SEM – BSE



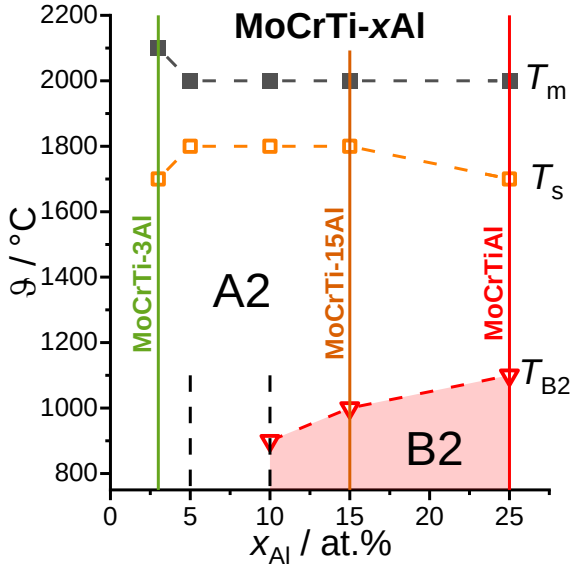
TEM – SAD

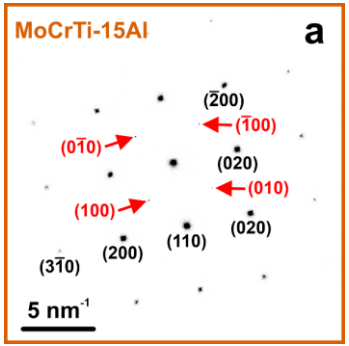


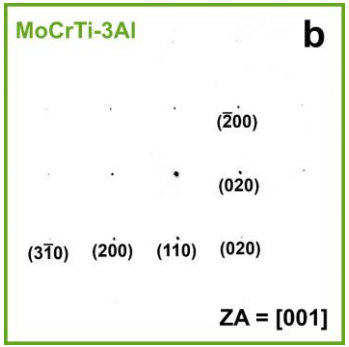
[1] H. Chen et al., *Acta Materialia 176* (2019) 123-133

MoCrTi-*x*Al

- Thermodynamic calculations
  - reduction of **Al** leads to a **disordered** matrix at RT
- RT crystal structure confirmed by TEM





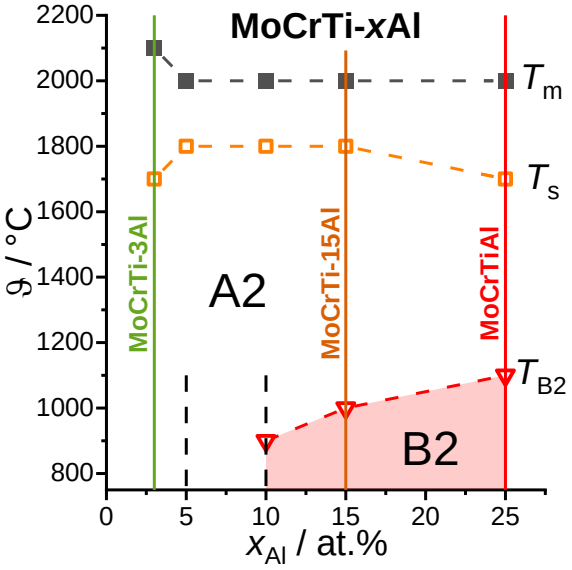


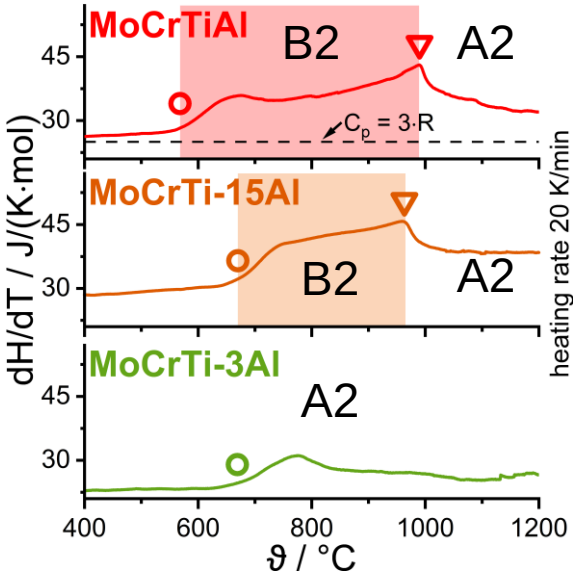
TEM – SAD

[1] S. Laube et al., *Journal of Alloys and Compounds 823* (2020) 153805

MoCrTi-*x*Al

- Thermodynamic calculations
  - reduction of **Al** leads to a **disordered** matrix at RT
- RT crystal structure confirmed by TEM
- phase transitions confirmed by DSC
- Increased plasticity at RT with an A2 matrix?



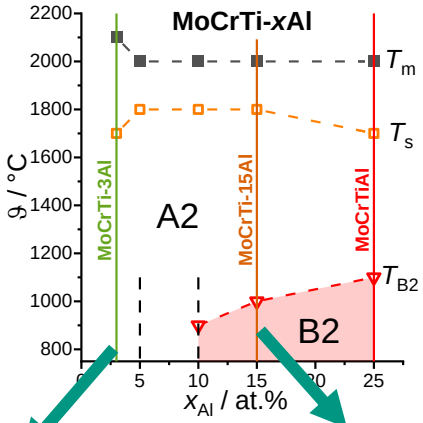


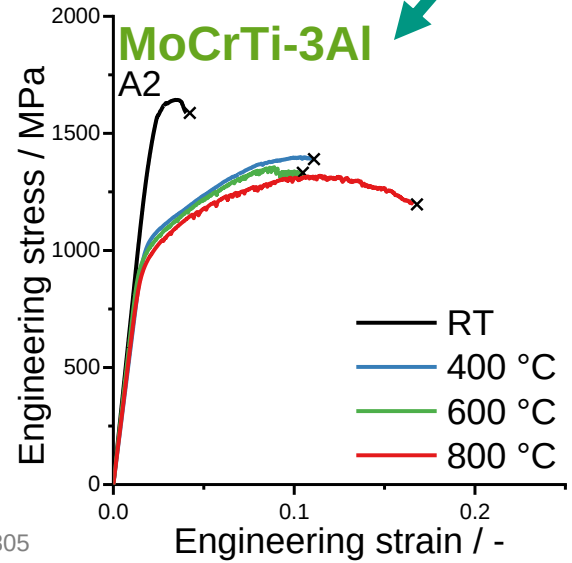
[1] S. Laube et al., *Journal of Alloys and Compounds 823* (2020) 153805

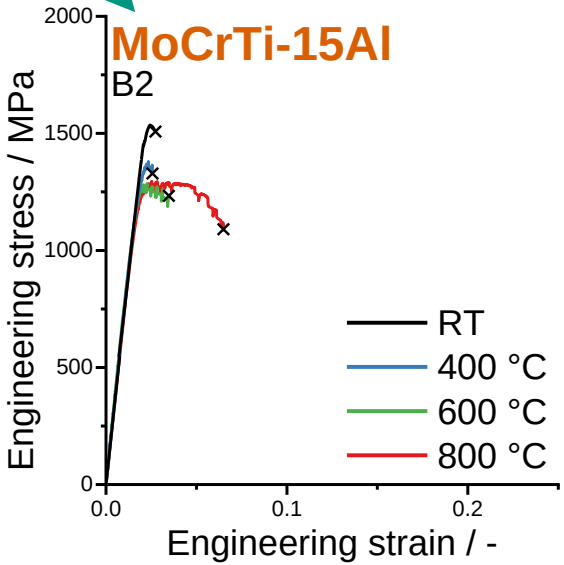
MoCrTi-*x*Al

- Brittle for ***x* > 10 at.% Al**

→ The B2 crystal structure is responsible for the brittle behavior







[1] S. Laube et al., *Journal of Alloys and Compounds 823* (2020) 153805

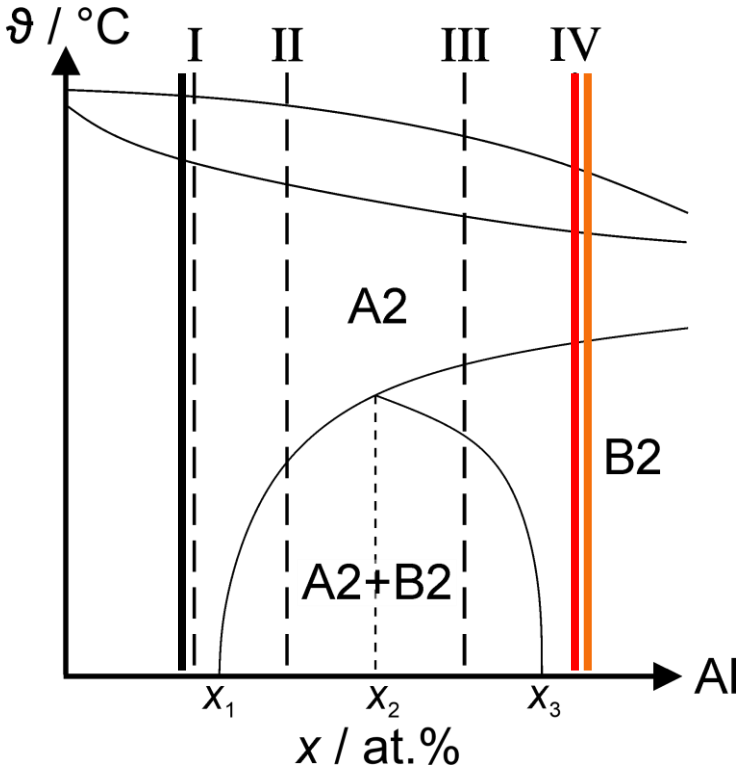
Multi-phase CCA

- **MoCrTiAl** and **TaMoCrTiAl** resemble line IV
- **MoCrTi-*x*Al** (x < 10 at.%) resemble line I
- Seems like $x_1 \approx x_3$ in case of **MoCrTi-*x*Al**

- How to **establish** and increase the size of the **A2+B2** phase field?

- FactSage calculations to predict an A2+B2 phase field
  - starting from the **MoCrTiAl** system:

Ta↑ Al↓



Summary

- TaMoCrTiAl and MoCrTiAl exhibit a B2 crystal structure after furnace cooling, which contributes to the intrinsic brittleness
- The A2 crystal structure can be retained down to room temperature by reducing the Al content in the MoCrTiAl alloy
- Increased plasticity under compression

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