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Low-cycle fatigue deformation behaviors of CoCrFeMnNi and CoCrNi

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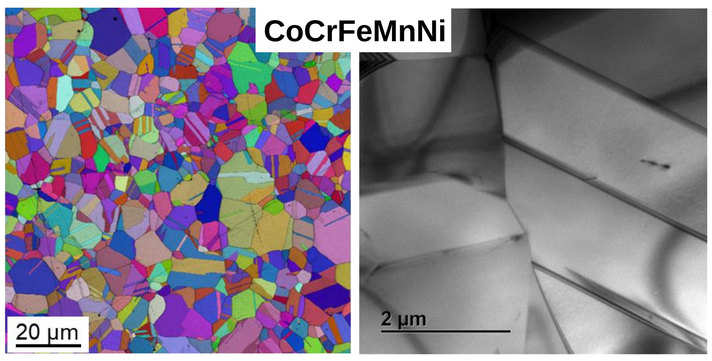
Motivation/objectives

- LCF behaviors and deformation mechanisms for two model MPEAs
- Origins for the difference in their LCF behaviors

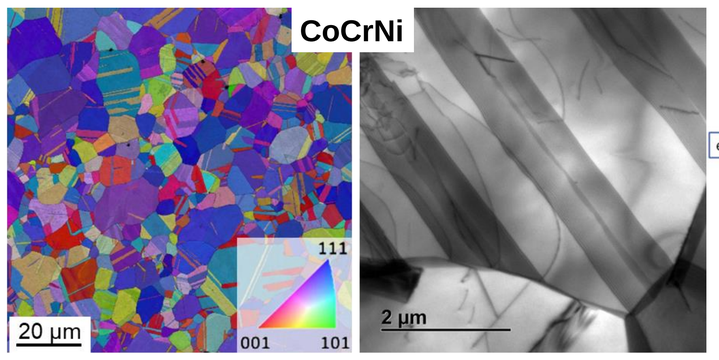
Materials and methodology

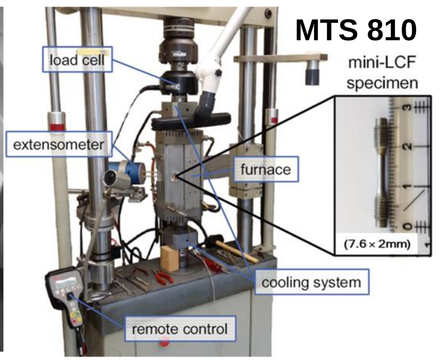


As-recrystallized state:

- FCC single phase.
- No significant texture
- Grain size ~ 7 μm
- Low dislocation density

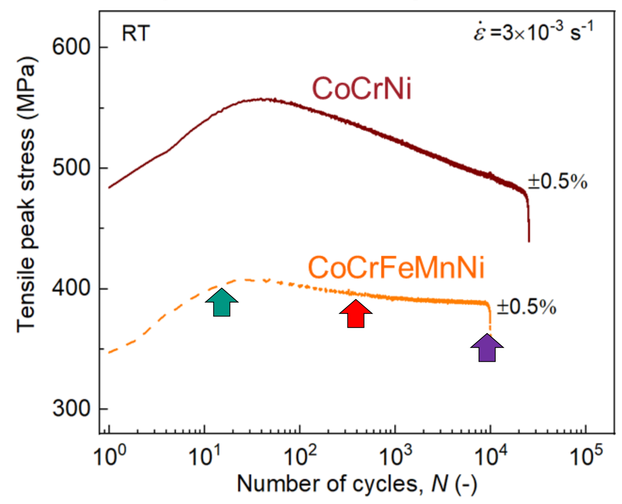
Reasonably fair comparison





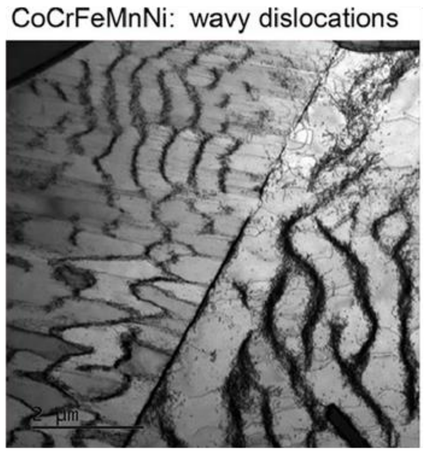
Results

Cyclic stress response

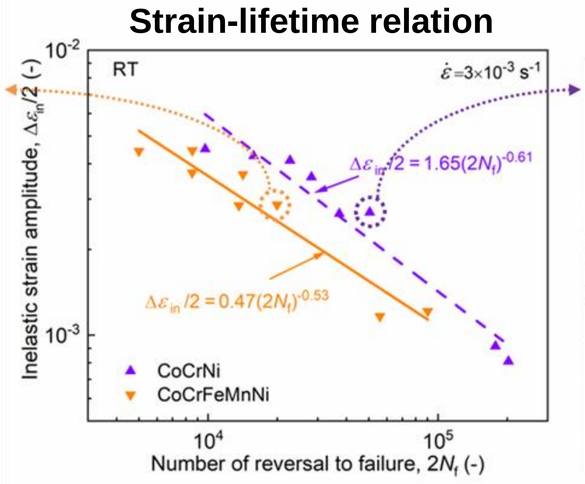


- Compared to CoCrFeMnNi, CoCrNi:
  - Higher strength
  - Longer lifetime
    - Planar dislocation arrays (SFs)
    - Relatively uniform deformation
    - Due to its lower SFE
  - Similar cyclic stress response (Correlated well with microstructures)
    - Initial cyclic hardening
    - Cyclic softening
      - Dislocation substructures formation
        - Multi-slip (including cross slip)
    - Near-steady state

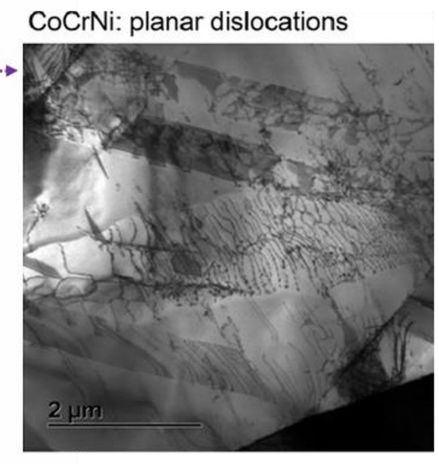
CoCrFeMnNi: wavy dislocations



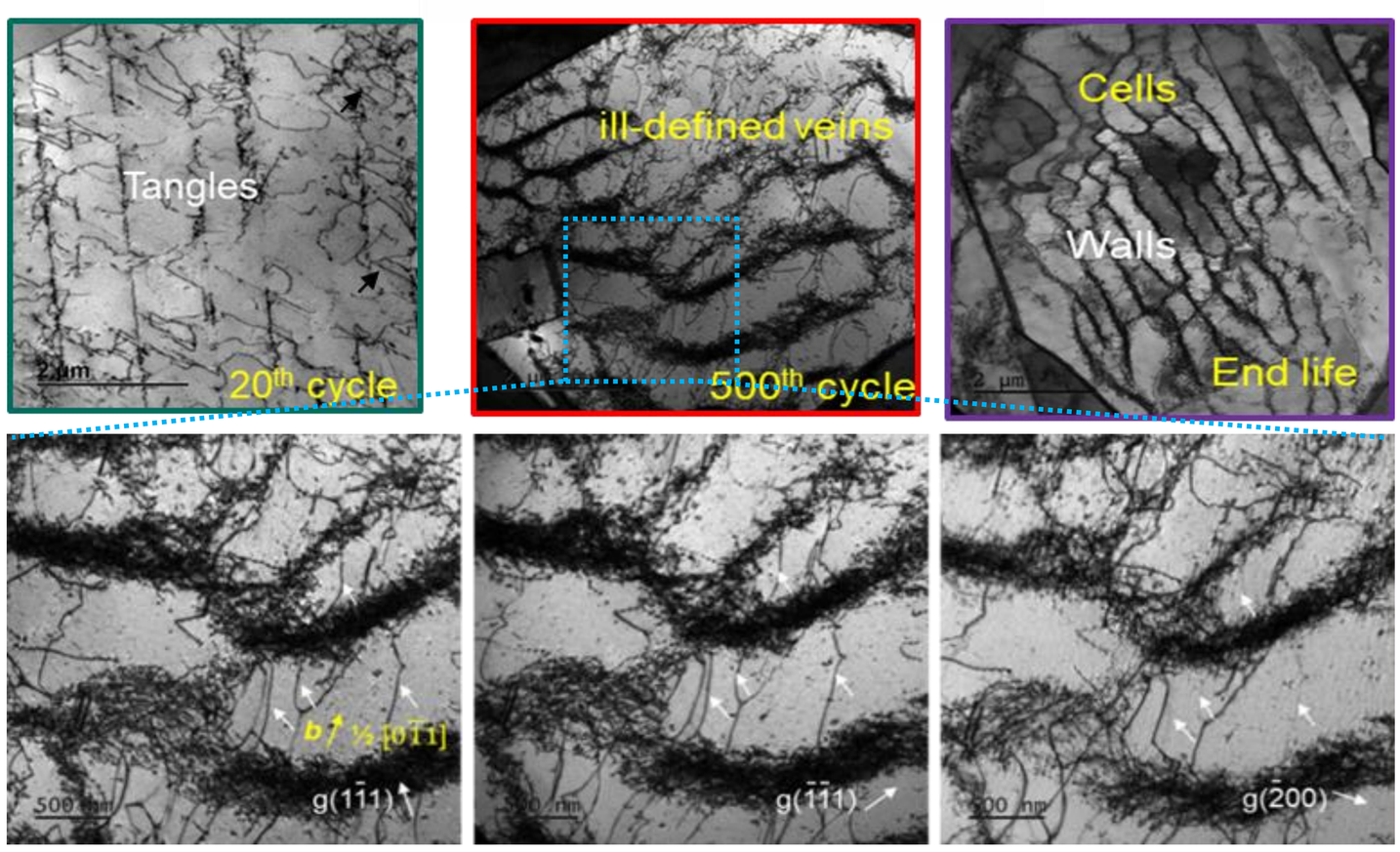
Strain-lifetime relation



CoCrNi: planar dislocations



Microstructural evolution of CoCrFeMnNi



Conclusions

- Both materials show cyclic hardening followed by softening and near-steady state
- CoCrNi exhibits higher strength and longer lifetime compared to CoCrFeMnNi
- In CoCrFeMnNi, dislocation substructures (e.g. walls, cells) dominate
- In CoCrNi, planar dislocation structures (e.g. slip bands, SFs) prevail, leading to improved fatigue life
- Dislocation slip mode of CoCrFeMnNi changes from planar-slip to cross-slip with increasing cycle number (and strain amplitude)

Outlook

- Detailed deformation mechanisms for CoCrNi
- Role of multiple slip upon cycling CoCrFeMnNi

References

[1] K. Lu, et al, Deformation mechanisms of CoCrFeMnNi high-entropy alloy under low-cycle-fatigue loading, Acta Mater, 2021.

[2] K. Lu, et al, Superior low-cycle fatigue properties of CoCrNi compared to CoCrFeMnNi, Scripta Mater, 2021.

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