

Effect of post-processing isothermal tempering heat treatment on the mechanical properties of additively manufactured 16Cr-2Ni martensitic stainless steel via Directed-Energy Deposition

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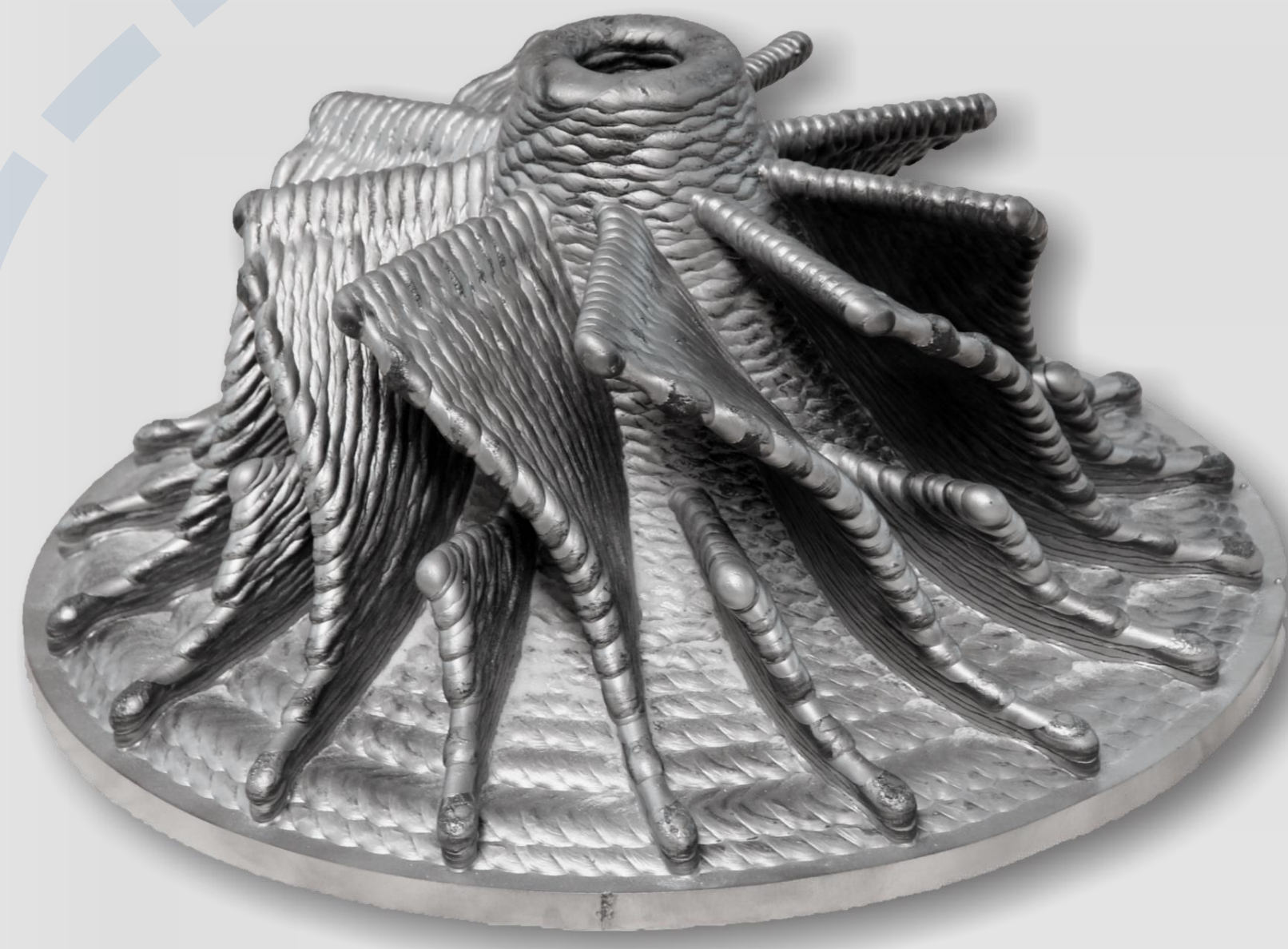
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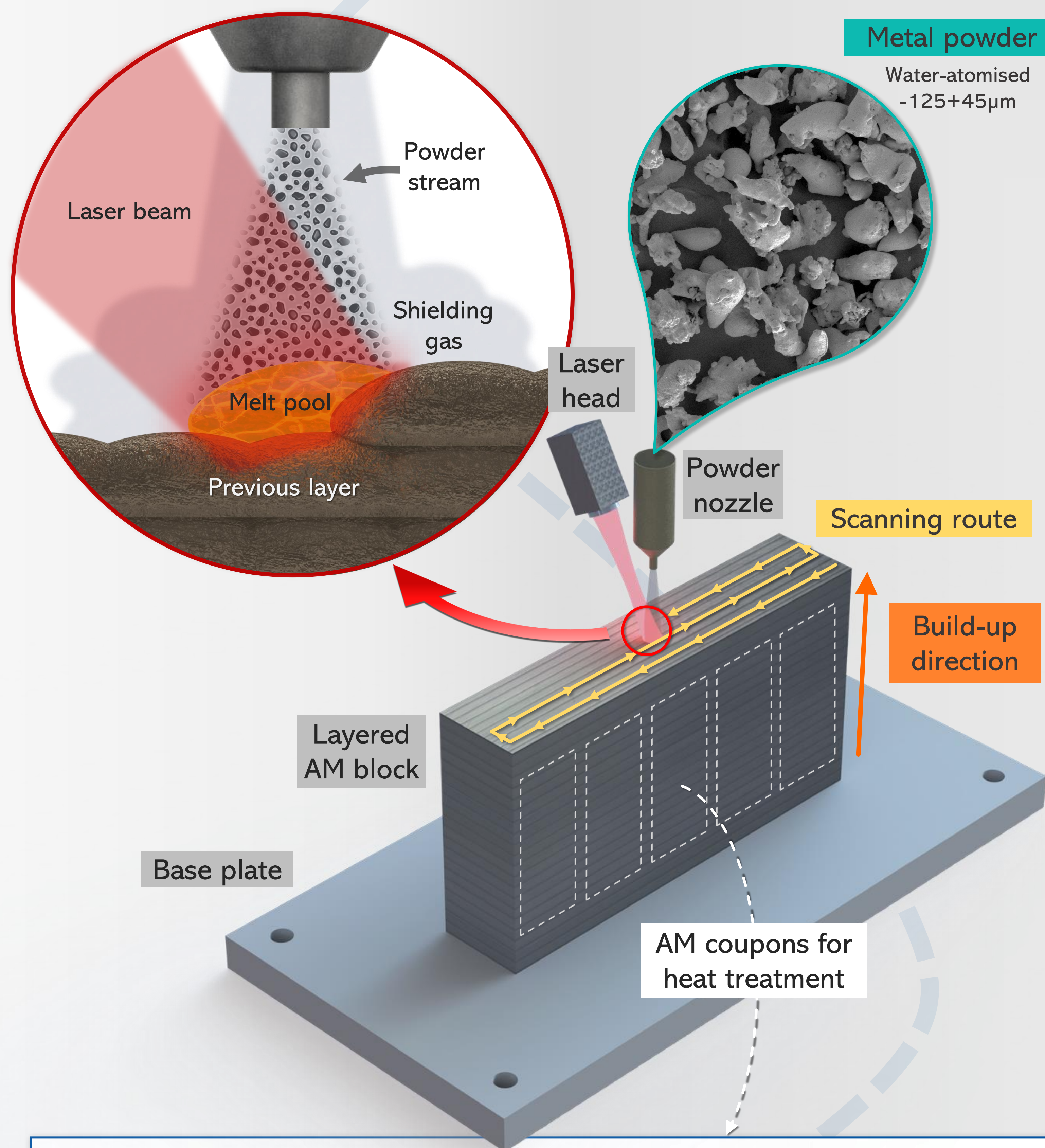
16Cr-2Ni Martensitic stainless steel

- Alloy designations: AISI 431 / UNS S43100 / EN-DIN 1.4057
- Highest corrosion resistant in AISI 400 series stainless steels
- Common applications: Compressor blades, pump & shaft parts, aircraft and marine components, valve & chemical container components



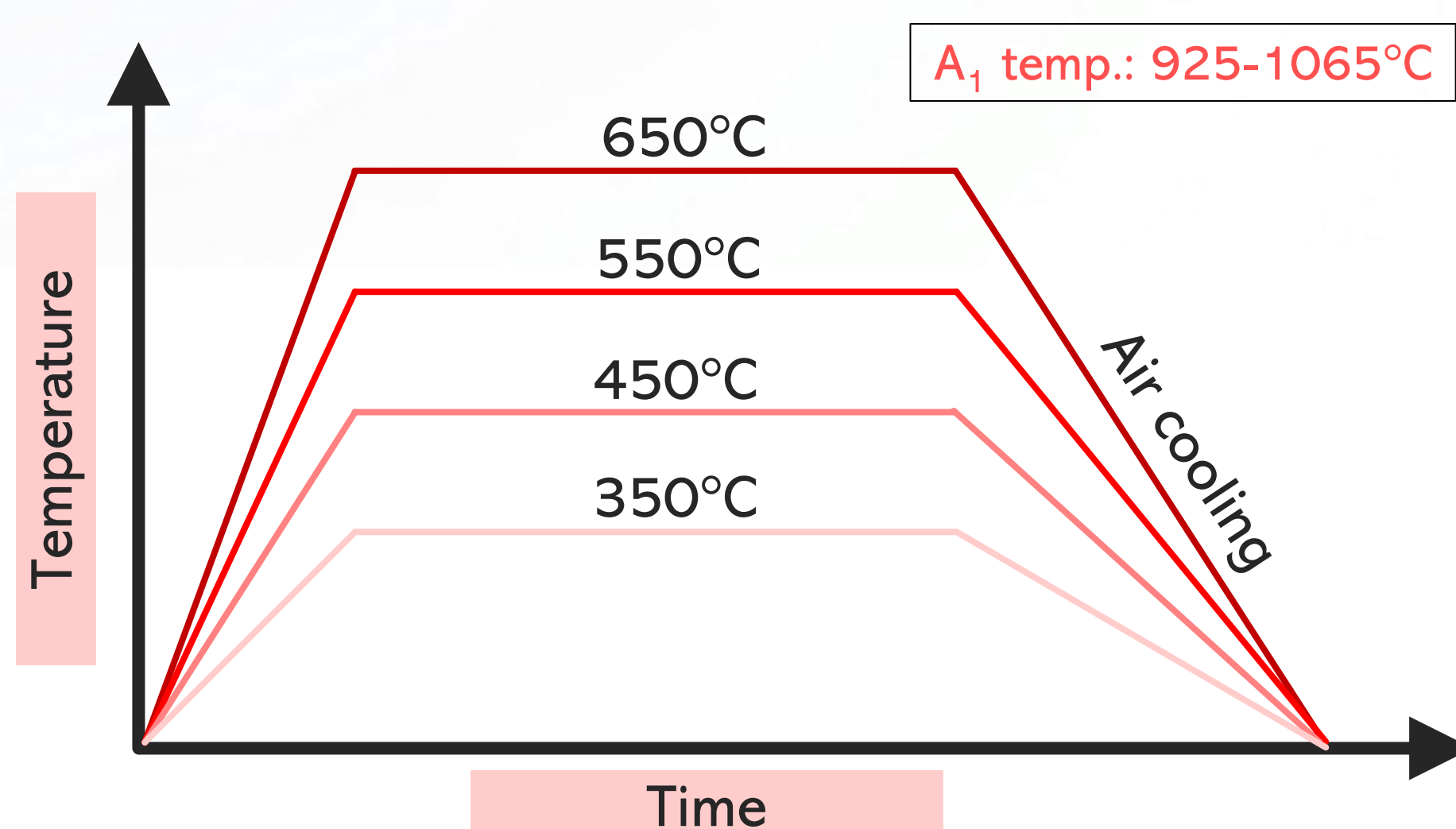
Conventionally manufactured 16Cr-2Ni stainless steel is commercially available in wrought form as hot-rolled tempered bars

Directed-Energy Deposition (DED)



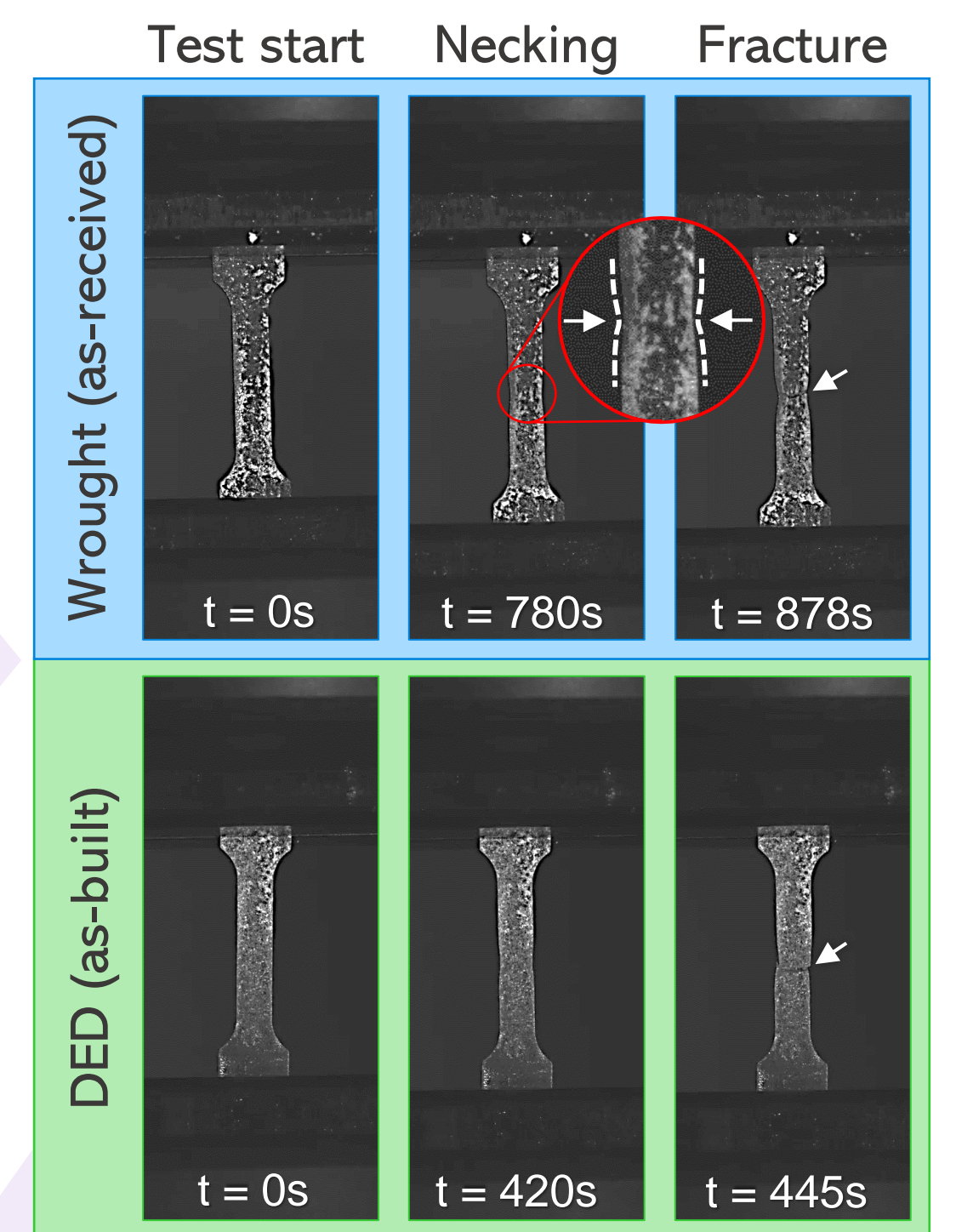
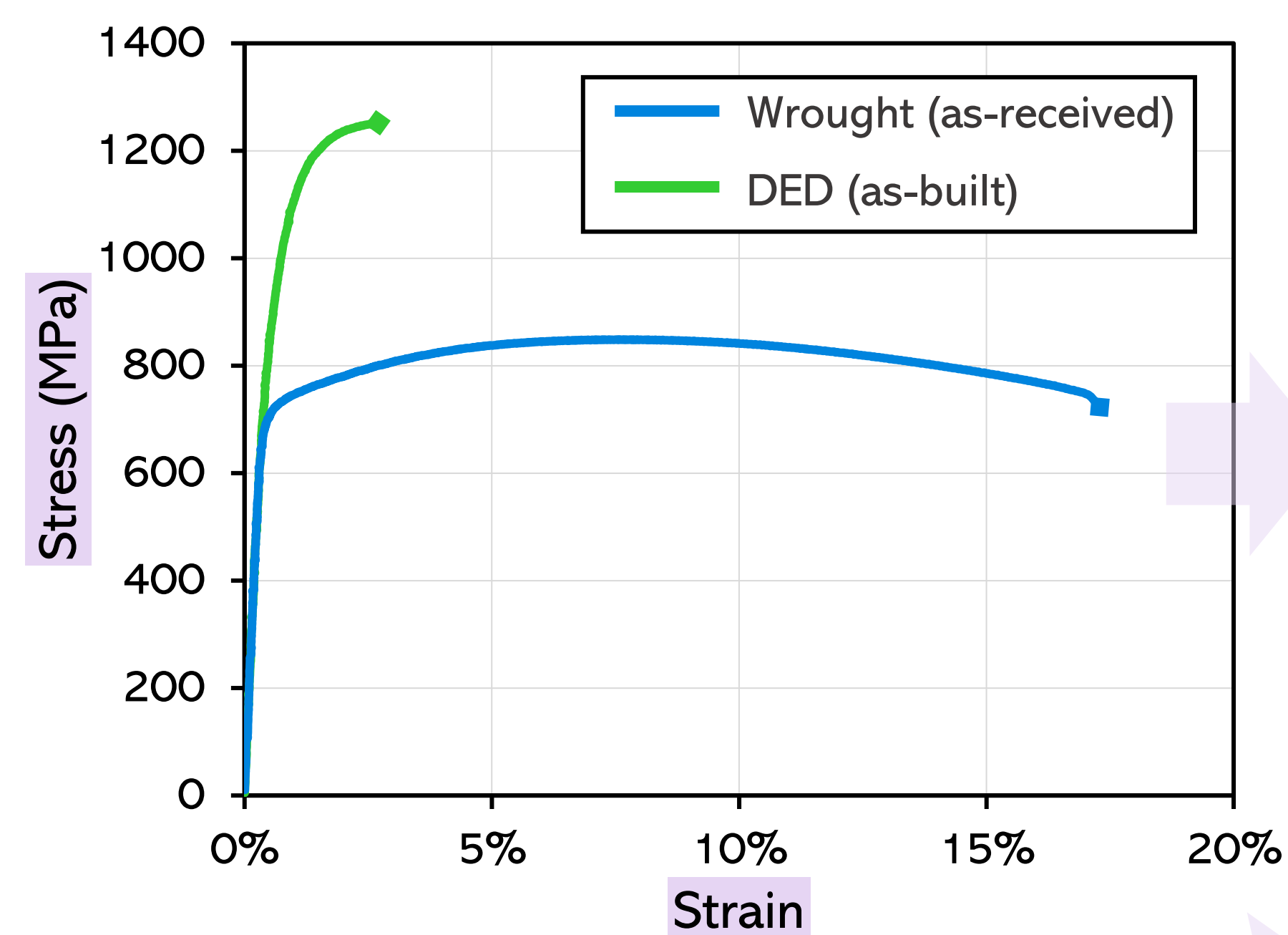
Post-processing isothermal tempering

- Tube furnace
- 2 hours
- Non-pressurized argon atmosphere

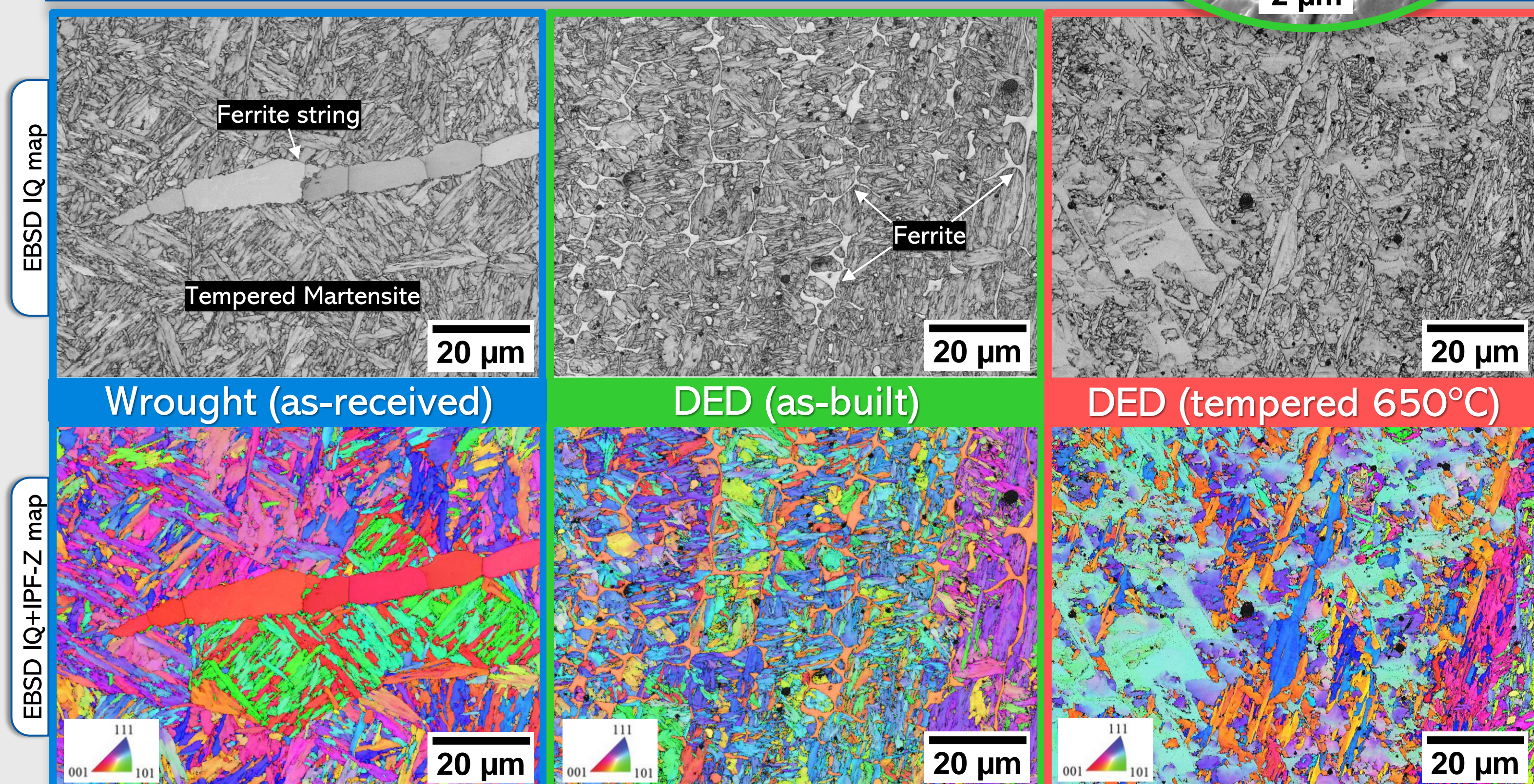
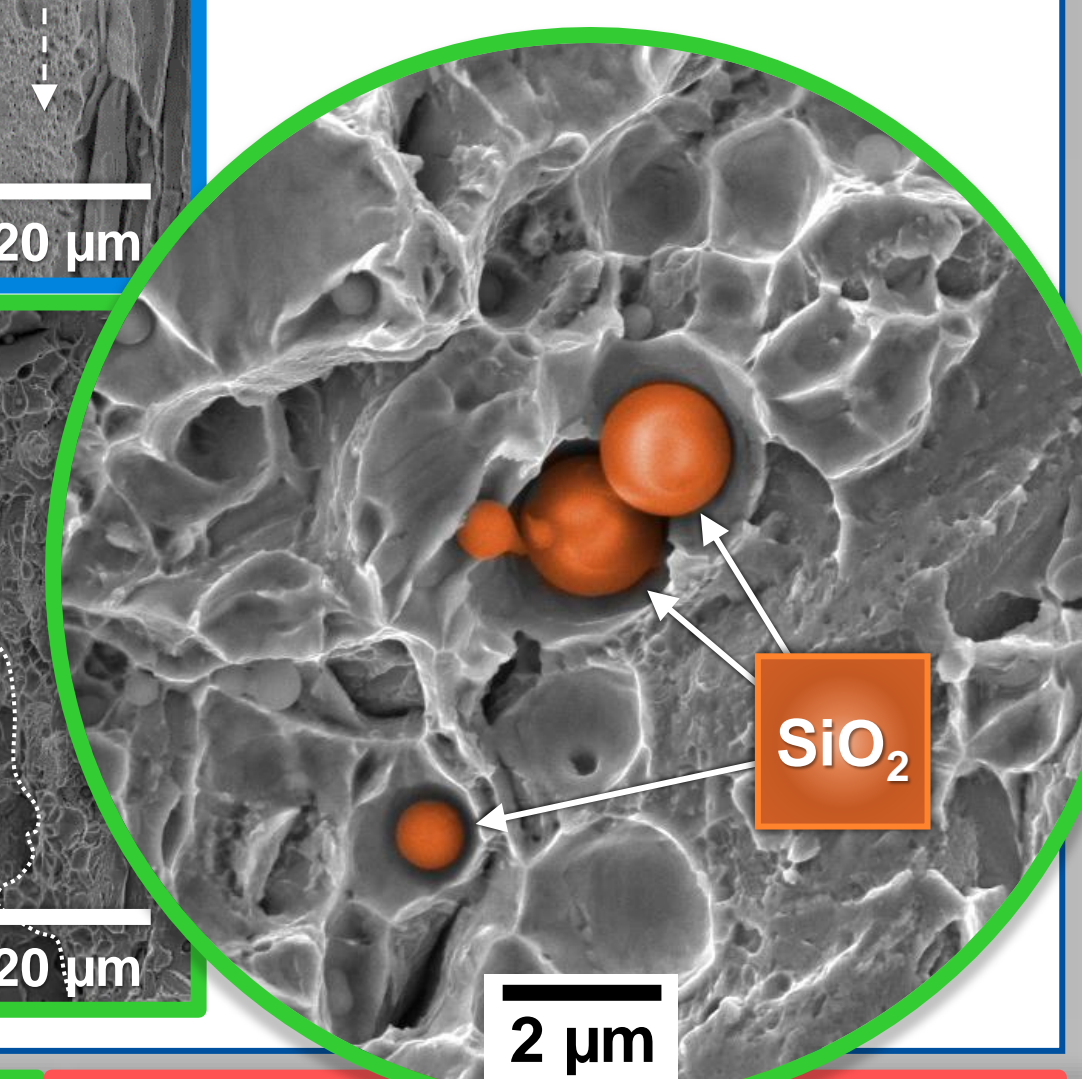
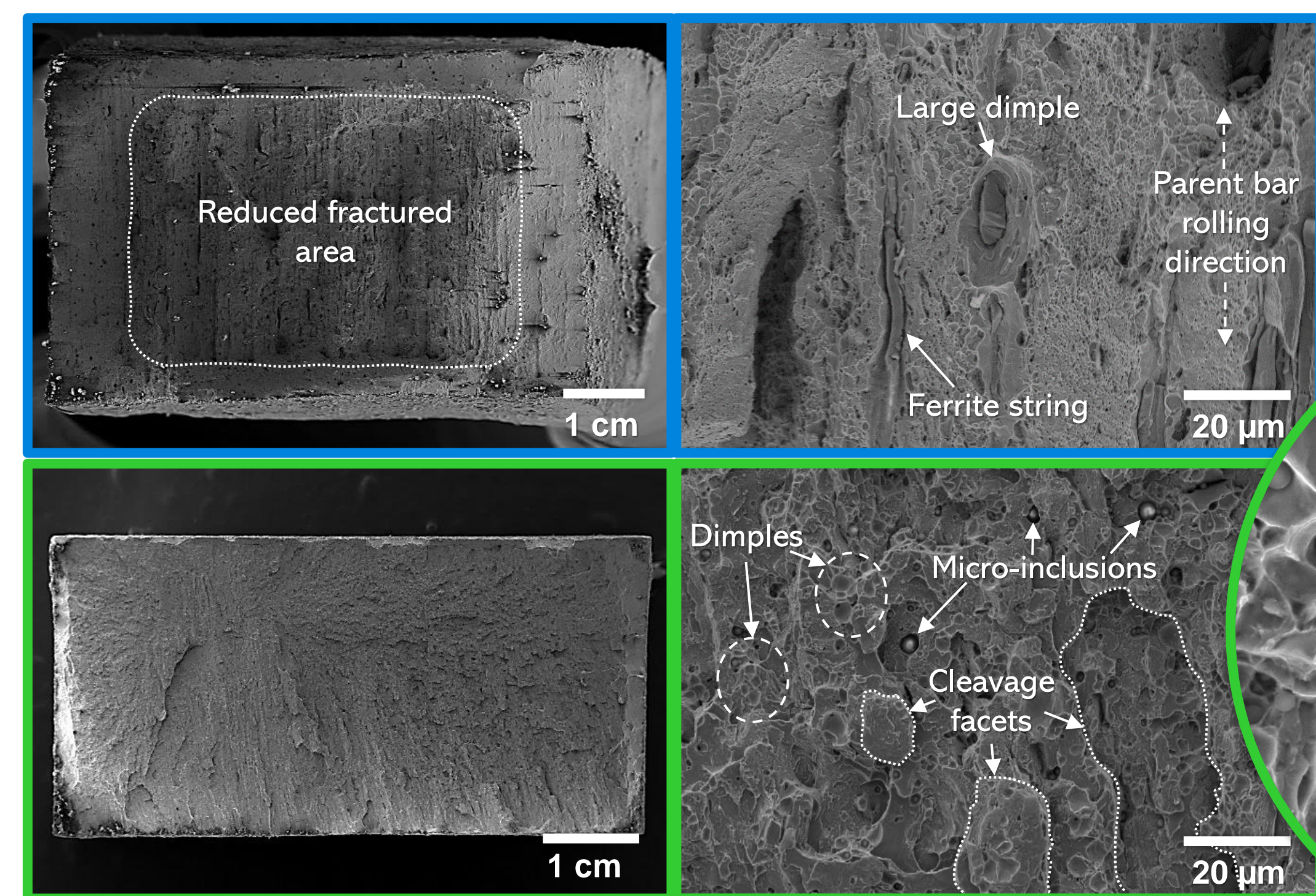


Conventionally vs. Additively manufactured

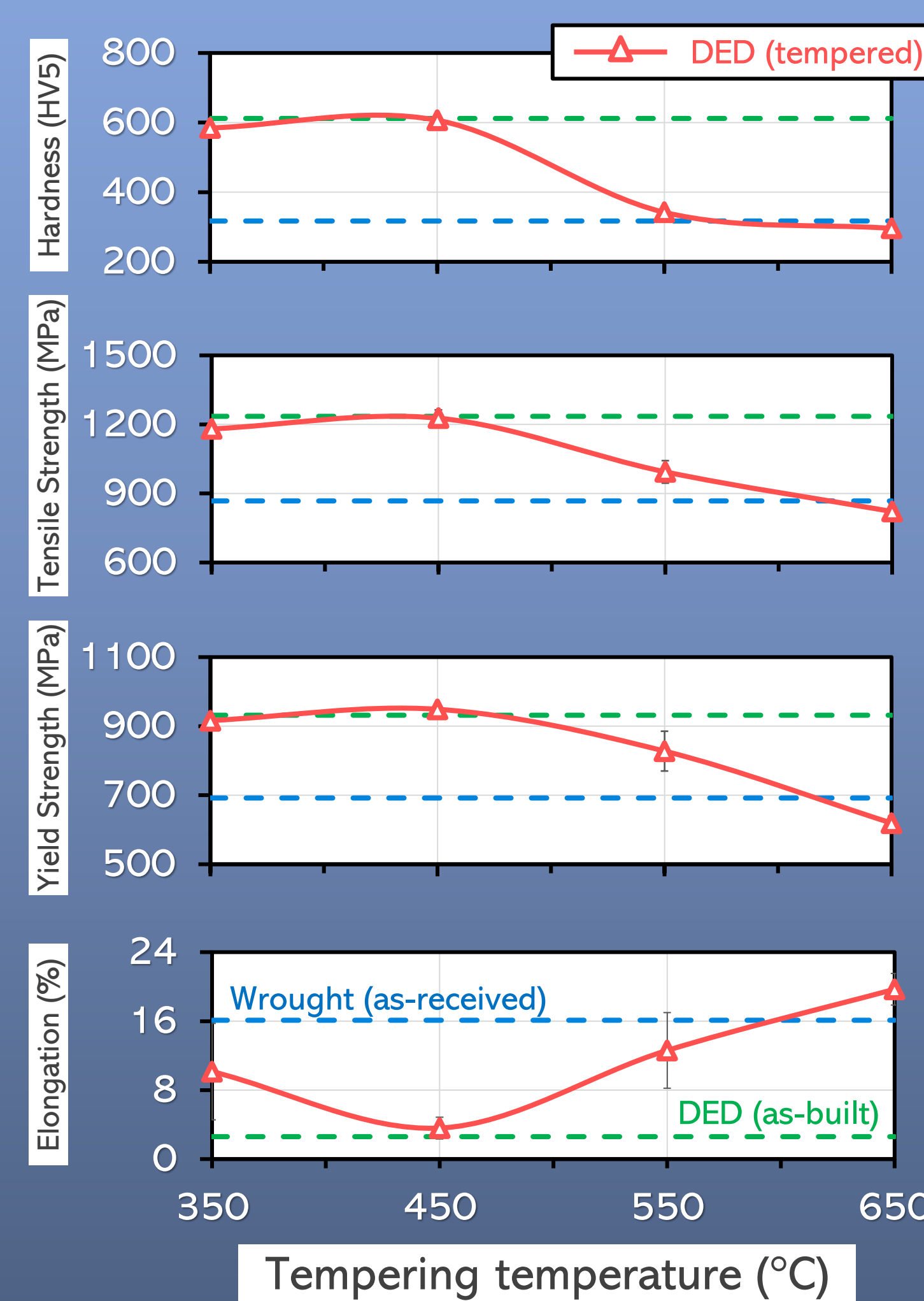
16Cr-2Ni Stress-Strain engineering curve



Fractography



Tempering on properties



Conclusion

- The DED (as-built) 16Cr-2Ni stainless steel presented a refined ferritic-martensitic microstructure compared to its commercially available wrought form, which resulted in a brittle mechanical behaviour.
- Micro-inclusions found in the DED (as-built) material were attributed to silica impurities present in the feedstock powder material.
- Tempering temperatures above 600°C can promote tensile properties in DED 16Cr-2Ni material comparable to its commercially available wrought form.
- A secondary hardening effect is observed in the 16Cr-2Ni DED material tempered at 450°C which may be caused by fine MxCy precipitation. Further analysis to be conducted in the material.

Presented at:



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