



Update on material testing for crab cavities

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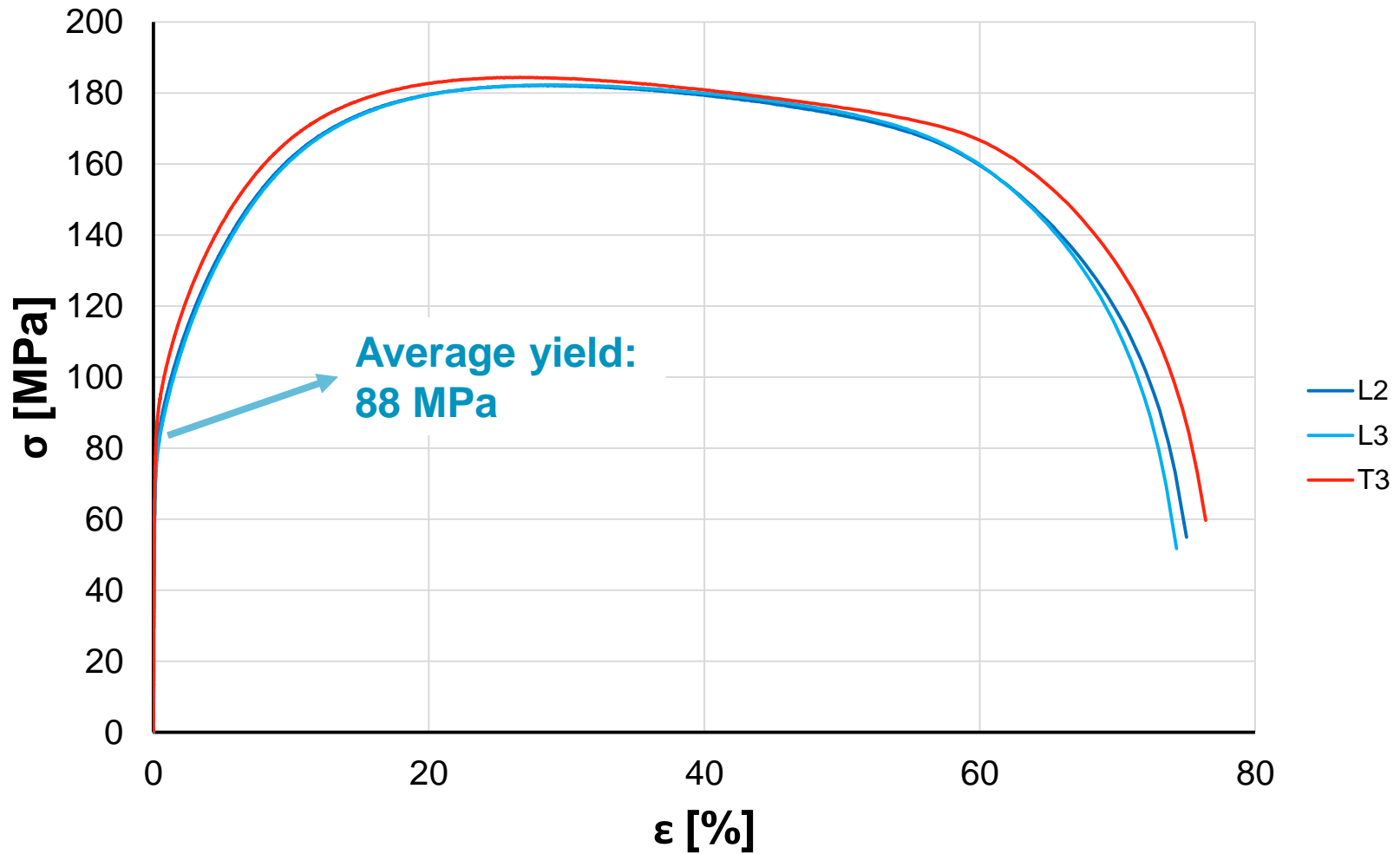
- Niobium sheets Tokyo Denkai (TD)
 - Tensile properties
- Ti/SS transition
 - Cu interlayer
 - Metallography
 - Tensile tests
 - Shear tests
 - He leak tightness
- Cryophy
 - Magnetic properties

Niobium Tokyo Denkai

- Material certificates from supplier TD reveal low yield strength (50-55 MPa)
- Yield strength critical for correct stress assessment (FEM)
- Tensile tests at RT to verify yield strength (sheet 5713, 4 mm)
- Additional tests at 4 K to evaluate cryogenic properties (sheet 5714, 4 mm)

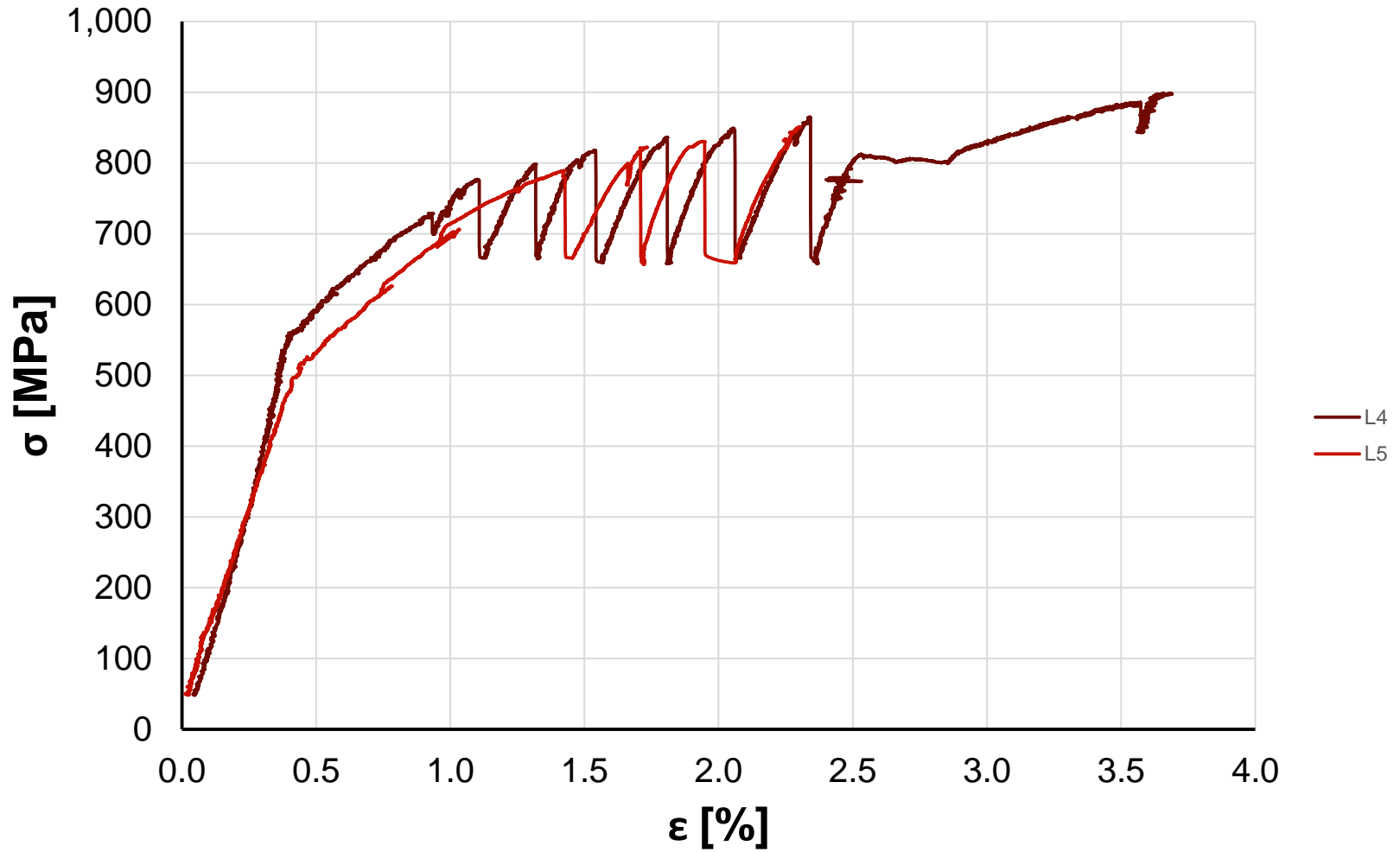
Niobium TD

RT tensile tests



Niobium TD

4 K tensile tests



Niobium TD

Mechanical properties

RT

	$R_{p0.2}$ [MPa]	R_m [MPa]	E [GPa]	A_g [%]	A [%]
Experimental	88±9	183±2	106±2	27±2	75±1
Certificate	55	175	n/a	n/a	65

4 K

$R_{p0.2}$ [MPa]	R_m [MPa]	A [%]
630±20	880±20	2.4±0.7

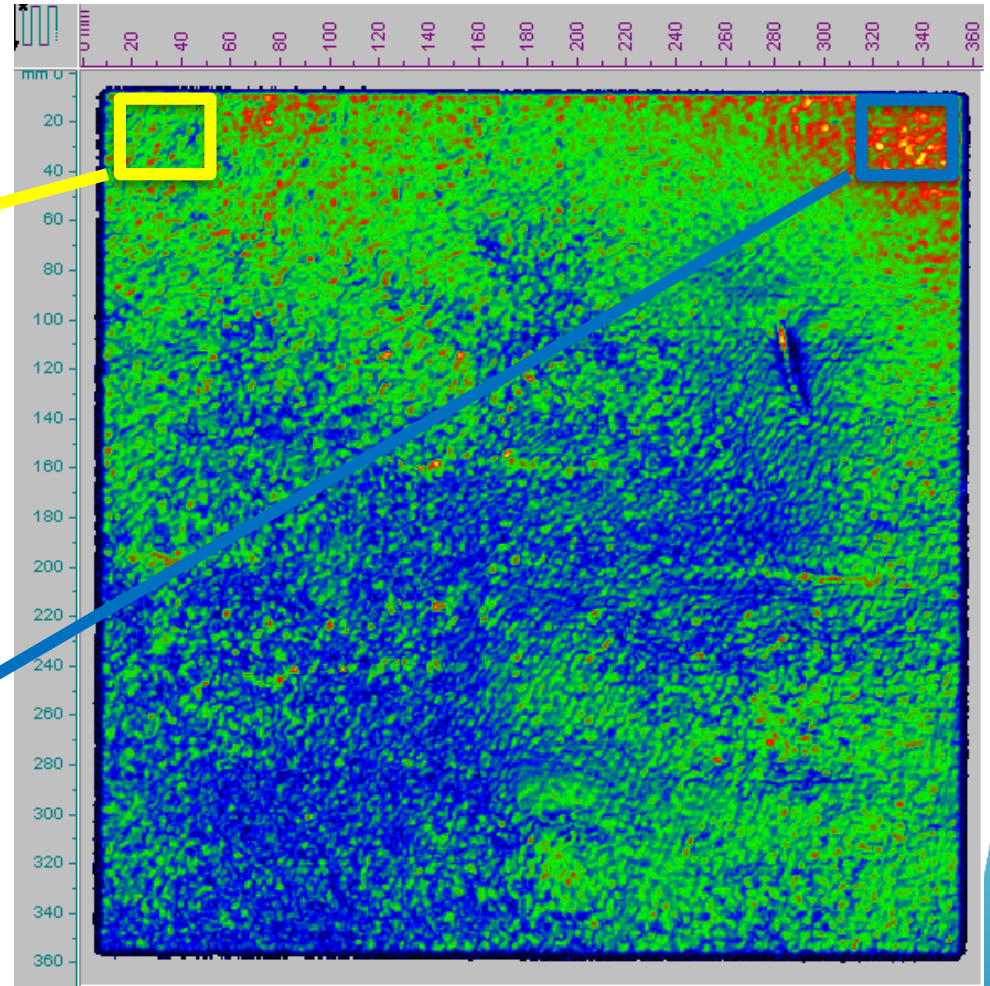
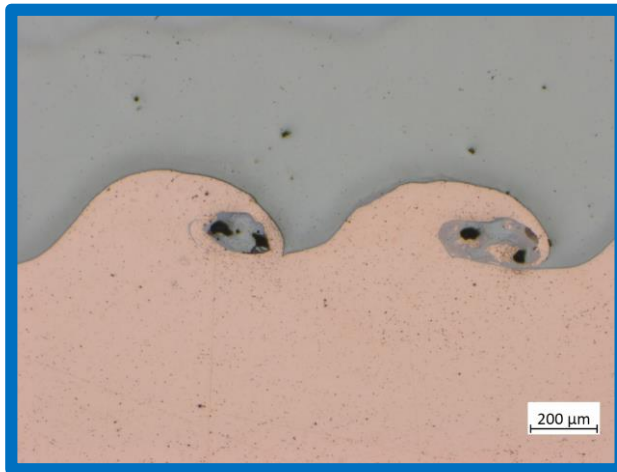
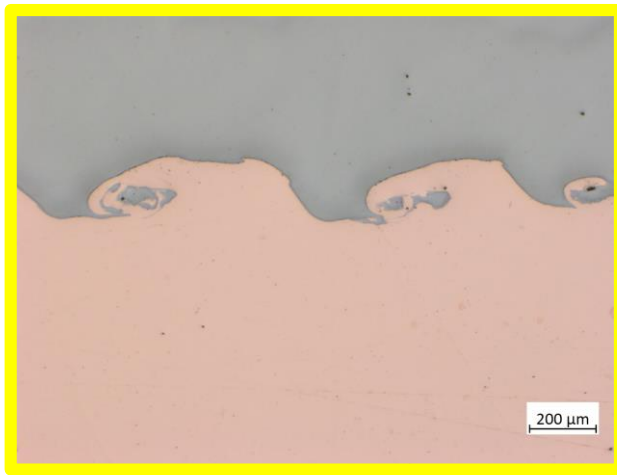
Niobium TD Conclusions

- Yield stress is 88 MPa in average in contrast to 55 MPa stated by the material certificates
- Why this discrepancy in yield stress?
 - Tensile tests performed at a preliminary stage? (e.g. before rolling)
- Mechanical properties much higher at cryogenic temperature, but more brittle (low elongation)
- Report (in work) on [EDMS 1722302](#)

Explosion bonding Ti/Cu/SS

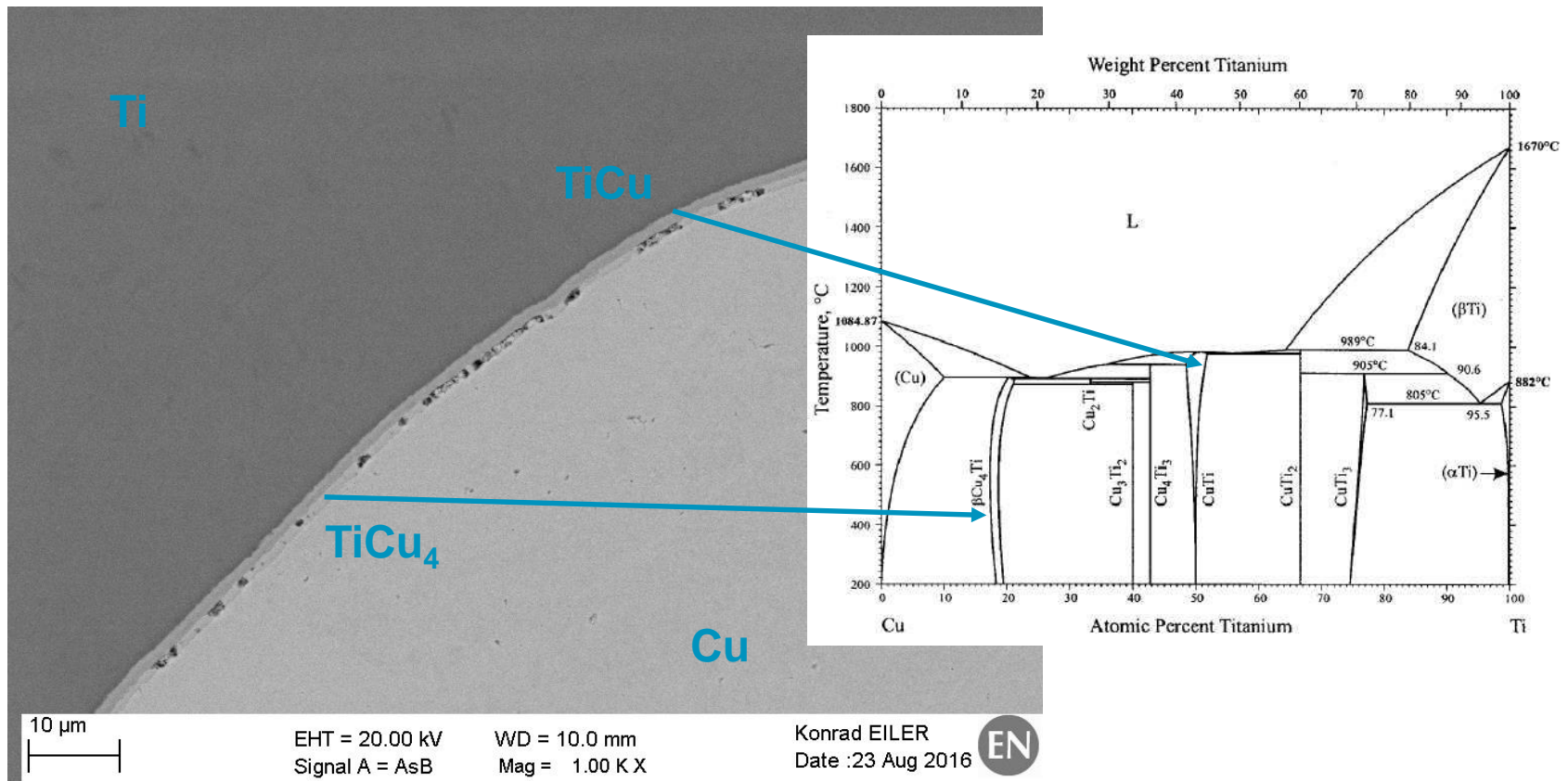
- Material: Ti grade 1 + Cu-OF + 316L

Explosion bonding Ti/Cu/SS Metallography Ti/Cu interface



Explosion bonding Ti/Cu/SS Metallography Ti/Cu interface

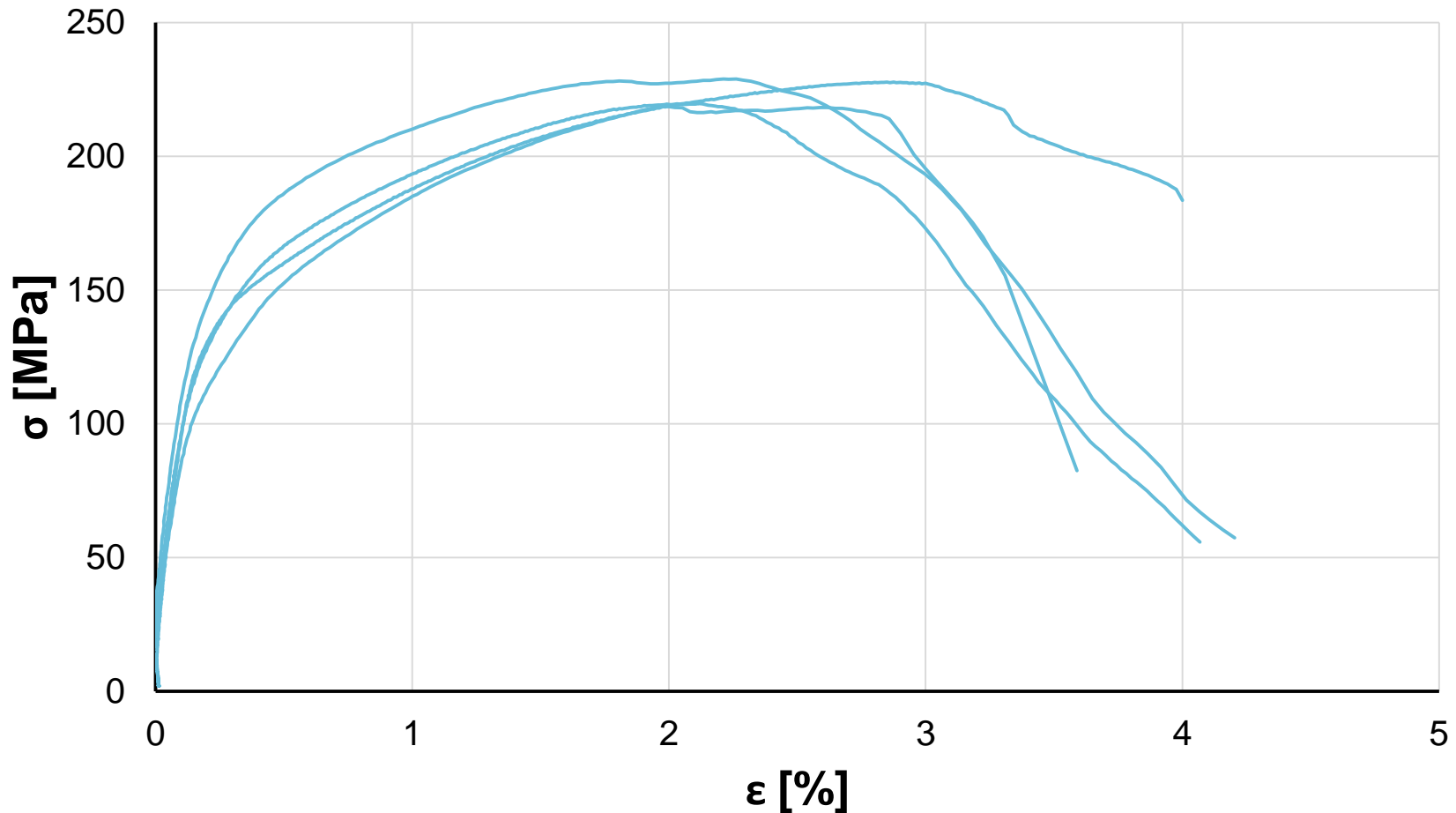
- Two layers of intermetallics of $\sim 1 \mu\text{m}$ thickness



Explosion bonding Ti/Cu/SS

Tensile tests RT

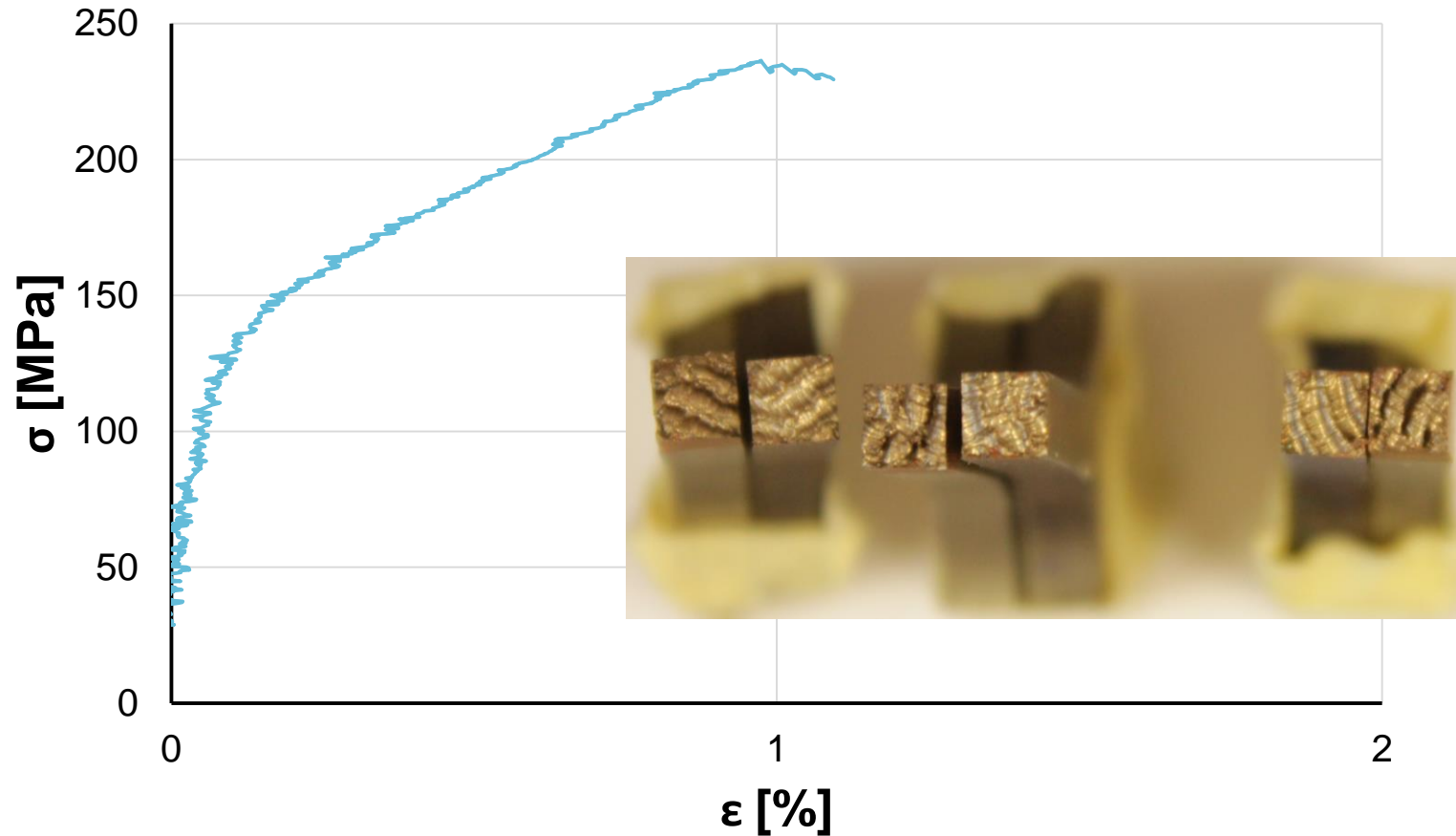
- Failures at RT: in Cu, close to Ti/Cu interface



Explosion bonding Ti/Cu/SS

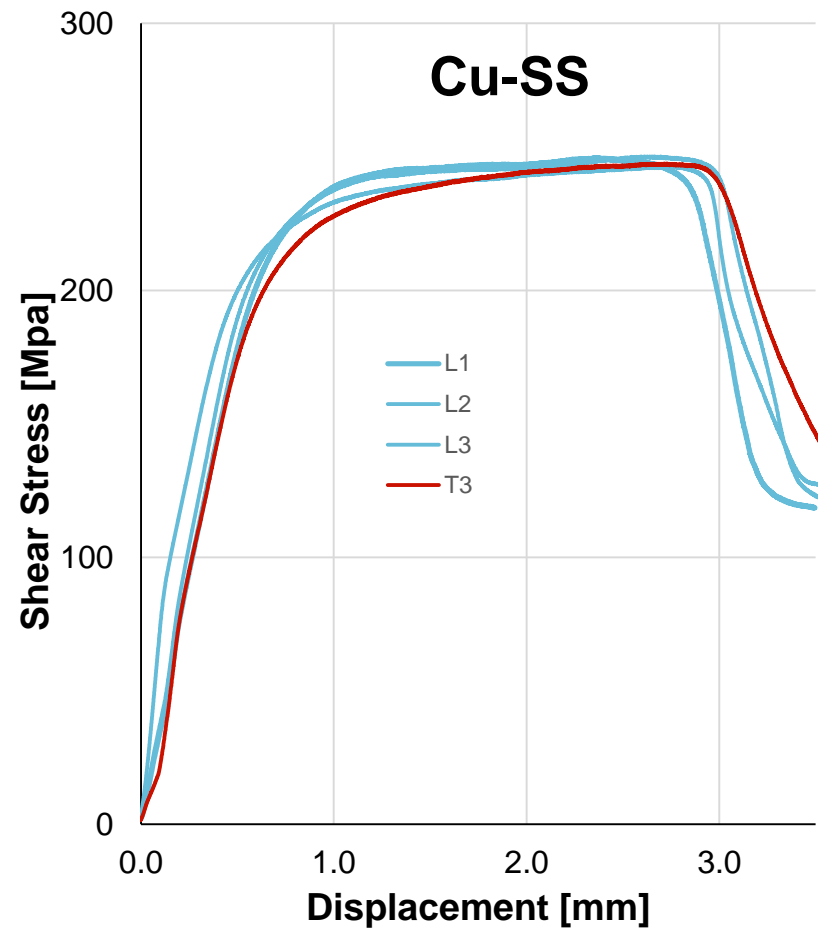
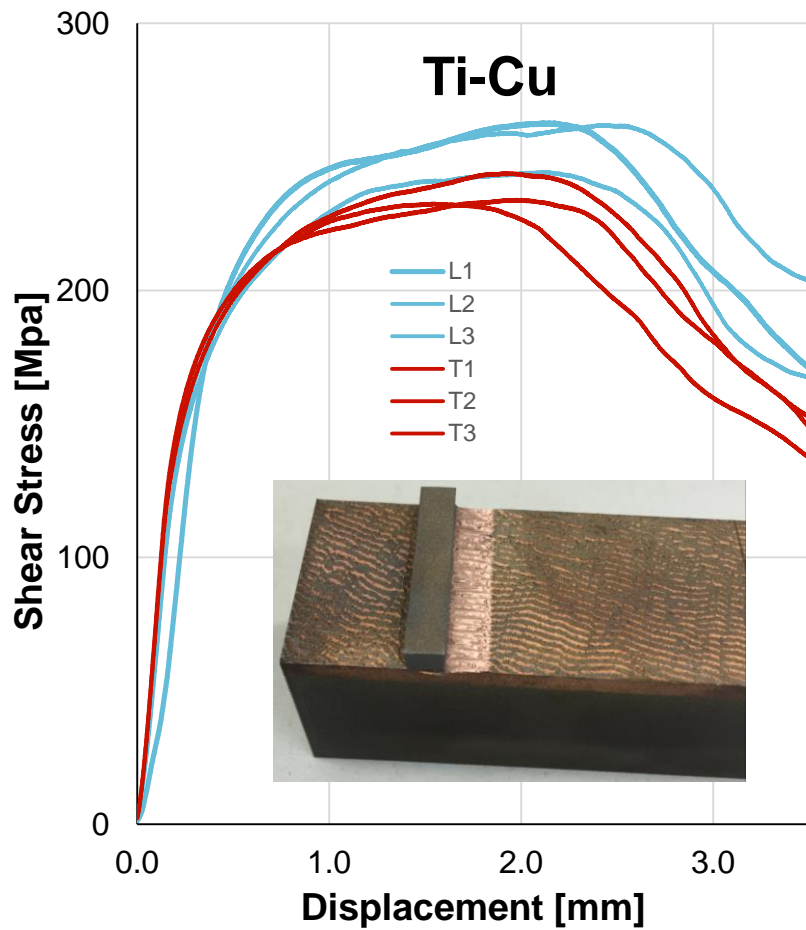
Tensile tests 4 K

- Failures at 4 K: at Ti/Cu interface



Explosion bonding Ti/Cu/SS

Shear tests RT



Explosion bonding Ti/Cu/SS

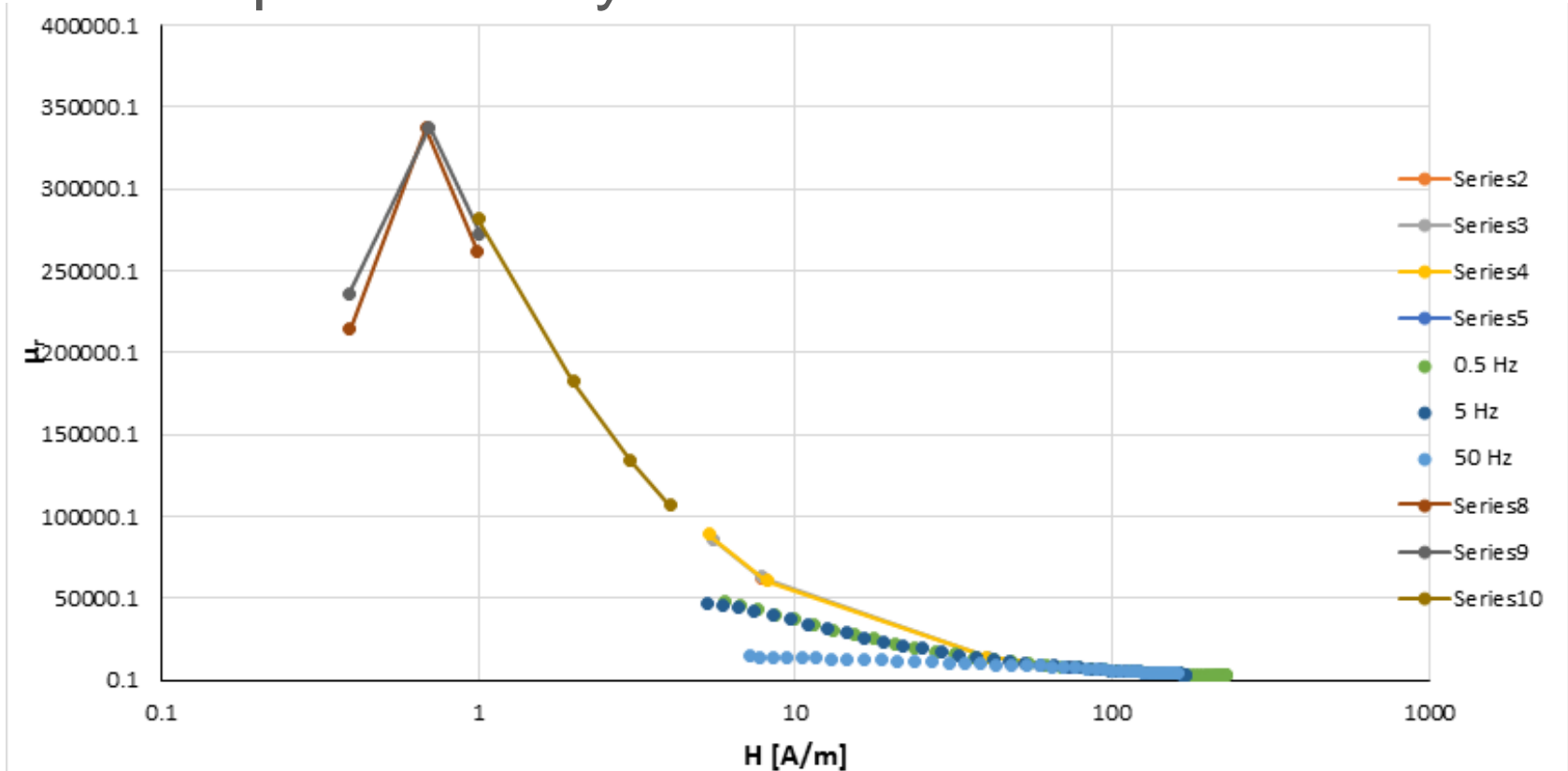
Conclusions

- He leak test: passed (wall thickness 2 mm, as in application)
- Shear tests satisfactory
- Tensile tests at 4 K exhibit tensile strength comparable to RT
- Brittle behaviour at 4 K
- Two brittle, intermetallic phases are present along the whole Ti/Cu interface
- Report (in work) on [EDMS 1724598](#)
- Next tests: plate with Ta interlayer received

Cryophy

Magnetic measurements RT

- Peak permeability at 340.000



- Set-up for 4 K measurements in work

Courtesy of A. Parrella