

# Characterization of localized tensile properties of 316LN -HG4169-Inconel 718 dissimilar welding joints at cryogenic temperature through a digital image correlation technique

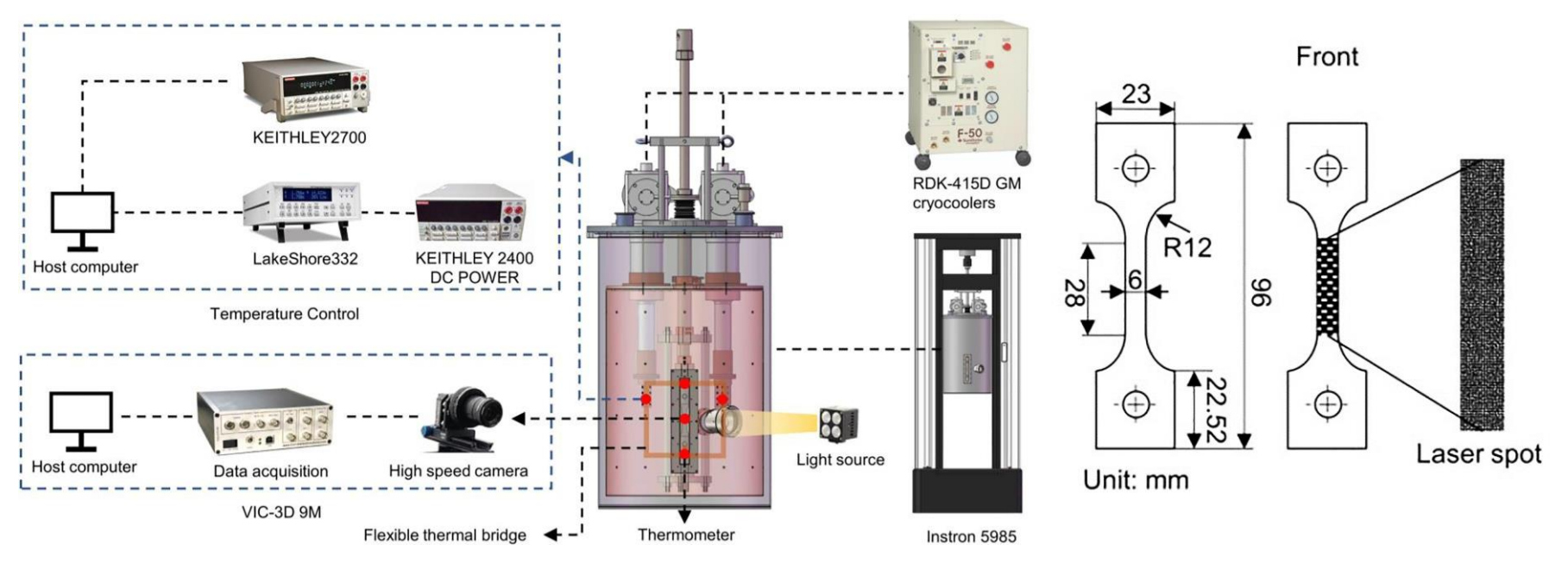
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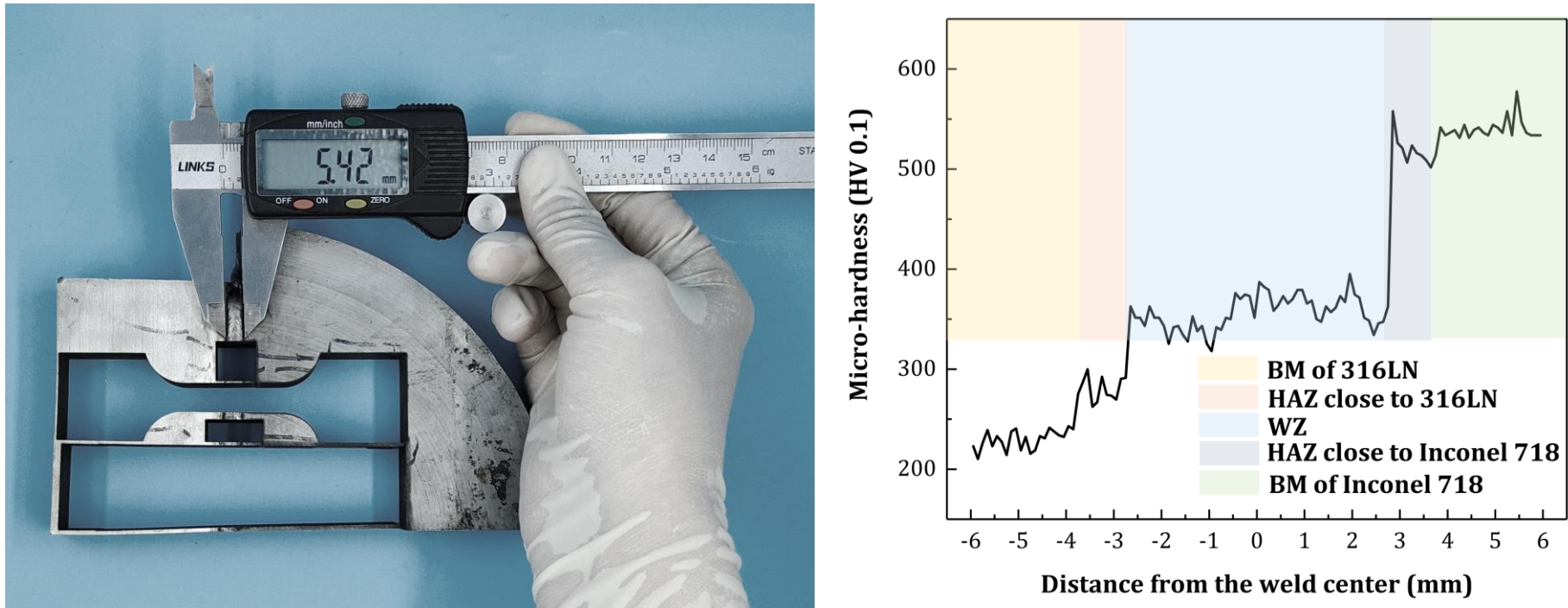
## Abstract

- ◆ Regional boundaries of the WZ, the HAZ and the BM of dissimilar welding joints was determined by the macroscopic observation and micro-hardness measurements.
- ◆ Global tensile properties obtained by the DIC technique was proven to be reliable compared with electronic extensometer when applied to dissimilar welding joints at cryogenic temperature (6 K).
- ◆ Local yield strength ( $R_{p0.2}$ ) of three different zones were investigated at cryogenic temperature (6 K), demonstrating transform of mismatch states of dissimilar welding joints from 300 K to 6 K.

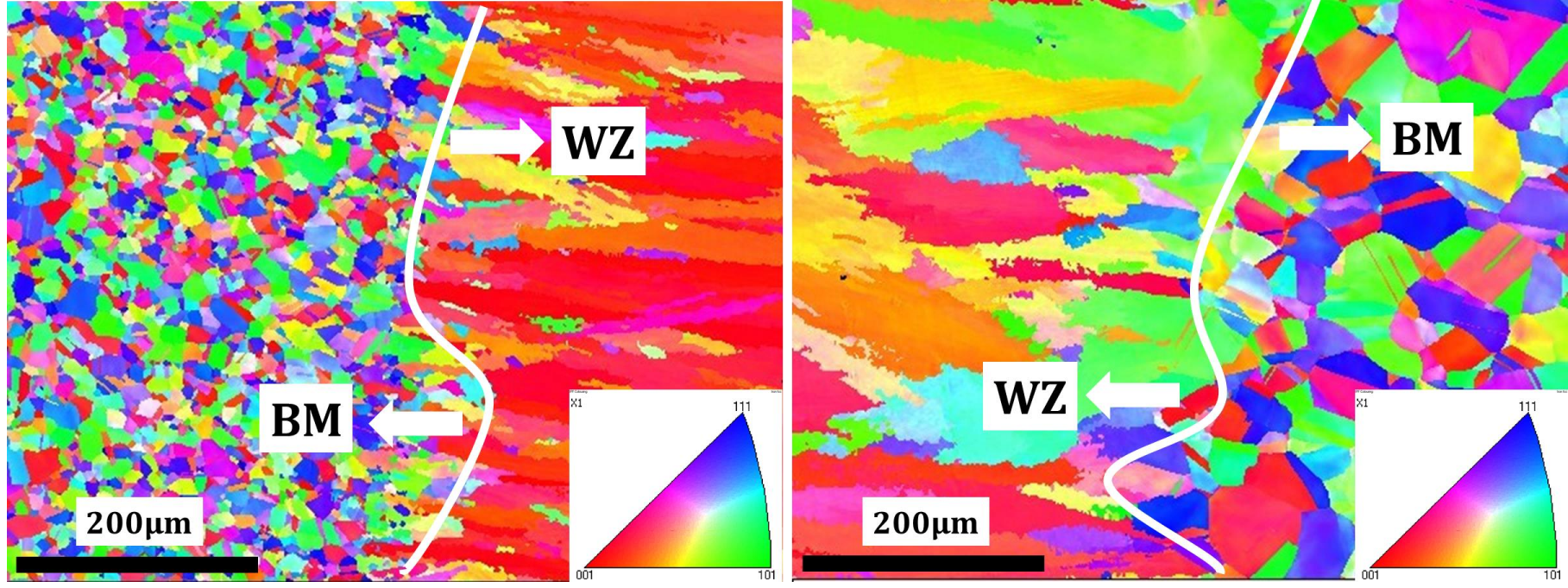
### 1. Material and Method



### 2. Determination of Regional Boundaries

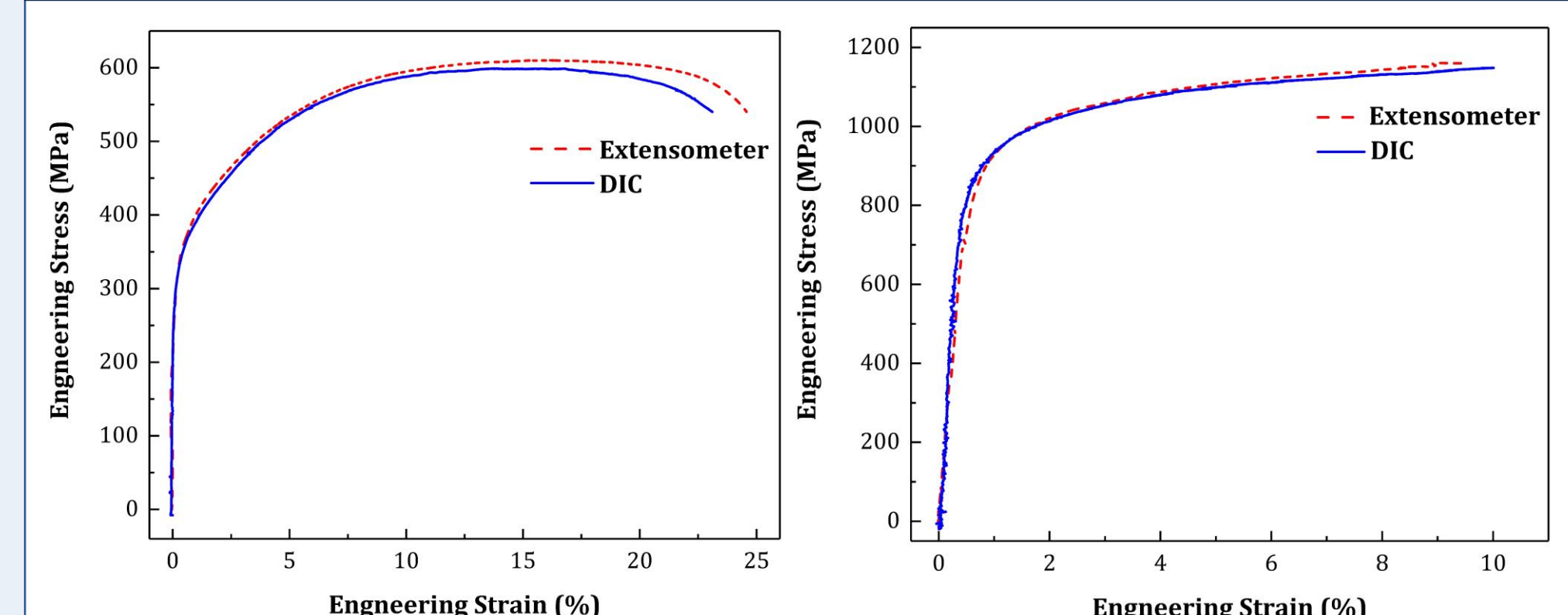


- The width of the WZ was identified as 5.4 mm through macroscopic observation.
- The width of the HAZ was determined as 1 mm left and right from the WZ.



- The area to the left and right of the white dividing line is the BM of Inconel 718 and 316LN, and the WZ respectively.

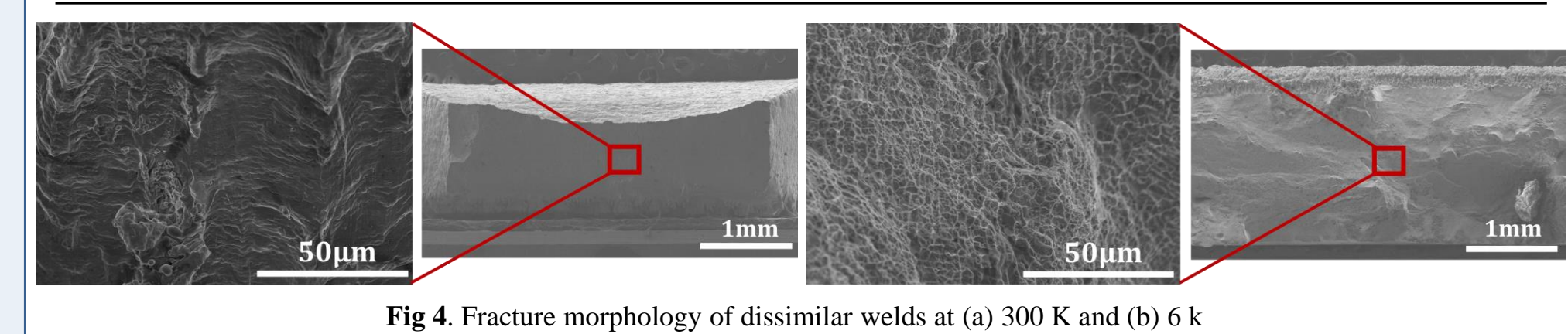
### 3. Global Tensile Properties by the DIC Technique



- The DIC Technique was proven to be reliable compared with electronic extensometer when applied on dissimilar welds both at room temperature and cryogenic temperature.

Tab.1 Global tensile properties of dissimilar welds at 300 K and 6 K

		$R_{p0.2}$ / MPa	$R_m$ / MPa	$e$ / %	$Z$ / %
300 K	DIC	326.5	598.7	23.1	58.3
	Extensometer	333.4	610.2	24.6	
6 K	DIC	867.0	1148.1	10.0	15.7
	Extensometer	858.1	1155.1	9.5	



### 5. Conclusion

- Global tensile properties of dissimilar welds obtained by the DIC technique were verified to be highly accurate compared with extensometer verification.
- Local tensile properties were obtained by the localized optical DIC, which demonstrated that mismatch state of dissimilar welds maintained the same: undermatch relative to the WZ and the BM of Inconel 718, and overmatch relative to the WZ and the BM of 316LN.

### 4. Global Tensile Properties by the Optical DIC

- The localized optical DIC was drawn using VIC-2D in the WZ, the HAZ and the BM to obtain corresponding curves of tensile engineering stress-engineering strain respectively at 300 K and 6 K based on the identification of regional boundaries in the part. 2.

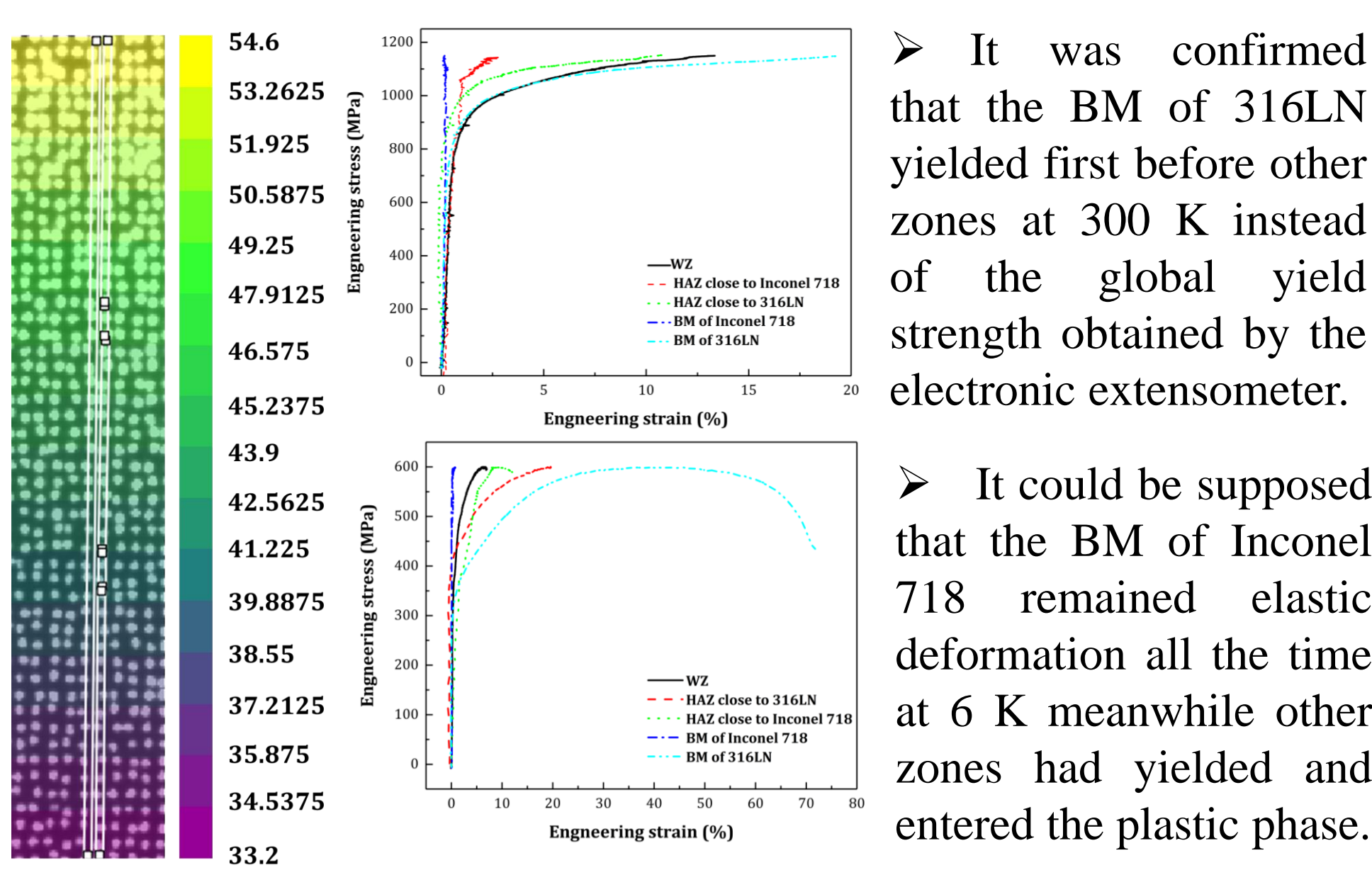


Fig.5 (a) Schematic diagram of virtual extensometers in localized zones for the localized optical DIC, and local engineering stress-engineering strain curves of the WZ, the HAZ, and the BM of dissimilar welds at (b) 300 K, and (c) 6 K

Tab.2 Local tensile properties of three different zones of dissimilar welds at 300 K and 6 K

	300 K			6 K		
	$R_{p0.2}$	$R_m$	$e$	$R_{p0.2}$	$R_m$	$e$
	MPa	MPa	%	MPa	MPa	%
WZ	378.7	599.5	6.9	813.7	1149.5	13.3
HAZ close to Inconel 718	371.3	598.7	11.9	1070.3	1143.0	2.8
BM of Inconel 718	595.4	600	0.6		1110.5	0.4
HAZ close to 316LN	365.48	599.2	19.5	951.46	1152.6	11.0
BM of 316LN	278.6	598.8	71.4	785.7	1147.8	19.2