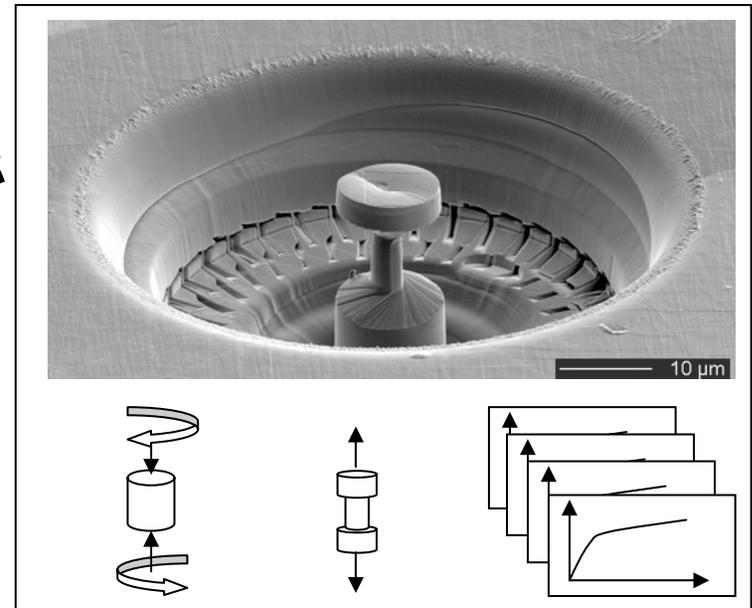
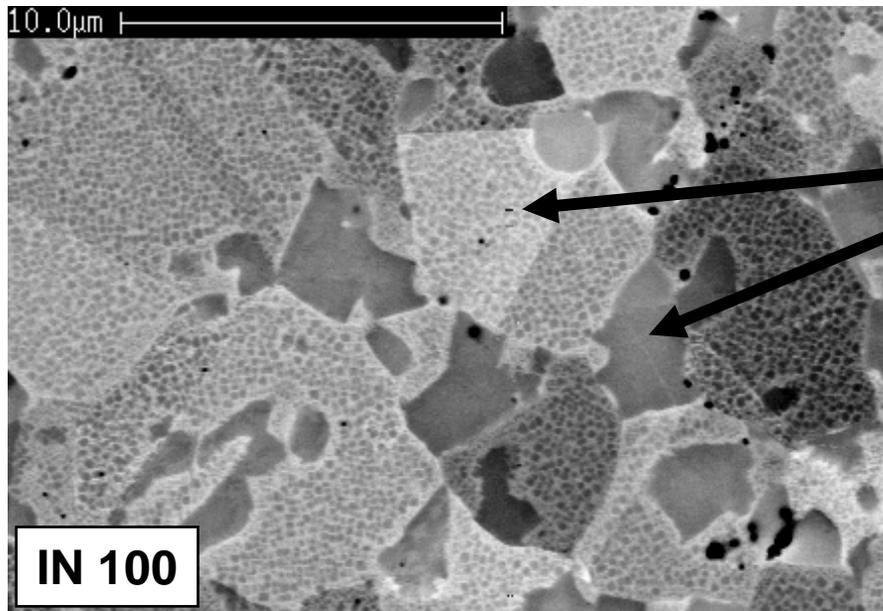




# How Does Metrology Affect Present Work?



**Need for 'single-crystal' data from microconstituents of 'fully-processed' alloys**

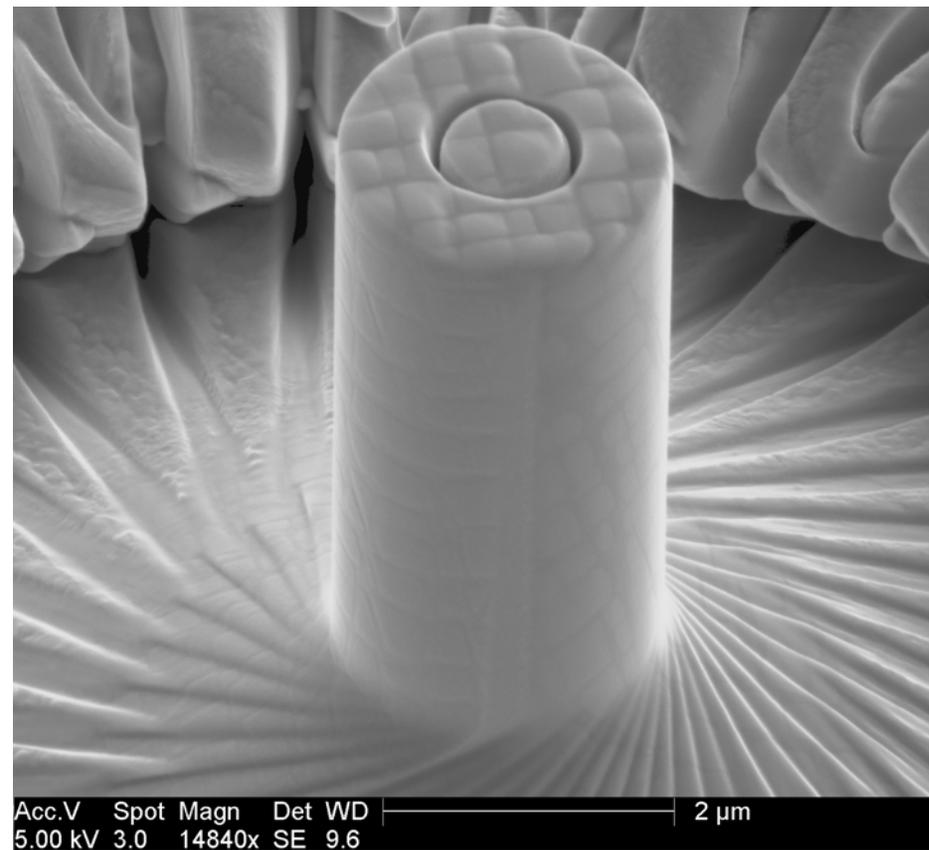


**Microconstituent sets length scale for test methodology— $\mu\text{m}$  sized samples**

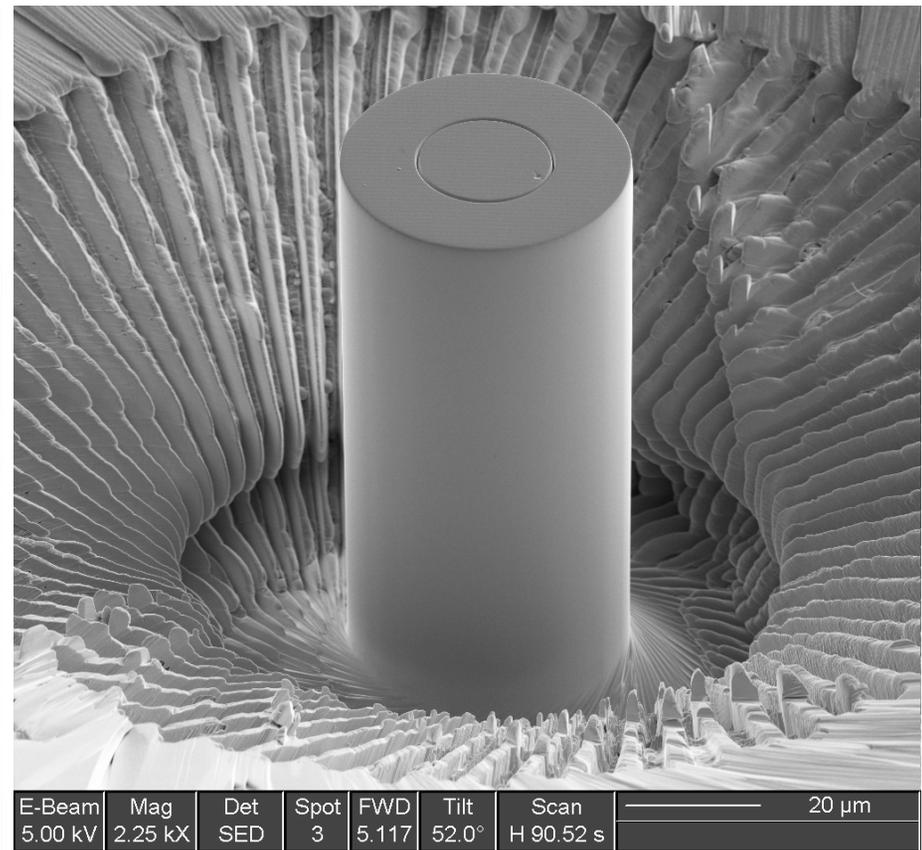
**Goal: scale testing methods to work with  $\mu\text{m}$  size samples  
- uniaxial and multi-axial loading over range of use temperatures**



# Examples of Auto-machined Samples



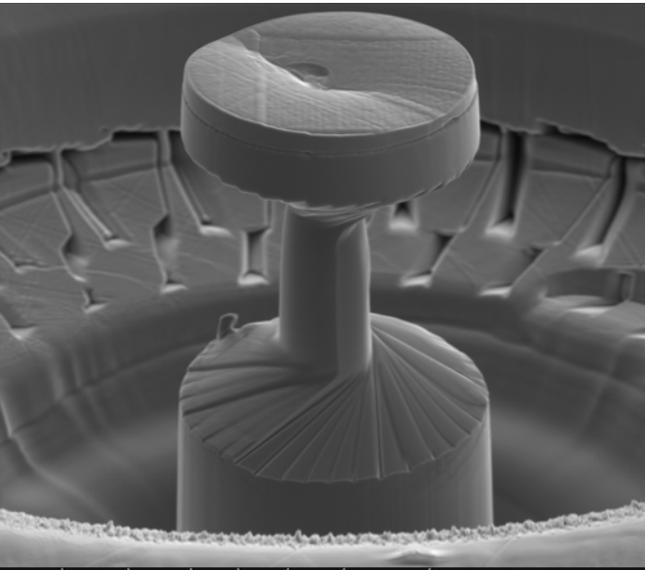
Ni superalloy (UM F19)  
2.3 μm in diameter  
4.5 μm gage length



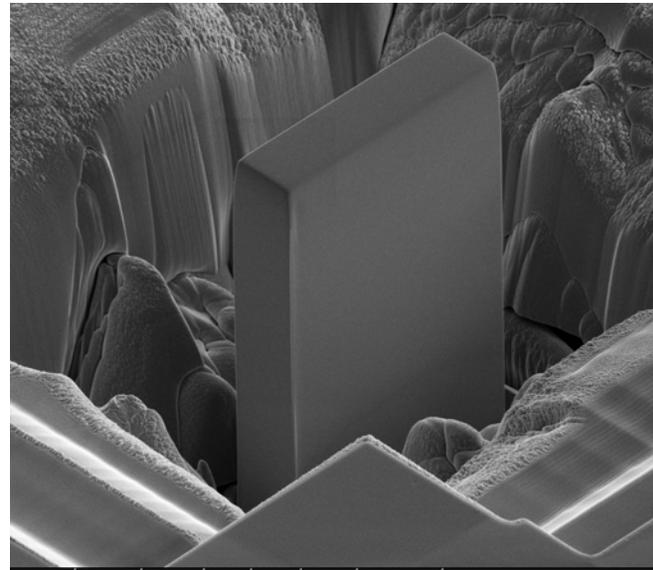
$\text{Ni}_3(\text{Al}, 0.2\% \text{ Hf})$   
43 μm in diameter  
90 μm gage length



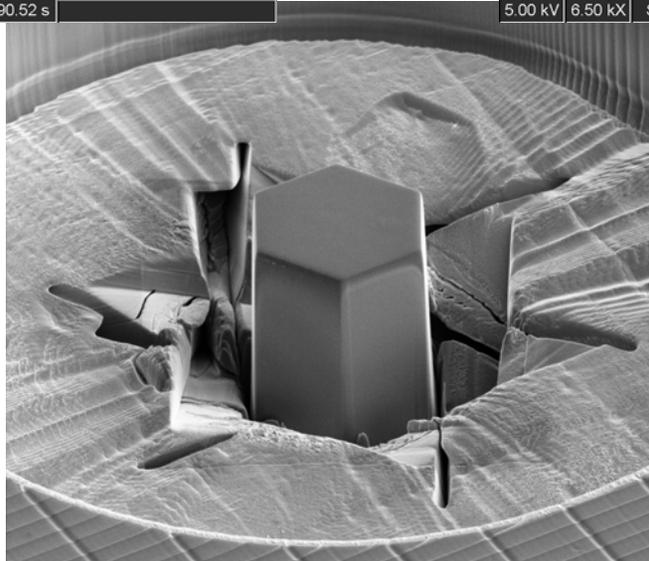
# Alternate test sample geometries



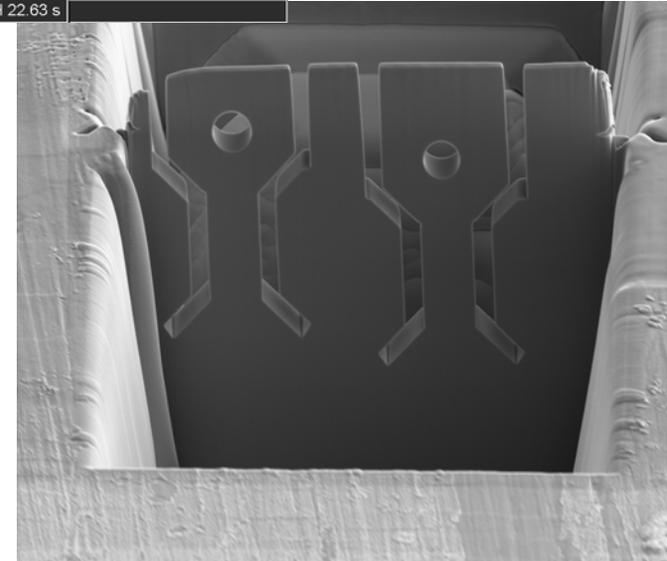
E-Beam	Mag	Det	Spot	FWD	Tilt	Scan	5 μm
5.00 kV	12.0 kX	SED	3	4.960	60.0°	H 90.52 s	



E-Beam	Mag	Det	Spot	FWD	Tilt	Scan	10 μm
5.00 kV	6.50 kX	SED	3	5.041	52.0°	H 22.63 s	



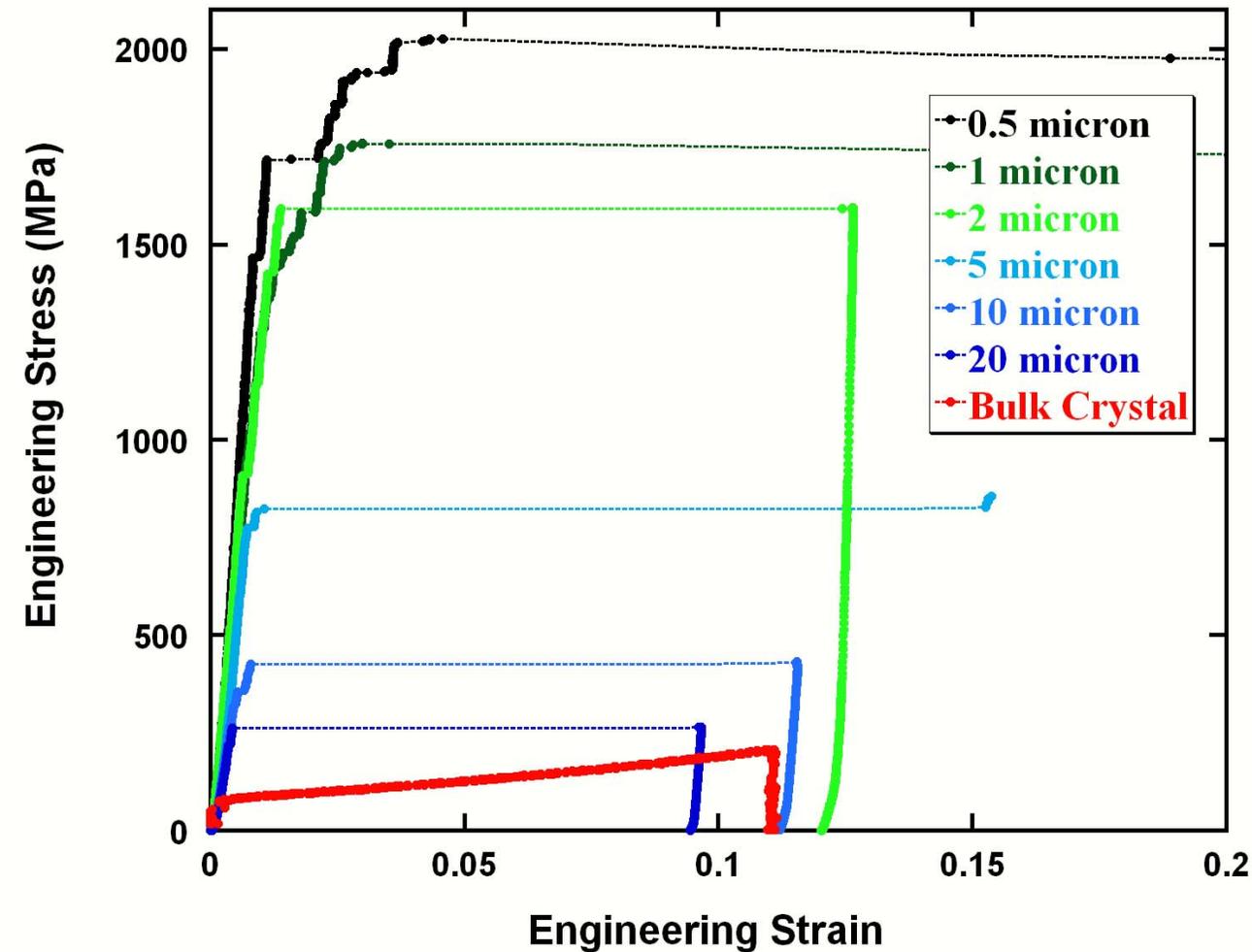
E-Beam	Mag	Det	Spot	FWD	Tilt	Scan	10 μm
5.00 kV	6.50 kX	SED	3	5.043	52.0°	H 45.26 s	



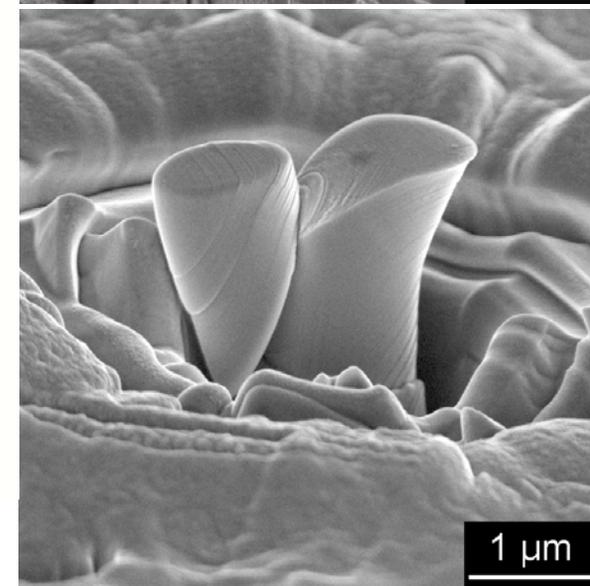
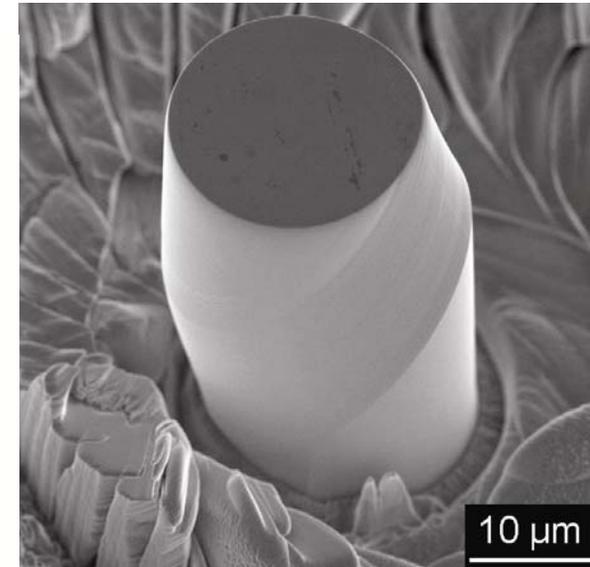
E-Beam	Mag	Det	Spot	FWD	Tilt	Scan	5 μm
5.00 kV	8.00 kX	SED	3	5.000	59.0°	H 90.52 s	



# $Ni_3(Al, Ta)$ Representative $\sigma-\epsilon$ curves

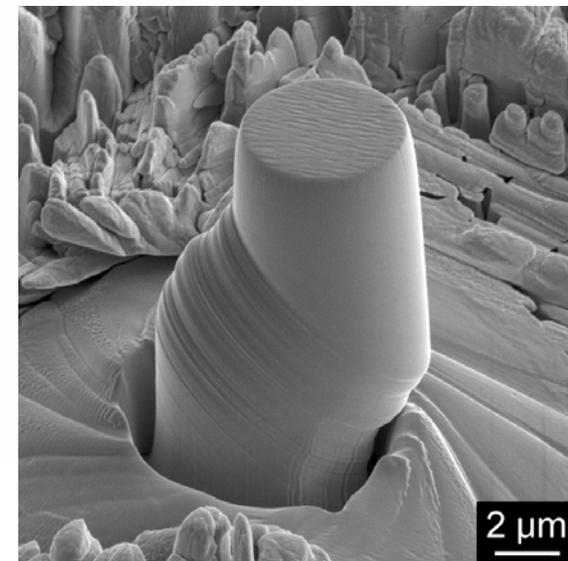
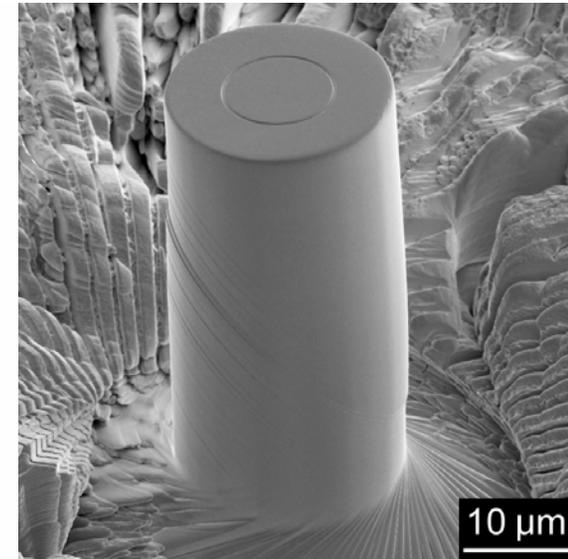
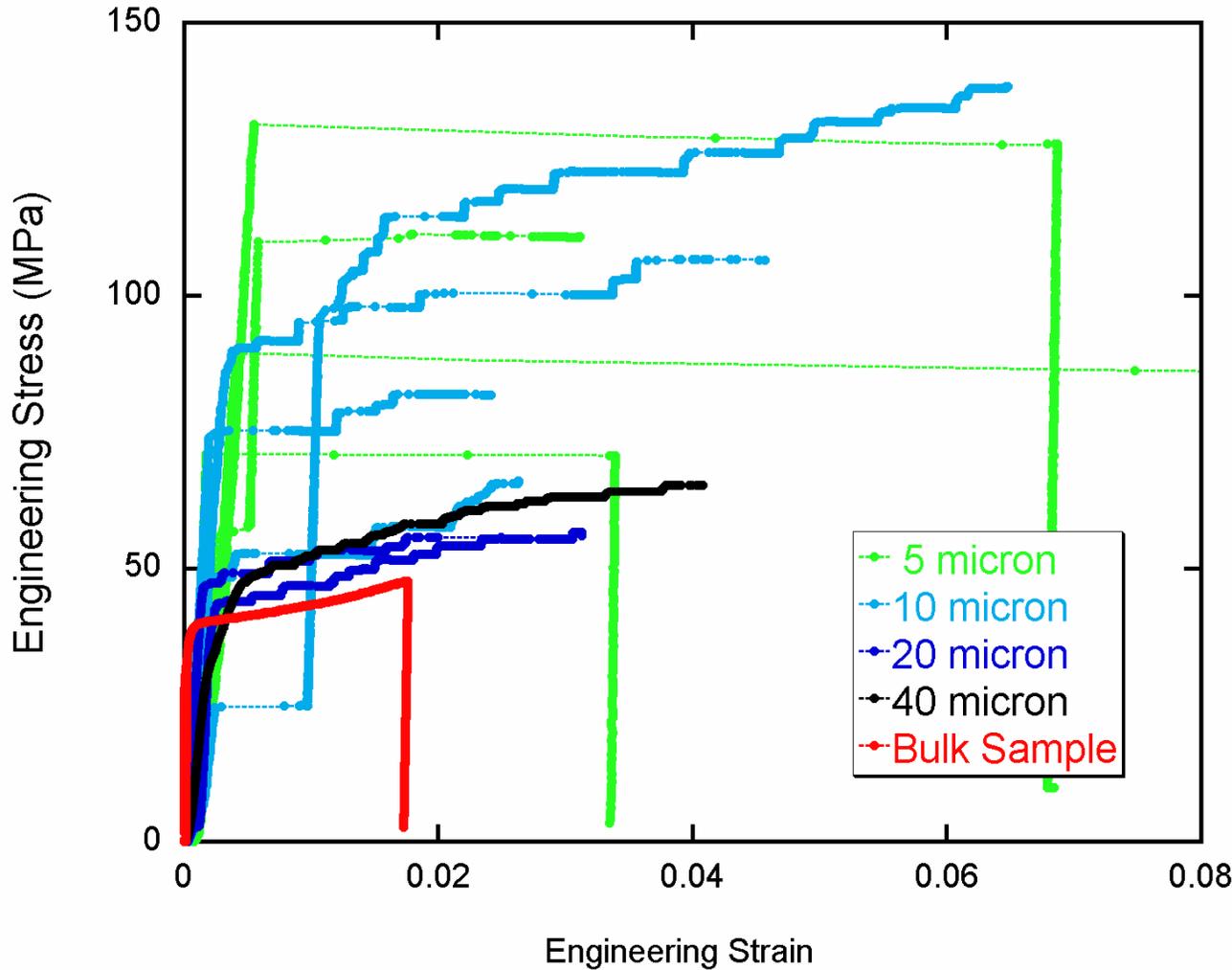


***A significant size effect!***





# Pure Nickel Stress-Strain Data



**Size effects observed for  $d \leq 10 \mu\text{m}$**



## *Micro-testing Metrology Needs in 5-10 Yr Time Frame*



- **Continued development of test methods which operate on micron-size specimen**
  - **At elevated temperatures**
  - **Multi-axial loading (tension-torsion, bi-axial)**
  - **Integration of deformation mapping (Local displacement measurements)**
  - **Tools for gripping, articulating micron-size samples without damage**
- **Need more fundamental research to understand size-effected plastic deformation**
- **Generate statistically-relevant data sets**
  - **Continued development of rapid, fully-automated fabrication methods which can be used on most materials**
  - **Fully-automated test methodologies which accomplish full range of test needs**
- **Calibration standards (COTS) for nano-test equipment**