

# Effect of thermal relaxation of residual stress and fatigue performance of laser peened CMSX-4 nickel superalloy

## Microstructure Data Update

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# SEM: Images of Baseline, LP+TME, and LP+TME w/ TE

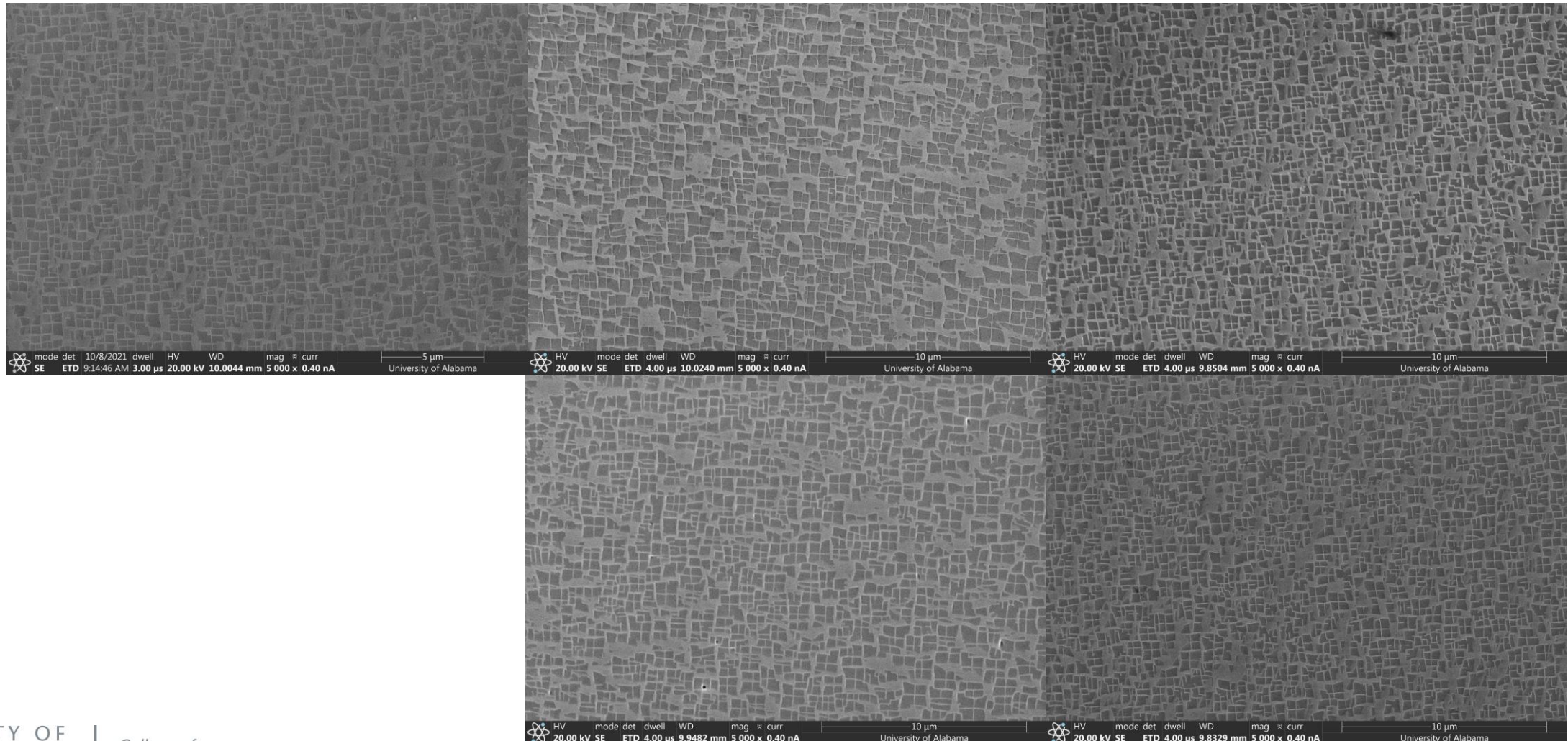


Baseline (No Treatment)

7-18-3 LP+TME

7-18-3 LP+TME w/ TE

50  $\mu$ m



>5 mm



# SEM: ImageJ Area Fraction Analysis

Distance from the LP Surface

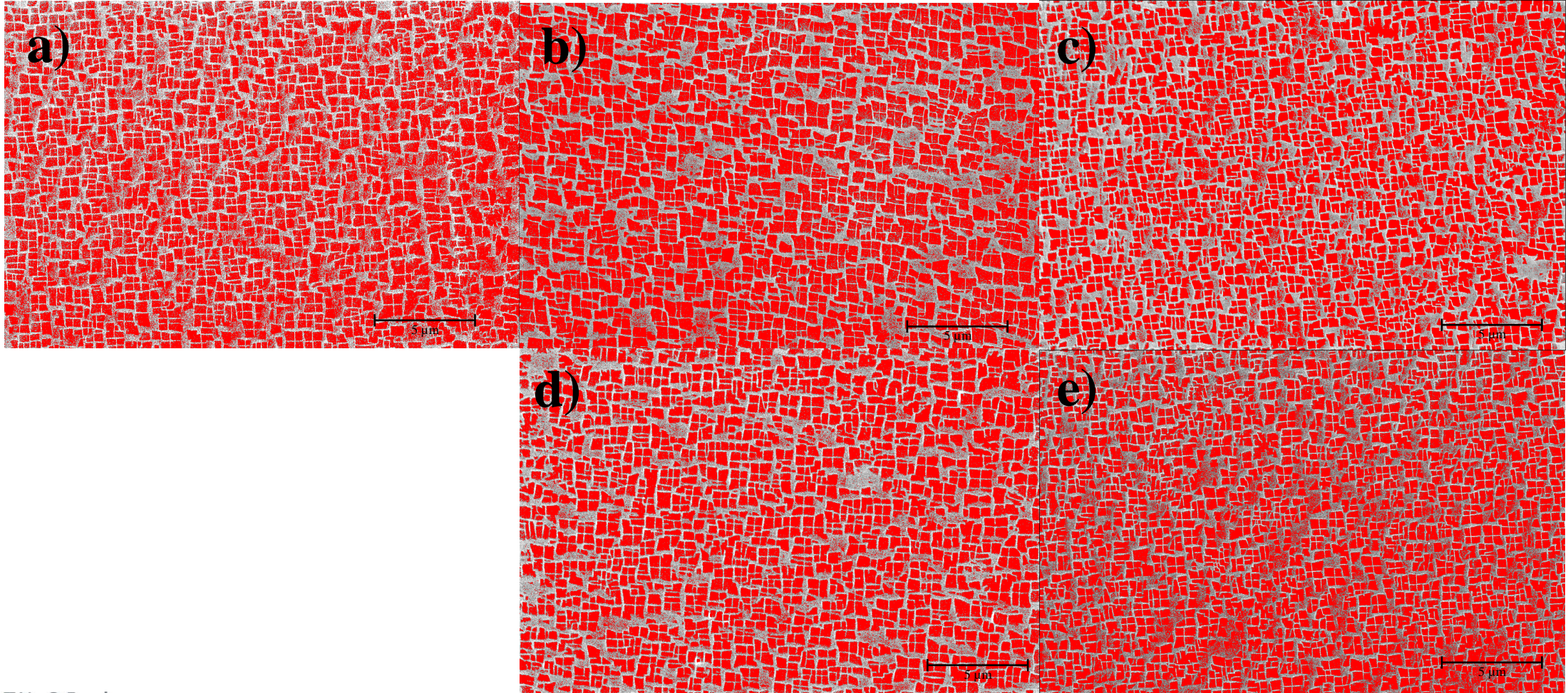
50  $\mu\text{m}$

>5 mm

Baseline (No Treatment)

7-18-3 LP+TME

7-18-3 LP+TME w/ TE





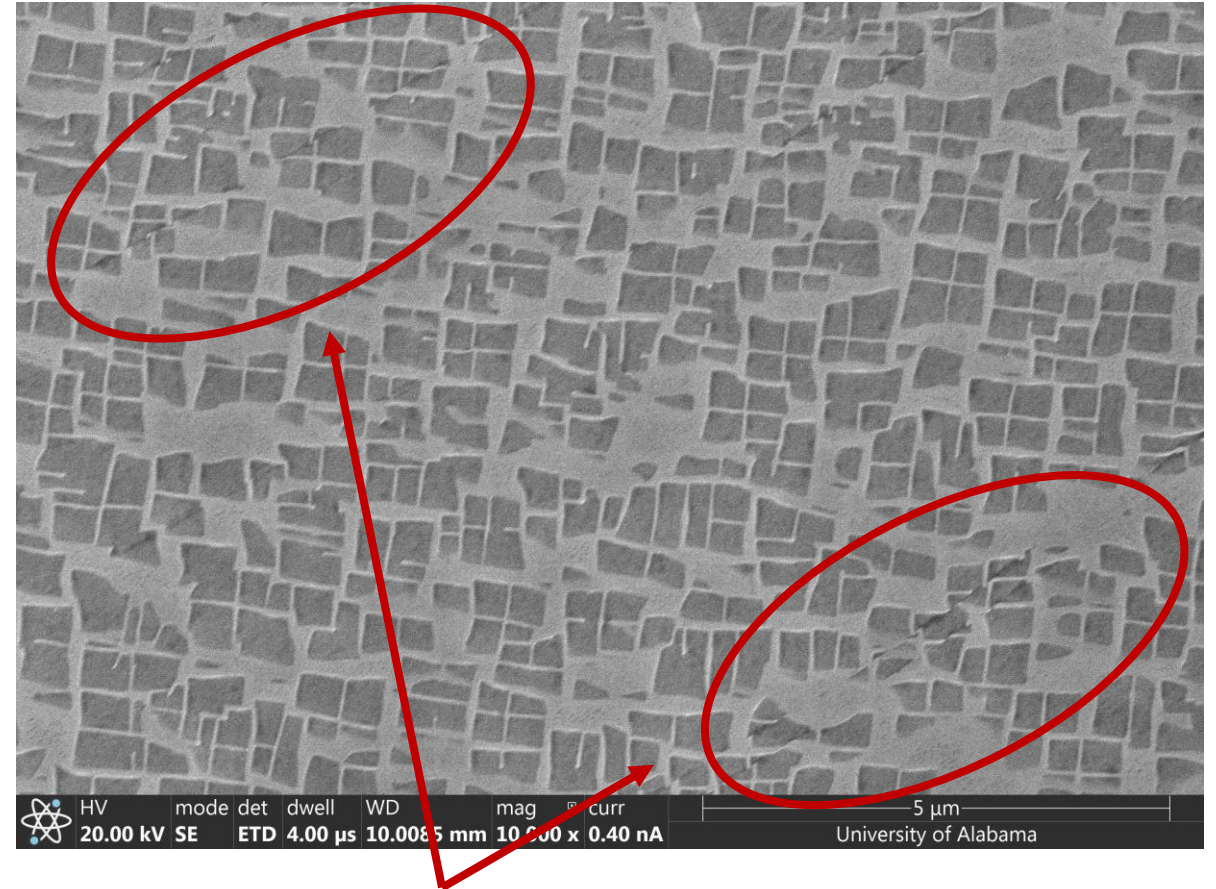
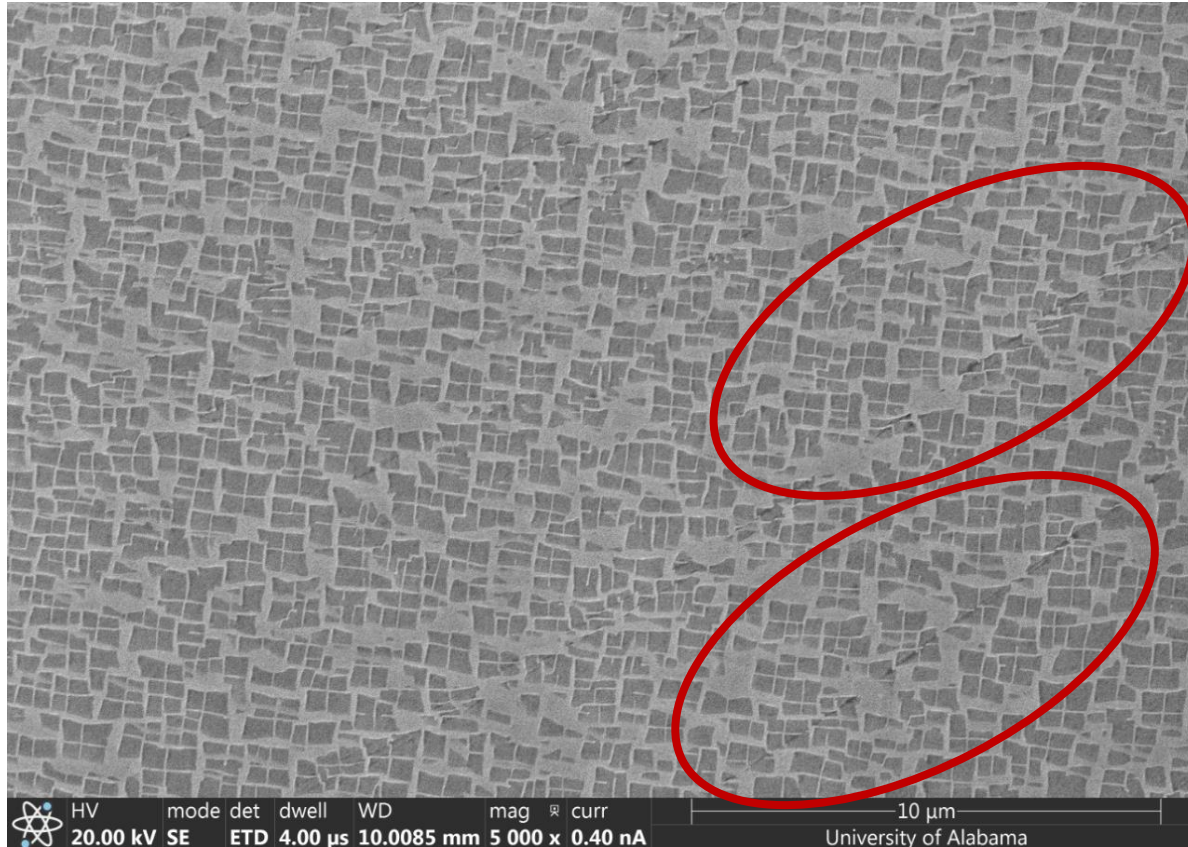
# SEM: ImageJ Area Fraction Percentage

- $\gamma'$  area fraction is displayed as a percentage in Table 1
- Area fraction analysis was conducted in ImageJ
- Area fraction remains approximately constant after LP+TME and after thermal exposure

Distance from LP Surface	Baseline	7-18-3 LP+TME	7-18-3 LP+TME w /TE
50 $\mu\text{m}$	51%	55%	51%
>5 mm	51%	52%	53%



# SEM: 7-18-3 LP+TME: Slip/shear bands 50 $\mu\text{m}$ from the surface

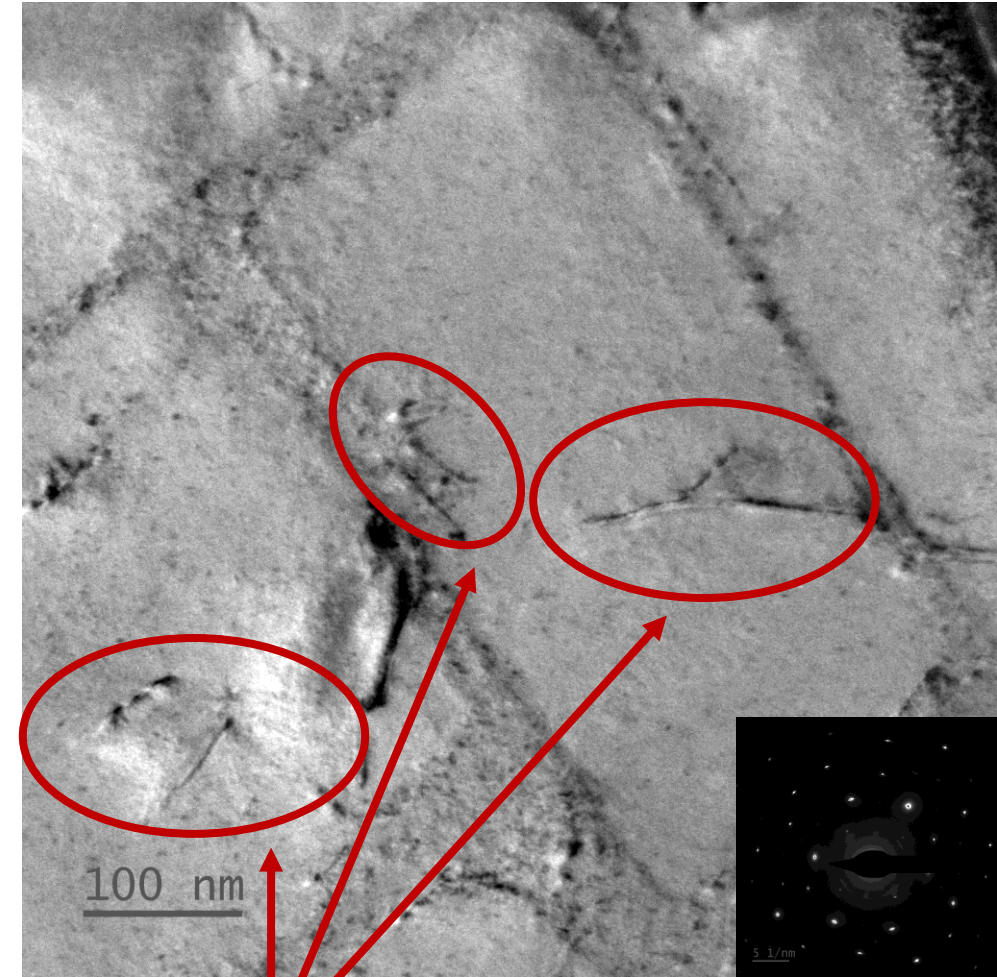


Potential slip/shear bands



# TEM: 7-18-3 LP+TME (150 $\mu\text{m}$ below LP surface)

- Dislocation shearing was observed in  $\gamma'$  precipitates
- This deformation mechanism is also seen in work by Geng et. al

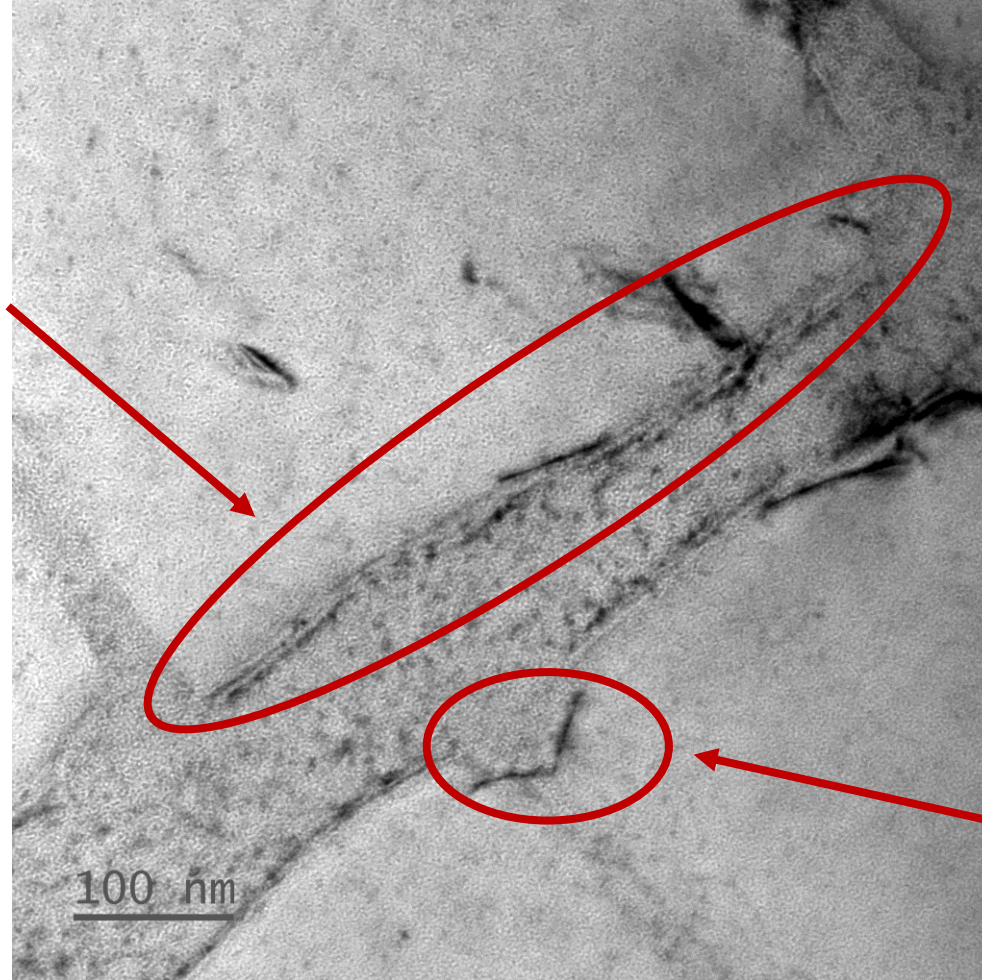


Dislocations shearing  $\gamma'$  Corresponding electron diffraction pattern



# TEM: 7-18-3 LP+TME (150 $\mu\text{m}$ below LP surface)

Dislocation pileup at the  $\gamma/\gamma'$  interface

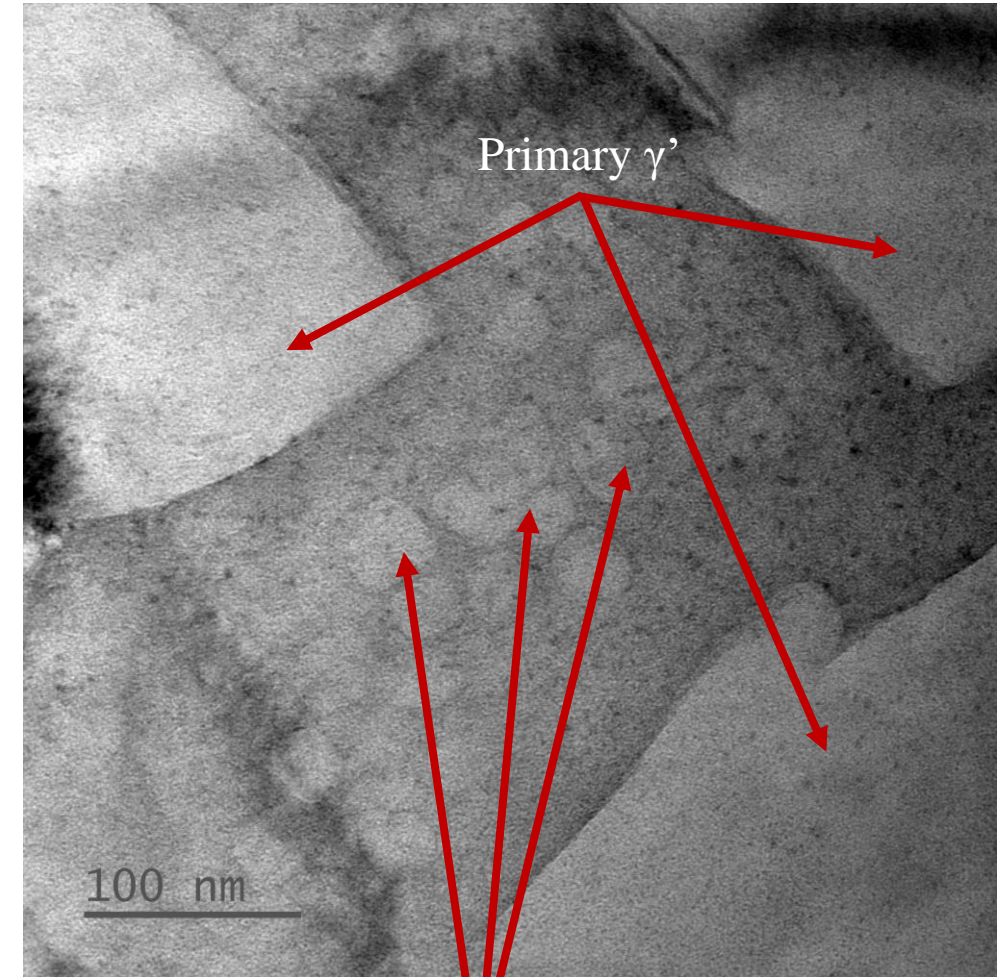


Dislocation being pinned  
by 2  $\gamma'$  precipitates



# TEM: 7-18-3 LP+TME (150 $\mu\text{m}$ below LP surface)

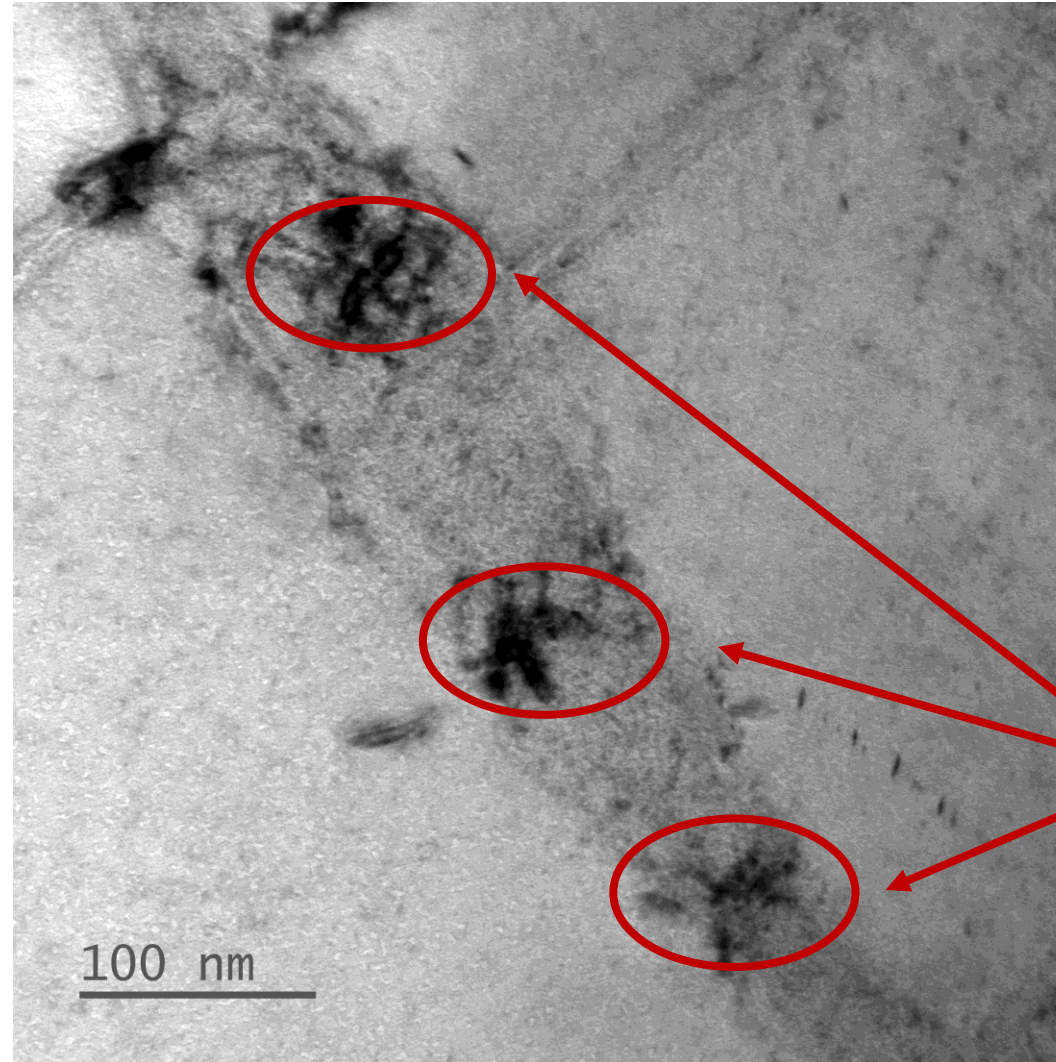
- Spherical  $\gamma'$  precipitates are seen in the  $\gamma$  channels.
- It is unclear currently whether those precipitates are a result of LP+TME or should occur naturally.



Spherical nanoscale  $\gamma'$



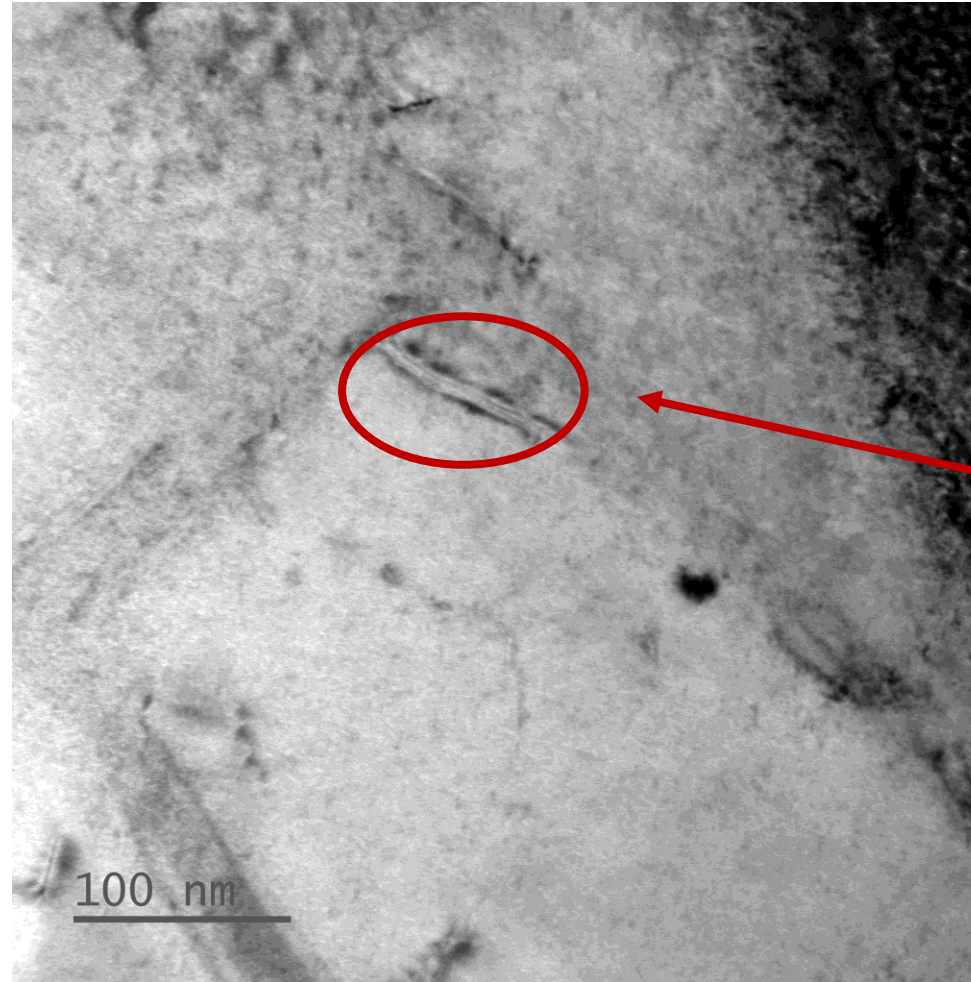
# TEM: 7-18-3 LP+TME (150 $\mu\text{m}$ below LP surface)



Could be a dislocation tangle but requires further reading. This is in the  $\gamma$  channels.



# TEM: 7-18-3 LP+TME (150 $\mu\text{m}$ below LP surface)



Potential dislocation pair. Dislocation pairs are required to shear  $\gamma'$