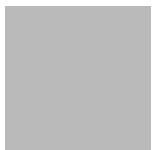


PAUL SCHERRER INSTITUT




Materials Science at Large Scale Facilities

Imaging - exercises

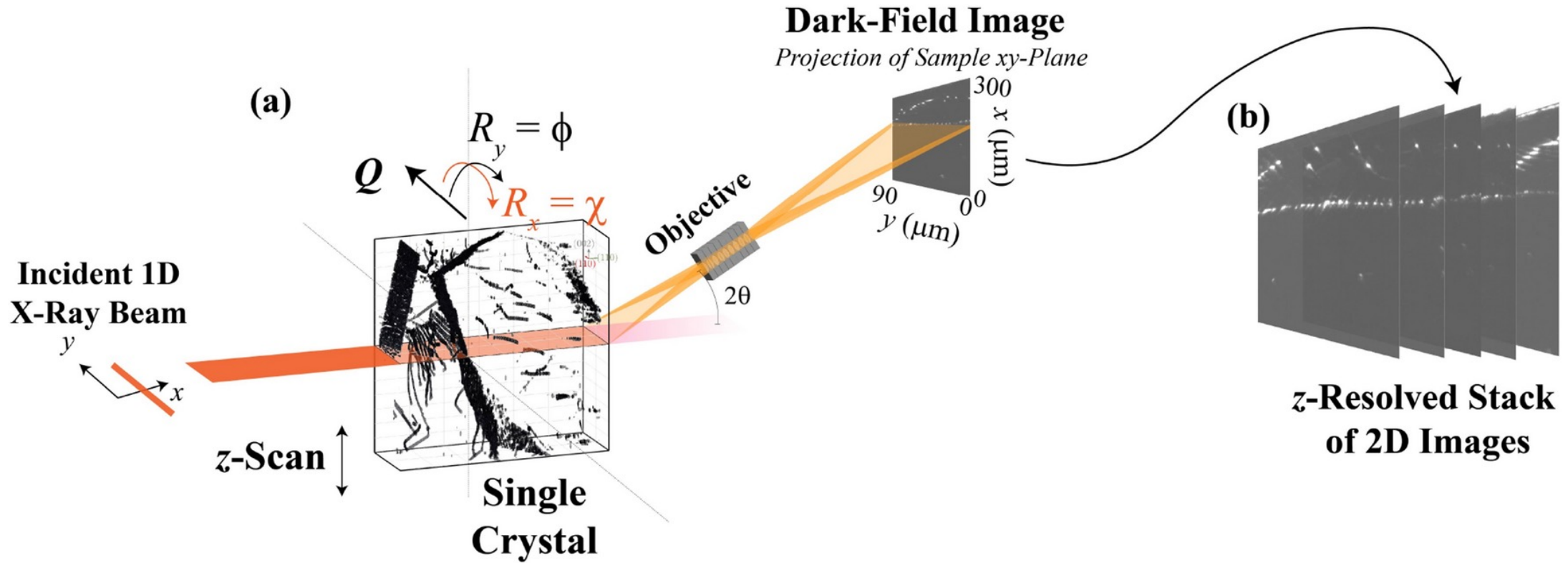


- Visualize evolution of the 3D dislocation structure in a single grain of aluminium during heating
- Visualize onset ($\sim 100\text{nm}$) of cracking and delamination during tensile loading of a carbon fiber – epoxy laminate. Fiber diameter is $7\ \mu\text{m}$, volume fraction 60%.
- Study the influence of the microstructure on the stress induced martensitic phase transformation (austenite \rightarrow hexagonal close-packed martensite), with particular focus on grain size, orientation and environment.
- Quick measurement on the quality of a Si wafer (i.e. low defect density)

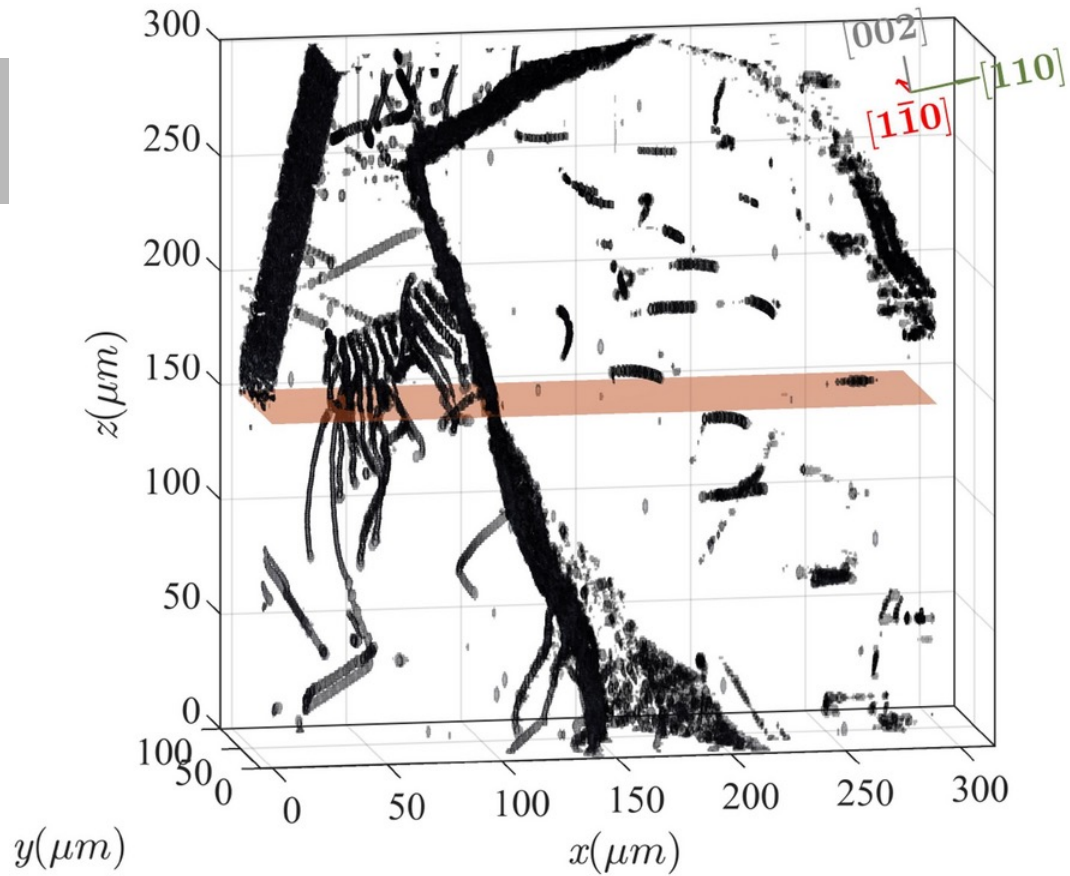
- 
- **Challenge:** visualize evolution of the 3D dislocation structure in a single grain of aluminium during heating
 - Method?

- **Challenge:** visualize evolution of the 3D dislocation structure in a single crystal of aluminium during heating
- Method?
- Solution: diffraction-based dark field x-ray microscopy

Dark field X-ray microscopy



Dark field X-ray microscopy



Can Yildirim *et al* Extensive 3D mapping of dislocation structures in bulk aluminum, Scientific Reports **13** (2023) 3834

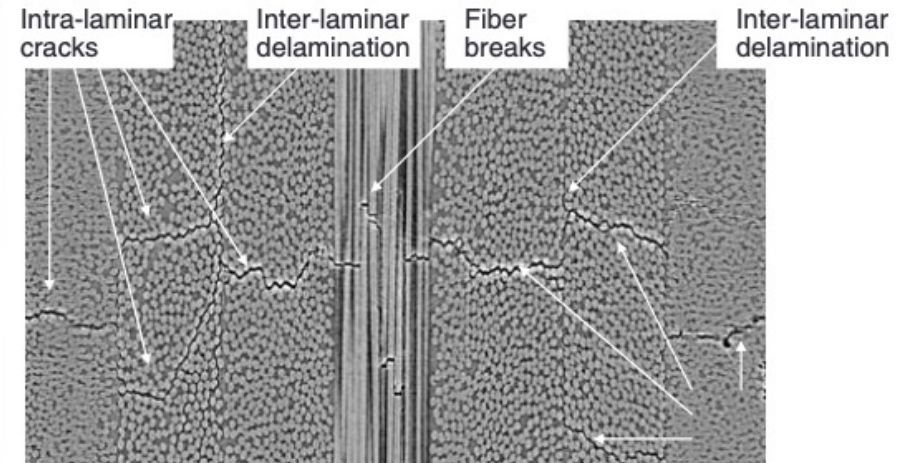
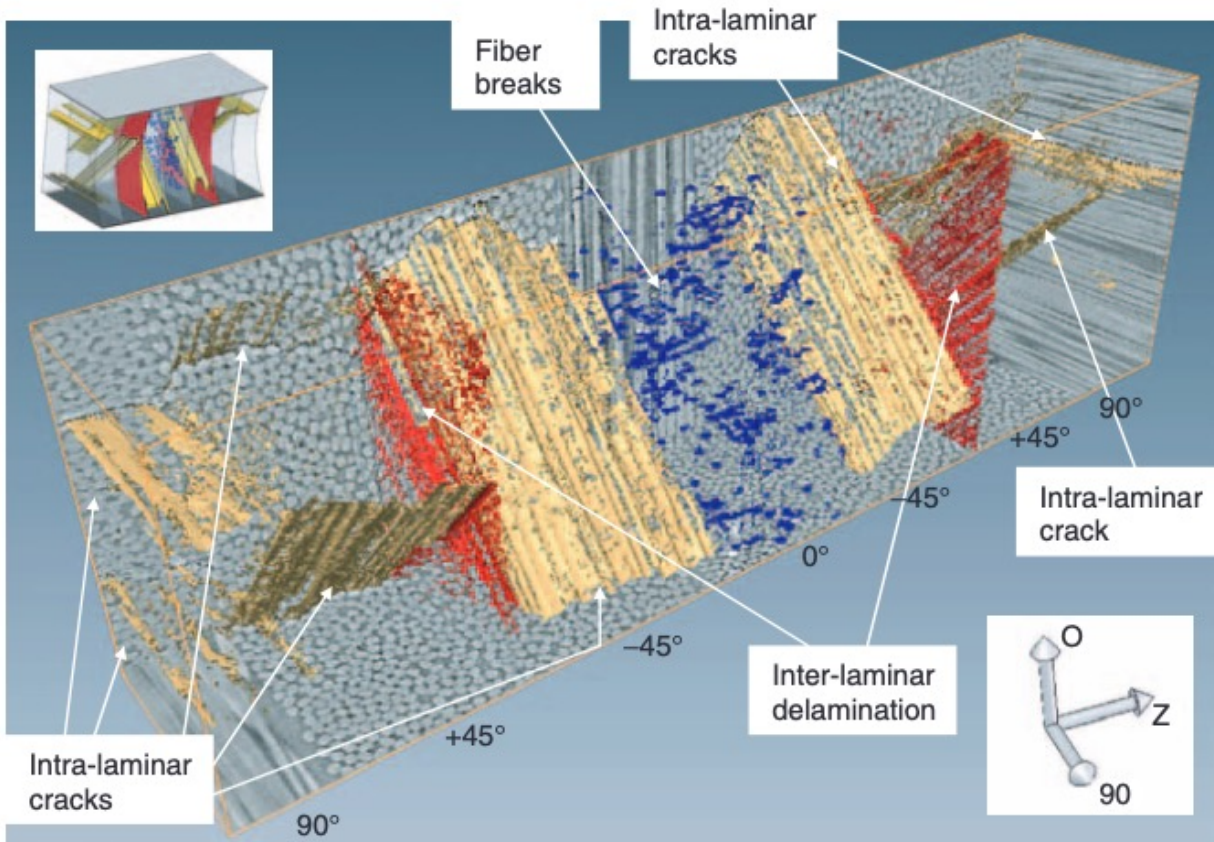
Damage in polymer-matrix composites

- **Challenge:** visualize onset ($\sim 100\text{nm}$) of cracking and delamination during tensile loading of a carbon fiber – epoxy laminate. Fiber diameter is $7\ \mu\text{m}$, volume fraction 60%.
- Method?
- What if the sample is extended in two directions?

Damage in polymer-matrix composites

- **Challenge:** visualize onset ($\sim 100\text{nm}$) of cracking and delamination during tensile loading of a carbon fiber – epoxy laminate. Fiber diameter is $7\ \mu\text{m}$, volume fraction 60%.
- Method?
- Solution: X-ray phase contrast tomography / laminography

Damage in polymer-matrix composites



P. Wright et al *Ultra high resolution computed tomography of damage in notched carbon fiber-exposy composites*
 Journal of composite materials **42** (2008) 1993

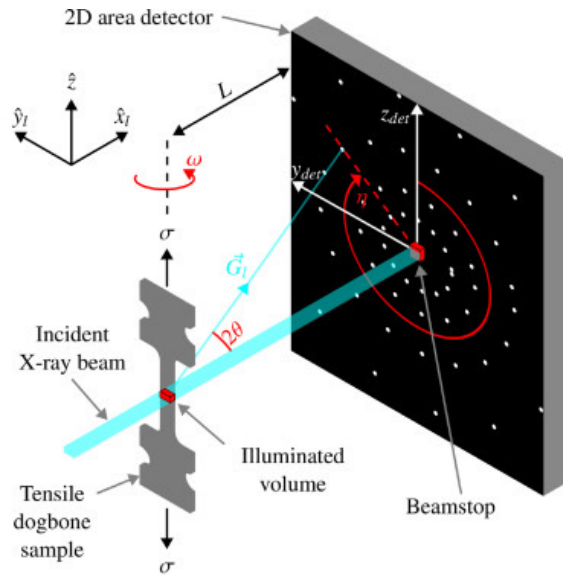
Influence microstructure on phase transformation

- **Challenge:** study the influence of the microstructure on the martensitic phase transformation (austenite \rightarrow hexagonal close-packed martensite), with particular focus on grain size, orientation and environment.
- Method?

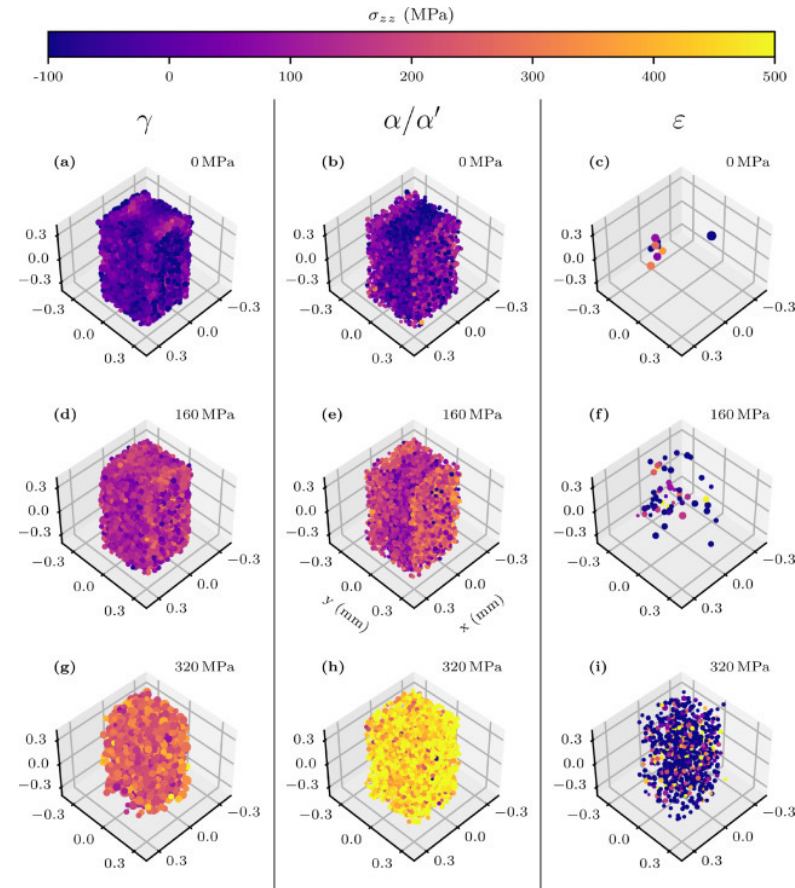
Influence microstructure on phase transformation

- **Challenge:** study the influence of the microstructure on the martensitic phase transformation (austenite -> hexagonal close-packed martensite), with particular focus on grain size, orientation and environment.
- Method?
- Solution: 3DXRD

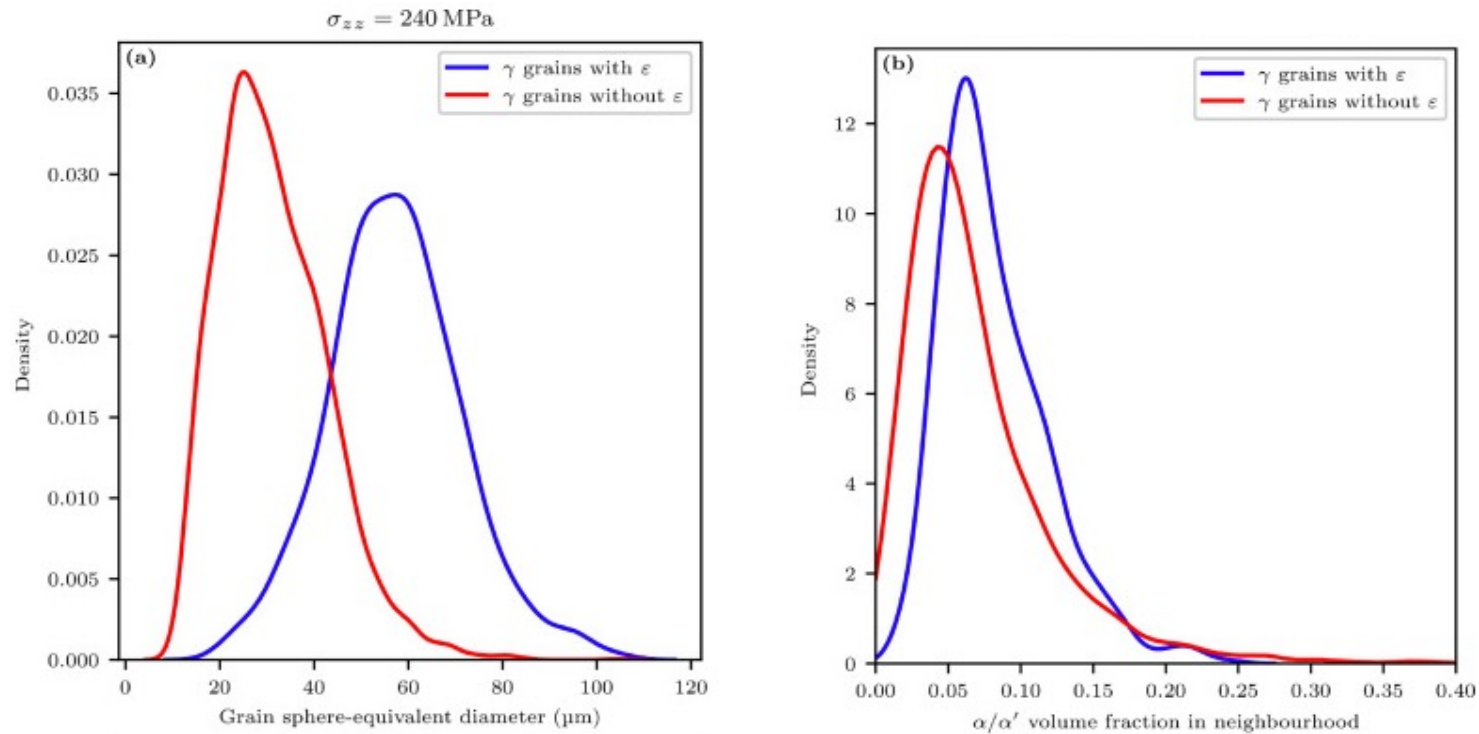
Influence microstructure on phase transformation



>10'000 grains were tracked!




Influence microstructure on phase transformation



J.A.D. Ball et al *Grain-level effects on in-situ deformation-induced phase transformations in a complex-phase steel using 3DXRD and EBSD*
Acta Materialia **265** (2024) 119608

Quality control Si wafers

- 
- **Challenge:** quick measurement on the quality of a Si wafer (i.e. low defect density)
 - Method?

Quality control Si wafers

- **Challenge:** quick measurement on the quality of a Si wafer (i.e. low defect density)
- Method?
- Solution: X-ray topography

Quality control Si wafers

