Imaging the Shapes of Nanocrystals using Coherent X-ray Diffraction

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Outline

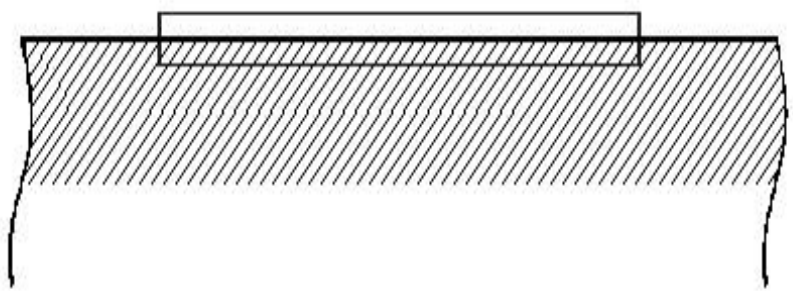
- Goals of Coherent X-ray Diffraction
- The Phase Problem
- Nanocrystal Shapes
- CXD beamline at Argonne
- Application to Strain Mapping

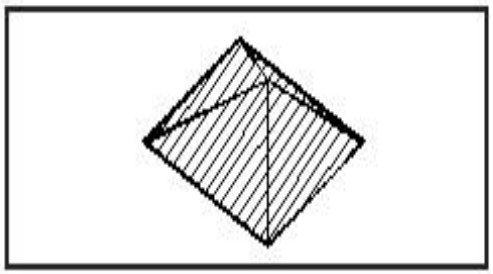
Goals of Coherent Diffraction

- Thermodynamic fluctuations
  - Will be hard because of beam-induced effects, sample damage and induced fluctuations
- Probe of structure on nm scale
  - 1D, 2D and 3D
  - non-periodic object gives continuous F(**q**)
- Oversampling (reciprocal space) permits solution of the phase problem

Coherence at the APS

Coherence of	ξ_{VER}	ξ_{HORIZ}	ξ_{LONG}	Flux
Raw Undulator	35μm	9μm	0.004μm	2×10^{12}
Si(111) Monochromator	35μm	9μm	1μm	1×10^{10}
C(111) Monochromator	35μm	9μm	3μm	3×10^{9}





Diffraction as a Surface Integral

Die äußere Form der Kristalle in ihrem Einfluß auf die Interferenzerscheinungen an Raumgittern

Von M. v. Laue

Annalen der Physik [5] 26 55 (1936)

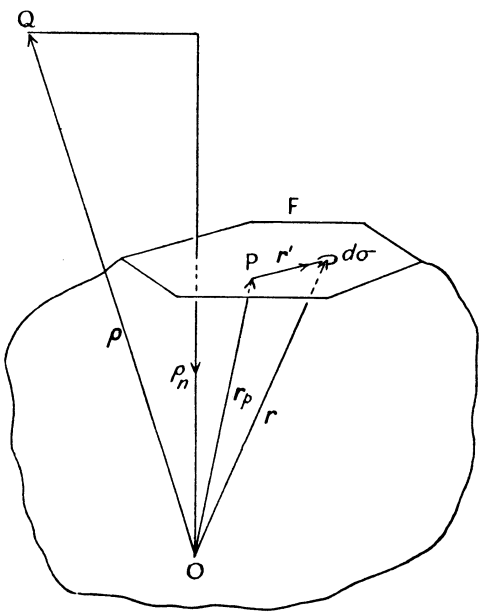
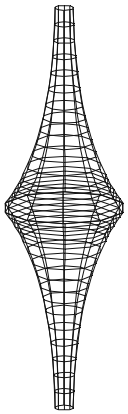
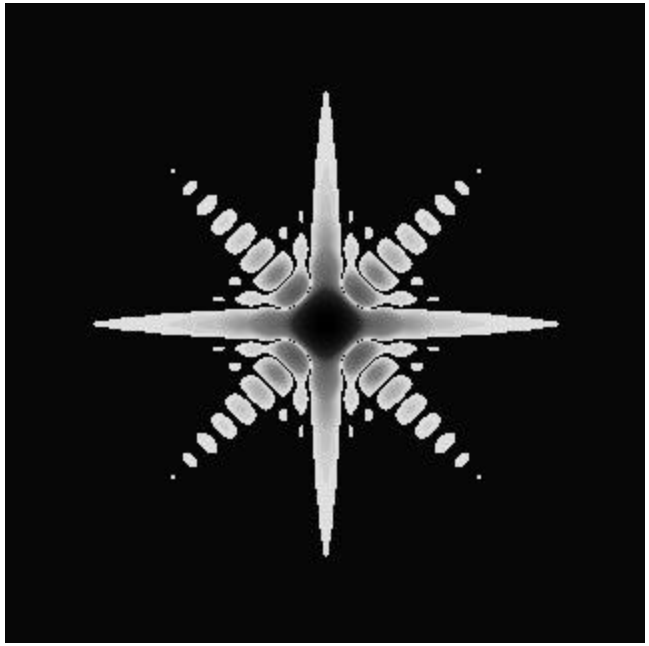
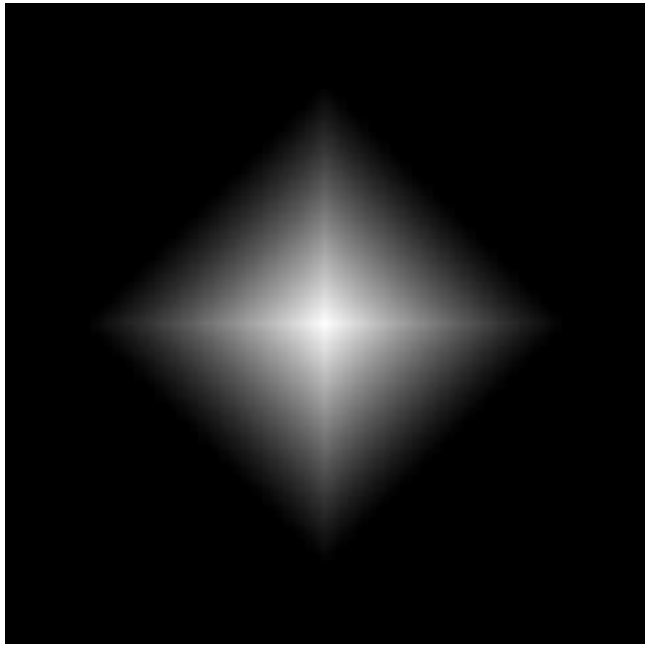


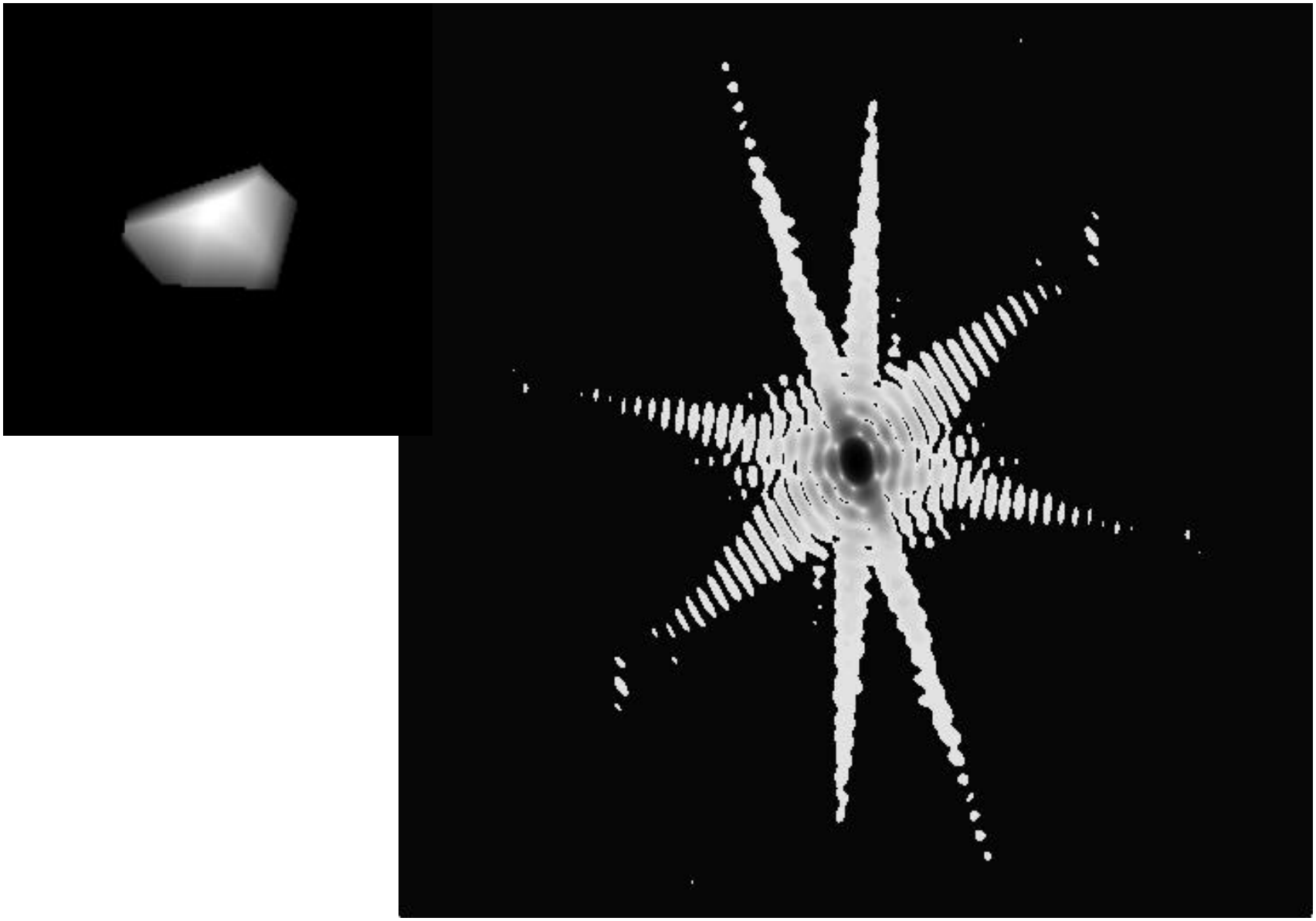
FIG. 200



“Stacheln”

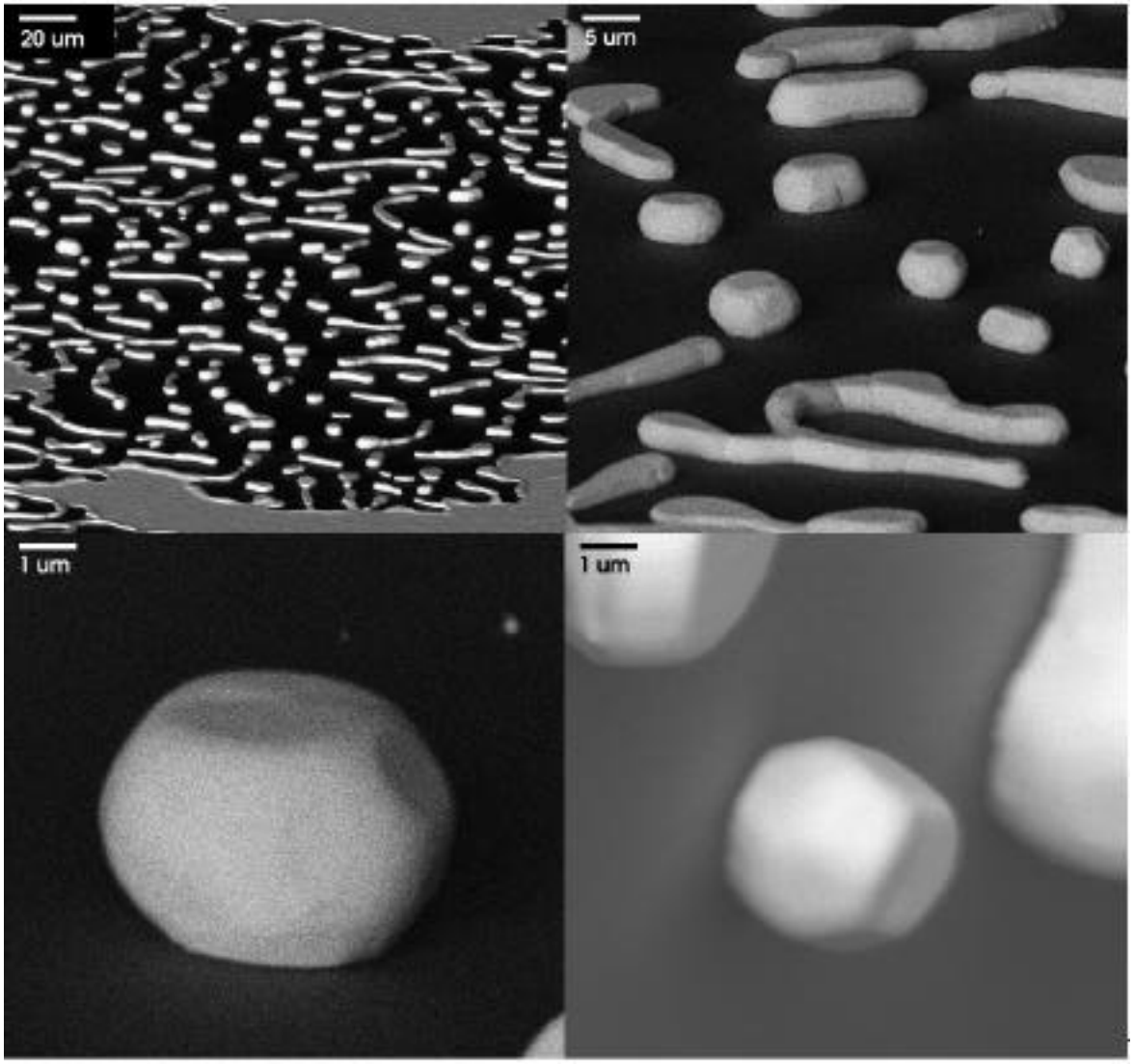


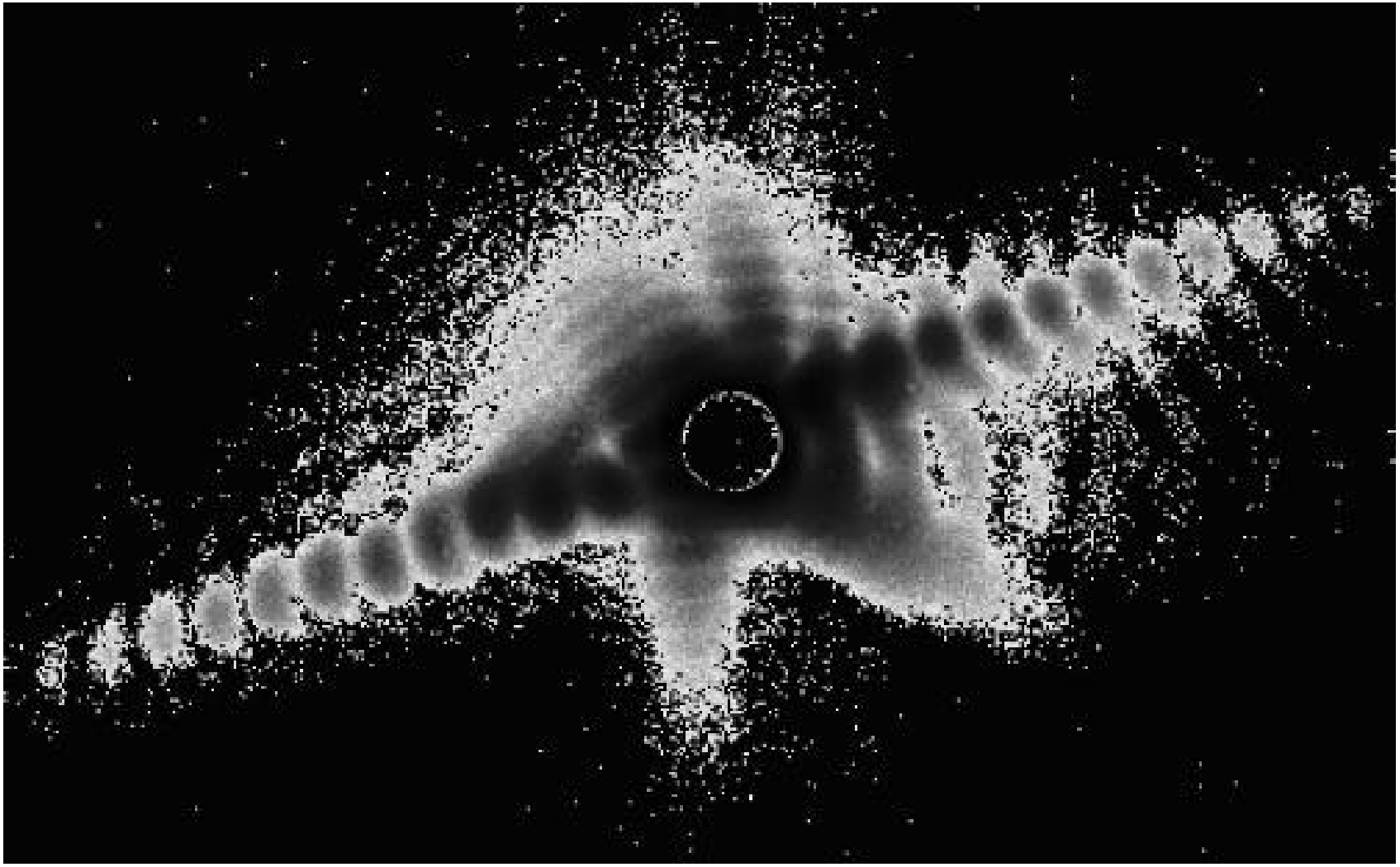




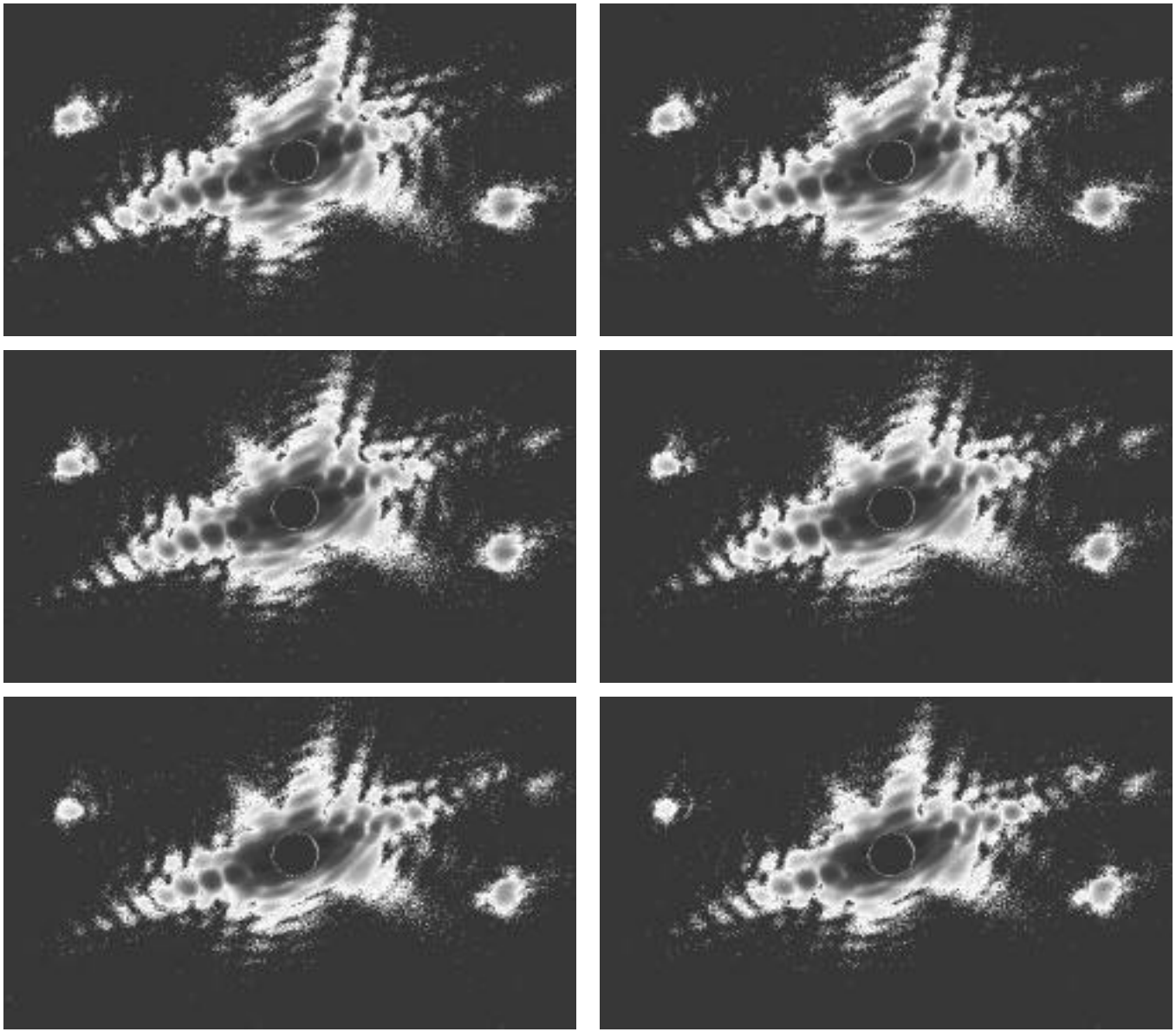
SEMS

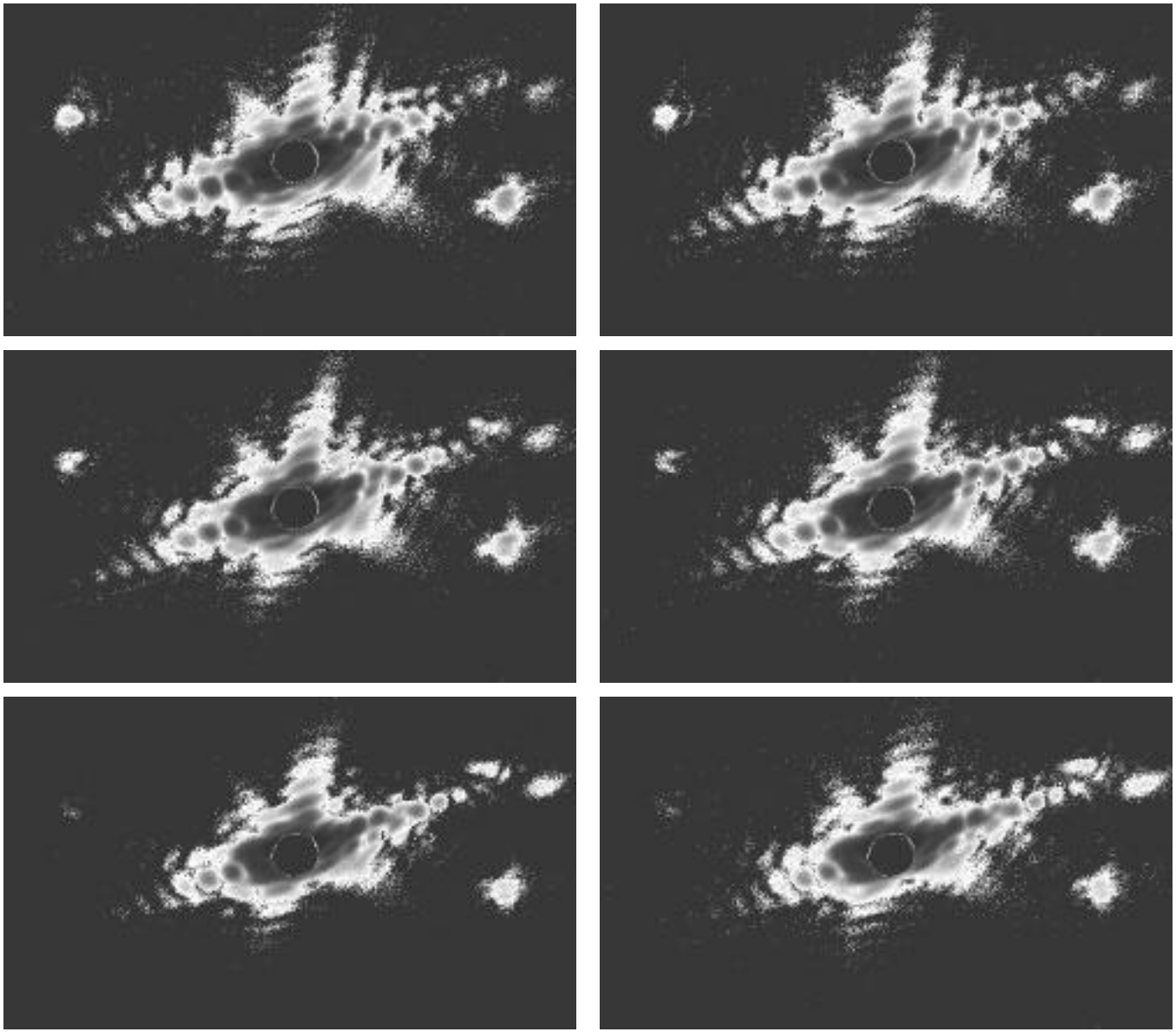
- Au blanket film
- Quartz substrate
- Annealed at 950°C for 70 hrs.





I. K. Robinson et al, submitted to PRL (2001) Figure 1


1
2
3
4
5
6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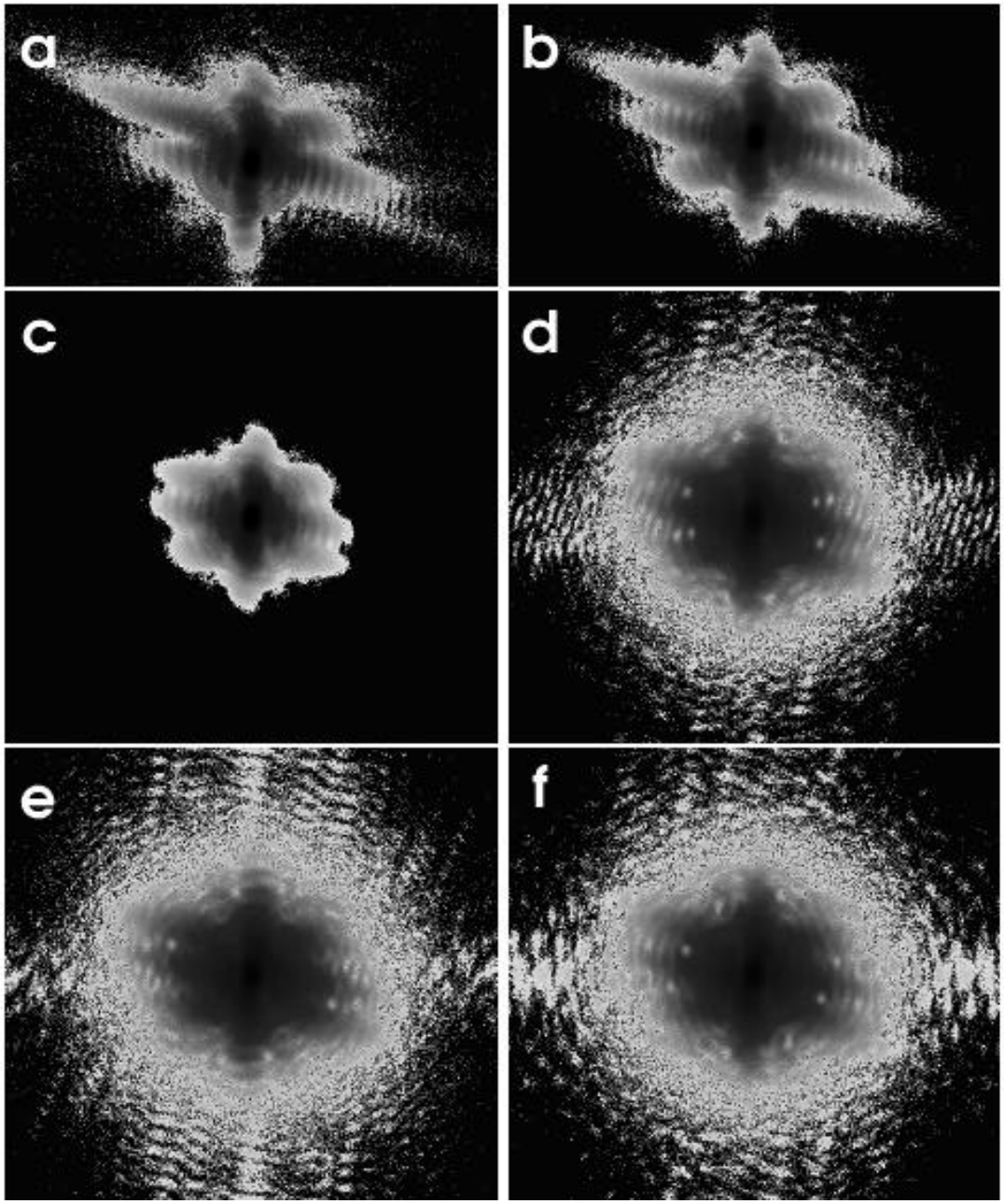
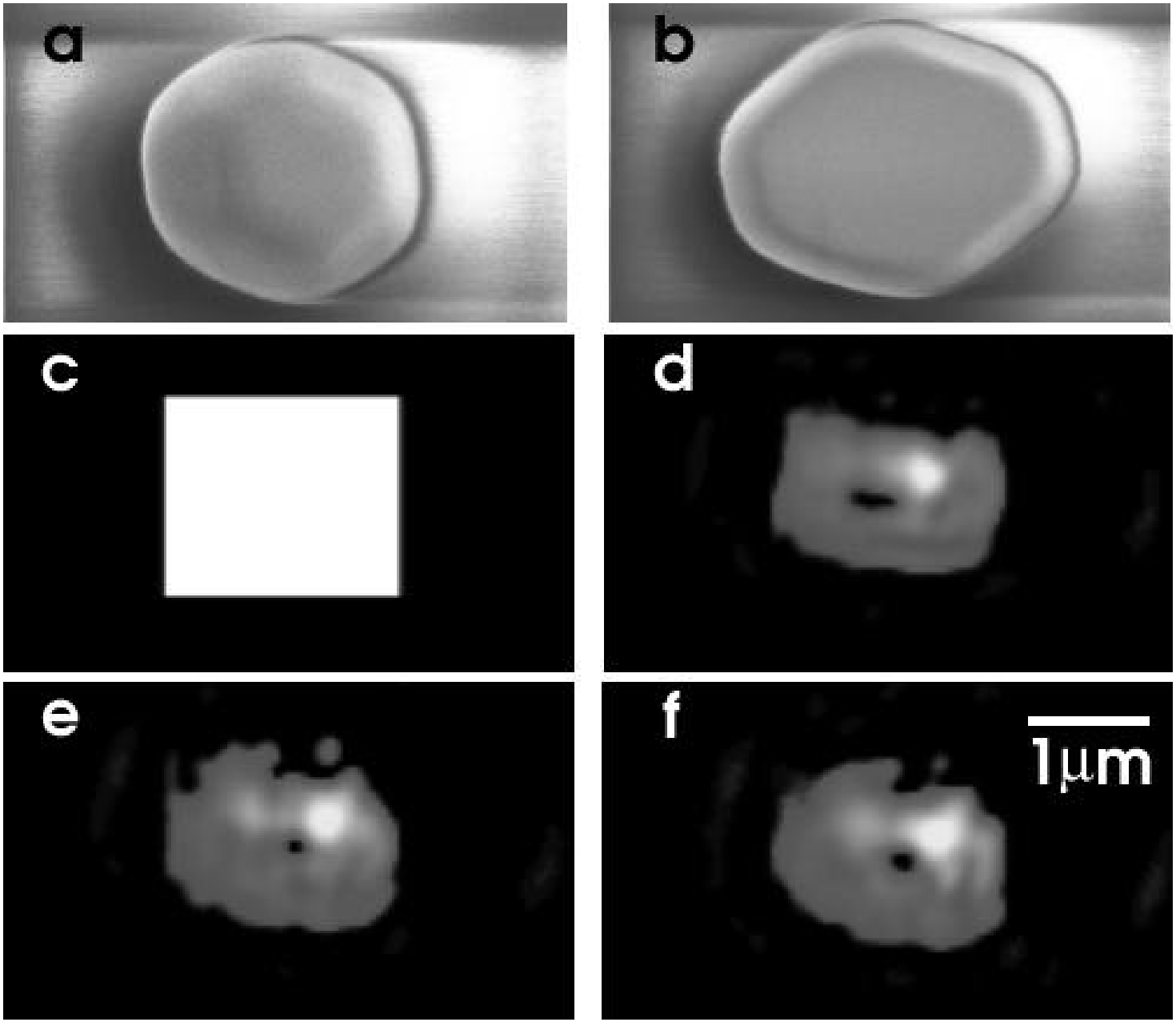
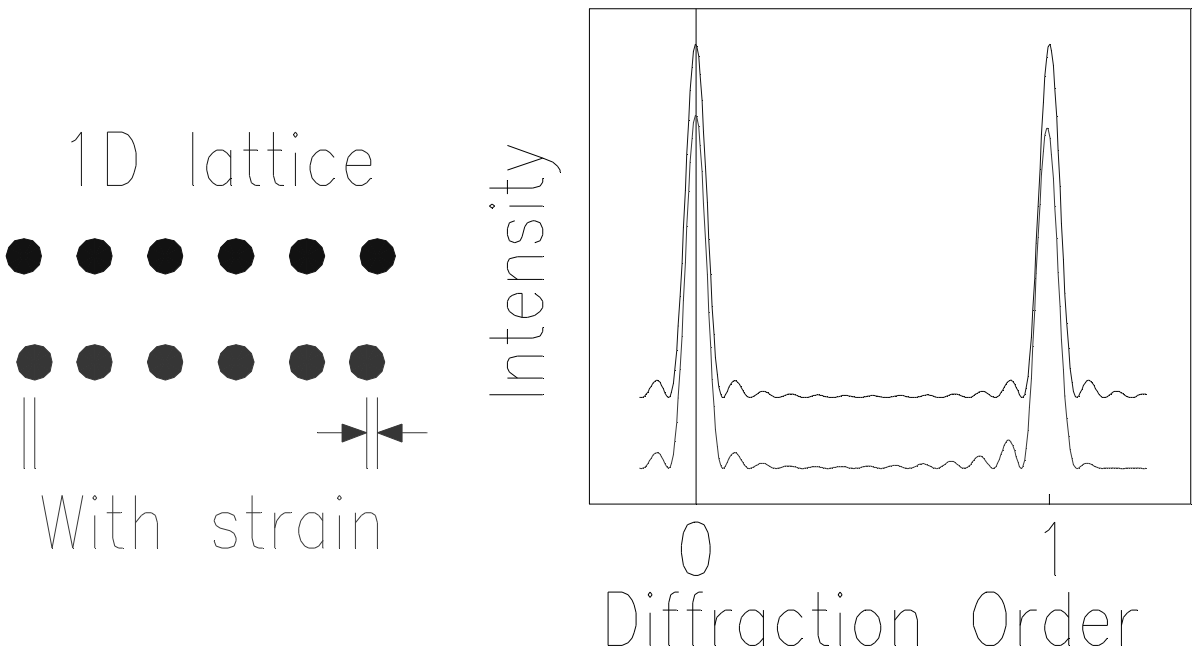
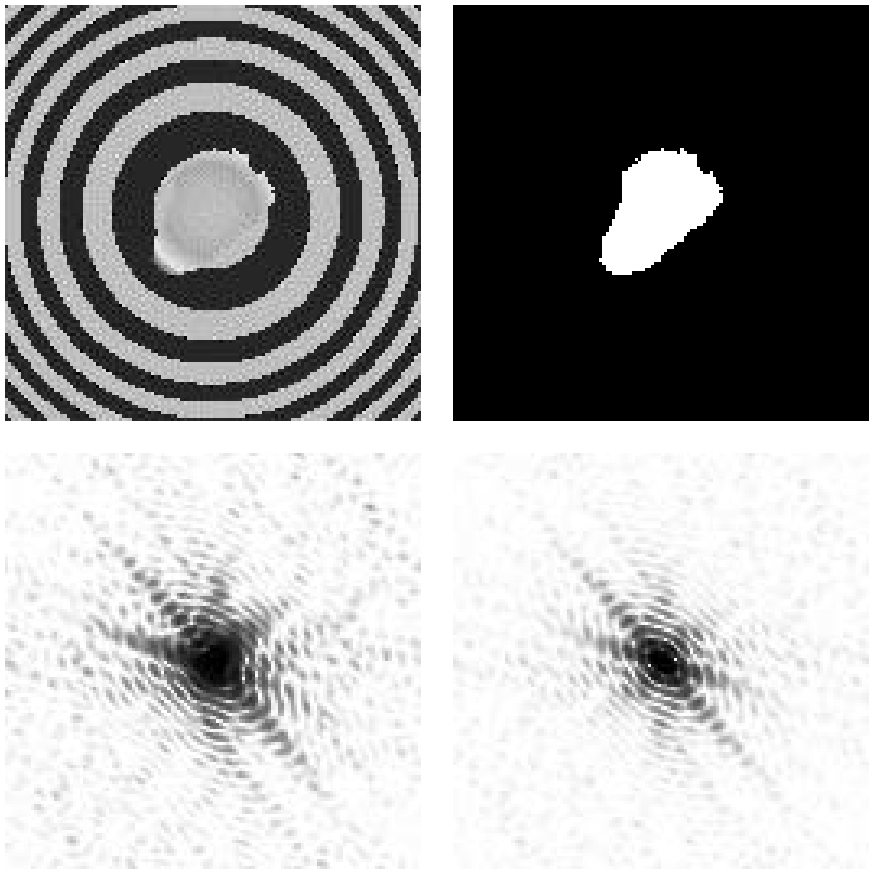
7
8
9
10


a
b
c
d
e
f

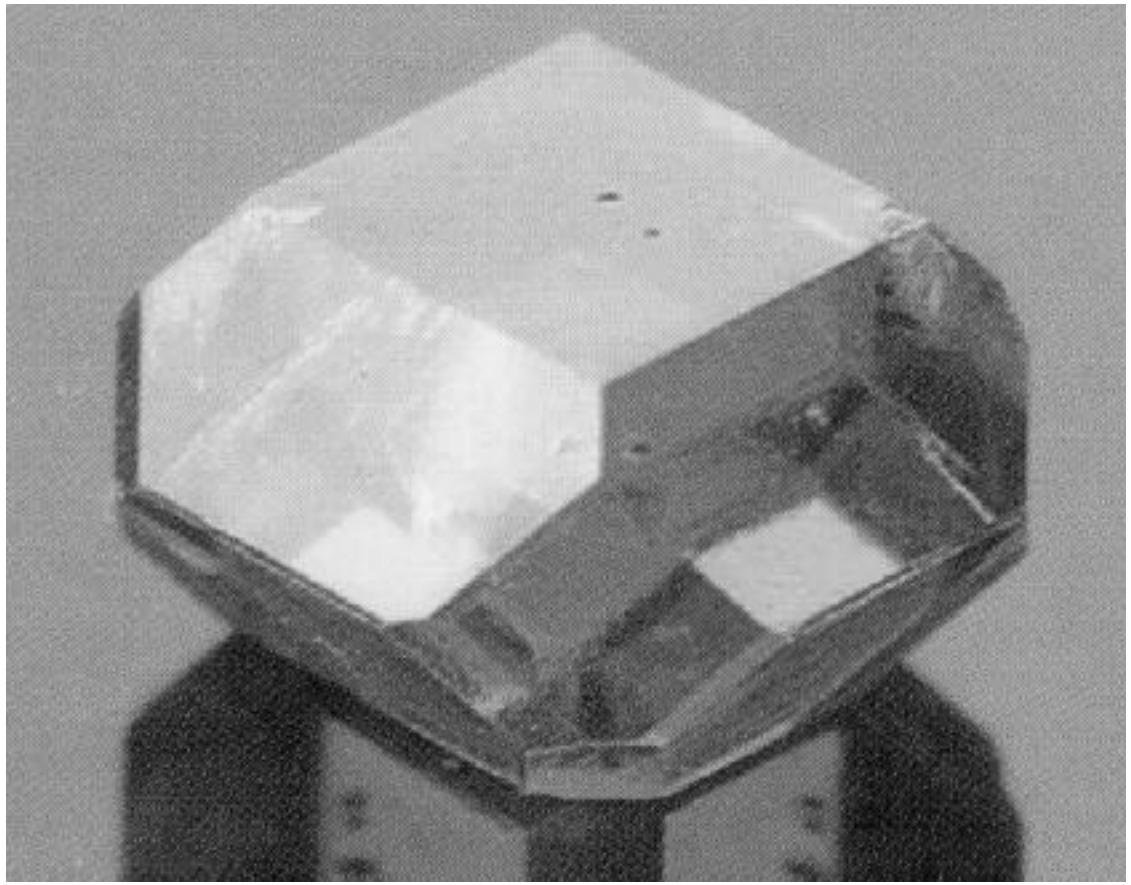

a
b
c
d
e
f
1μm

Imaging of Lattice Strains





Sector 34 CXD Monochromator Crystal
Sumitomo Electric Corp.



Conclusions

- “Diffuse” scattering acquires fine structure
- Shapes of small particles
- Reconstruction by Iterative Fourier Transform
- CXD facility completed
- Potential applications
  - Atomic-scale fluctuations
  - 3D Imaging of strain fields