



Many atoms!



Laue

silicon





enzyme Rubisco



Chris Jones, CafePress

(100)

XRD (powder) pattern



Figure 17.1 The basic fcc, bcc, and hcp parent structures.



Graef & McHenry, Structure of Materials(Cambridge)

Lattice plus basis



Hunklinger



First commercial TEM IG Farben, 30th

TITAN Scanning TEM (with spectroscopy) and TITAN Cube, FEI since 2005

General (conventional) TEM setup





TEM grid with specimen

Image and diffraction plane

warwick.co.uk (JEOL 2000FX Handbook), wikipedia

Spherical abberation



Bleloch, Materials Today (2004)

Correcting abberation



Scherzer (1949): Electron lenses have always abberation as long as the system

- is spherically symmetric
- produces a real image of the object
- fields of the system are constant in time
- there is no charge on the axis

Urban, Science (2008)



Bledloch, Mat. Today (2004)

High-resolution TEM



Scanning TEM images of AlN and Si(112)
Distance of silicon atoms is 78pm
Magnification is 5 10⁷

Urban, Science (2008).

Phase contrast transfer function



PCTF = sin [2 $\pi \chi(\mathbf{g})$] ACTF – resultion amplitude contrast

Urban, Phil. Trans. A (2013)

Light atoms I – Oxygen in BaTiO₃



Light atoms II – Go for hydrogen



Conventional TEM grid with graphene as new TEM grid



carbon and hydrogen ad-atoms

Meyer & Zettl, Nat. Comm. (2008)