Condensed Matter Physics

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Close-packed structures: hcp

- Fig 2.6, Solid State Physics: An Introduction, by Philip Hofmann, Wiley-VCH Berlin.

- The hcp lattice is NOT a Bravais lattice. It can be constructed from a Bravais lattice with a basis containing two atoms.
- the packing efficiency is of course exactly the same as for the fcc structure (74 % of space occupied).

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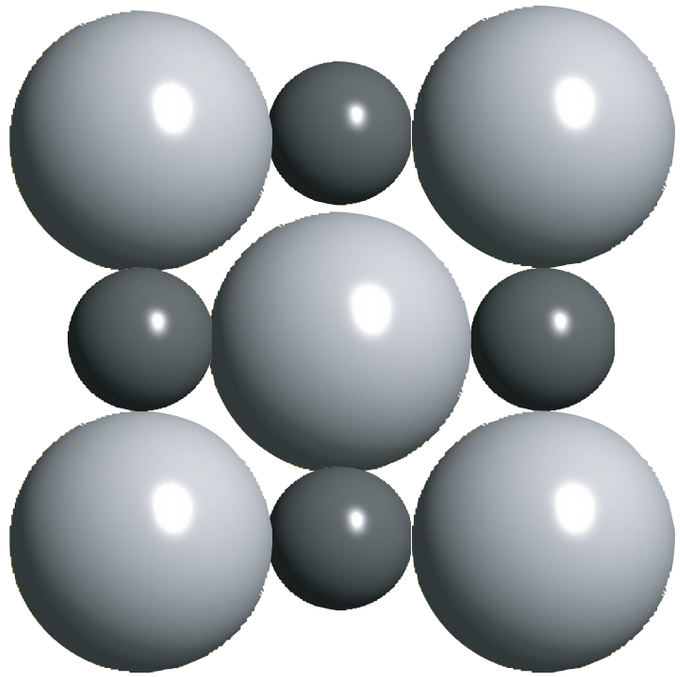
Close-packed structures

- Close-packed structures are indeed found for inert solids and for metals.
- For metals, the conduction electrons are smeared out and directional bonding is not important. Close-packed structures have a big overlap of the wave functions.
- Most elements crystallize as hcp (36) or fcc (24).

Close-packed structures: ionic materials

- In ionic materials, different considerations can be important (electrostatics, different size of ions)
- In NaCl the small Na are in interstitial positions of an fcc lattice formed by Cl ions (slightly pushed apart)



- Fig 2.5, Solid State Physics: An Introduction, by Philip Hofmann, Wiley-VCH Berlin.

Close-packed structures: ionic materials

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Non close-packed structures

- covalent materials (bond direction more important than packing)

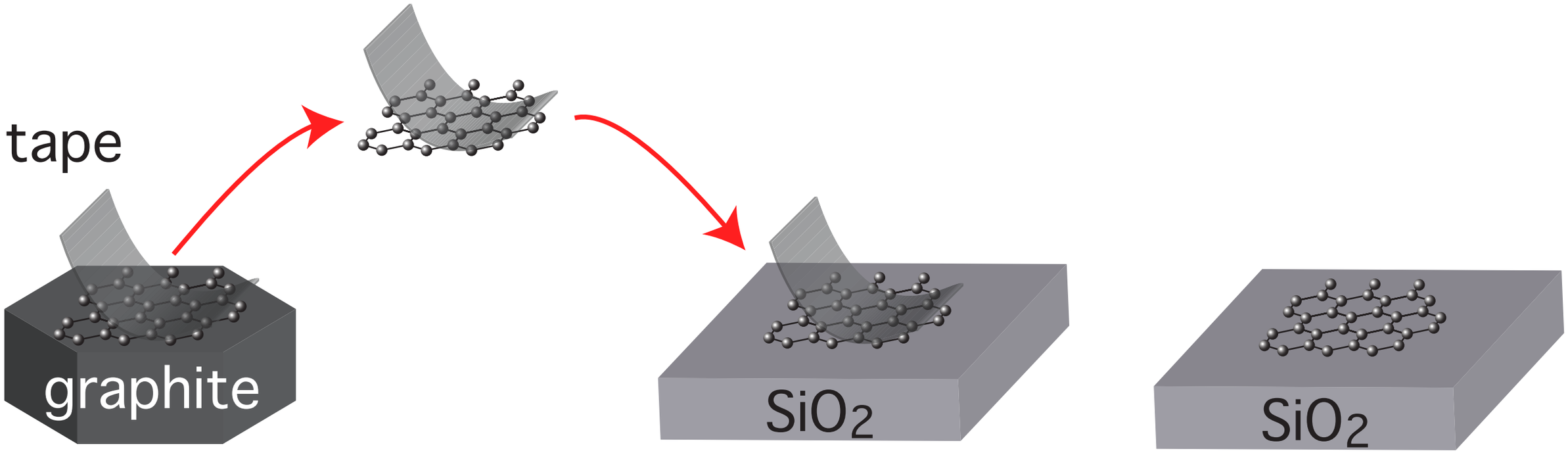
graphene

graphite

diamond (only 34 % packing)

- Fig 2.7, Solid State Physics: An Introduction, by Philip Hofmann, Wiley-VCH Berlin.

graphene



Crystal structure determination

X-ray diffraction

- The atomic structure of crystals cannot be determined by optical microscopy because the wavelength of the photons is much too long (400 nm or so).
- So one might want to build an x-ray microscope but this does not work for very small wavelength because there are no suitable x-ray optical lenses.
- The idea is to use the diffraction of x-rays by a perfect crystal.
- Here: monochromatic x-rays, elastic scattering, kinematic approximation