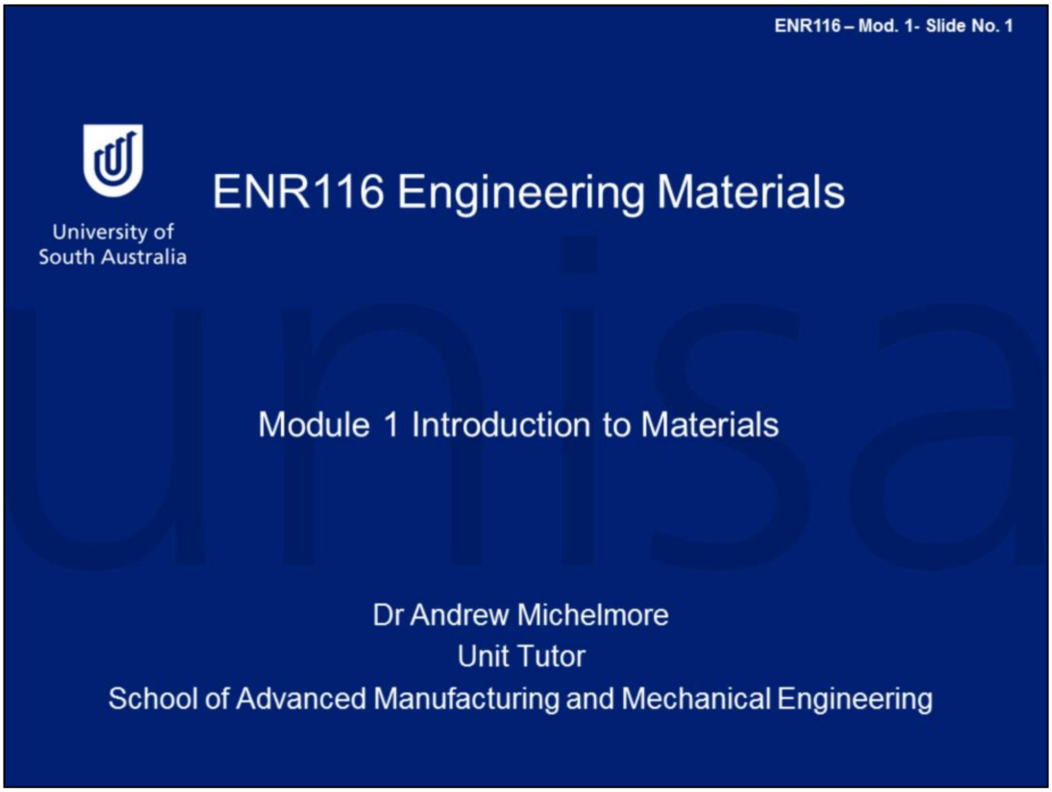


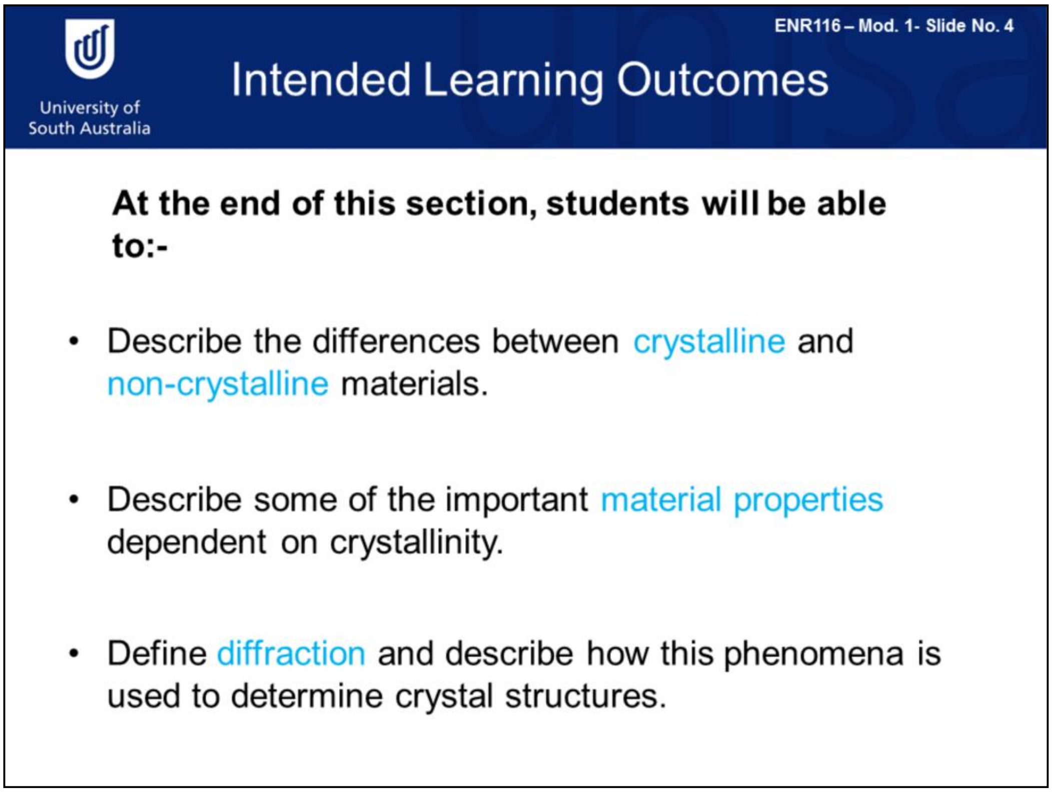
Welcome to ENR116 Engineering Materials Module 1

University of
South Australia

Copyright Notice

Do not remove this notice.

Crystalline and non-crystalline materials

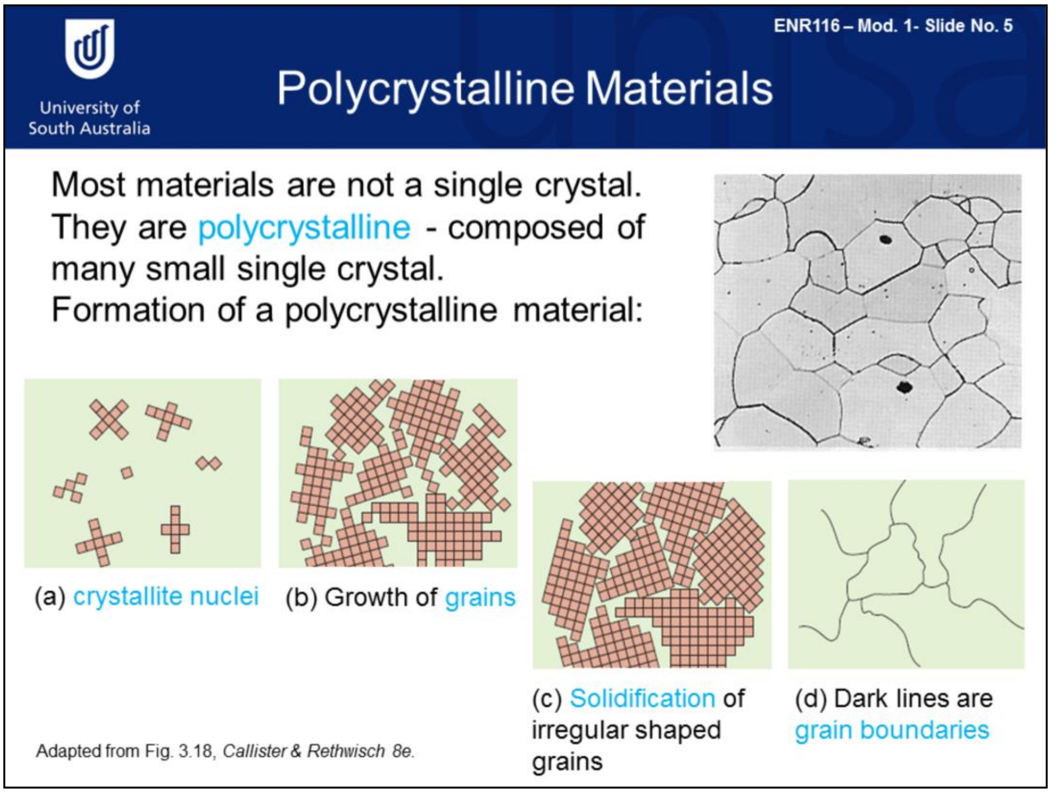


The intended learning outcomes from this presentation are:

Describe the difference between crystalline and non-crystalline materials

Describe some of the important material properties dependent on crystallinity

Define diffraction and describe how this phenomena is used to determine crystal structure



Polycrystalline materials exist because small crystals grow and touch each other

Crystals are separated by grain boundaries

University of South Australia

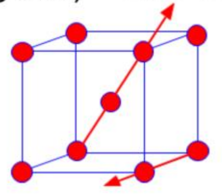
Single vs. Polycrystals

Single Crystals:

Properties vary with direction: anisotropic

Example: the modulus of elasticity (E) in BCC iron

E (diagonal) = 273 GPa



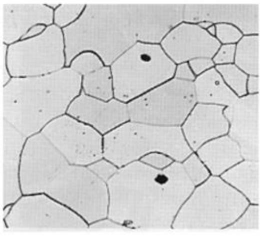
E (edge) = 125 GPa

Polycrystals:

Properties may/may not vary with direction.

If grains are randomly oriented: isotropic

If grains are textured, anisotropic



Adapted from Fig. 4.14(b), *Callister 7e.* (Fig. 4.14(b) is courtesy of L.C. Smith and C. Brady, the National Bureau of Standards, Washington, DC [now the National Institute of Standards and Technology, Gaithersburg, MD].)

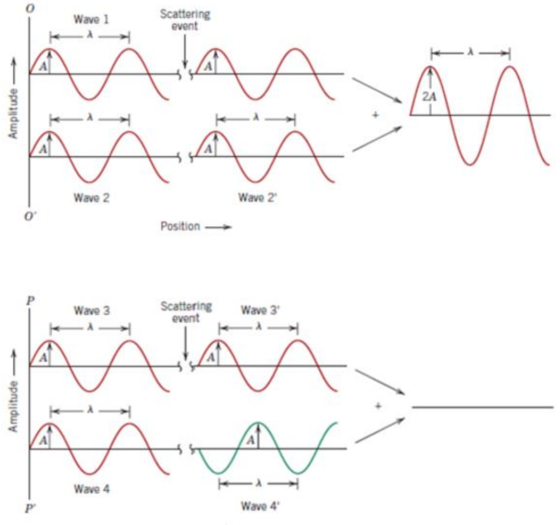
Single crystals are anisotropic

Polycrystals may be isotropic if grains are randomly oriented.

This can have a major effect on the material properties

University of South Australia

The diffraction phenomenon



Constructive interference

Fig. 3.19, *Callister & Rethwisch 8e.*

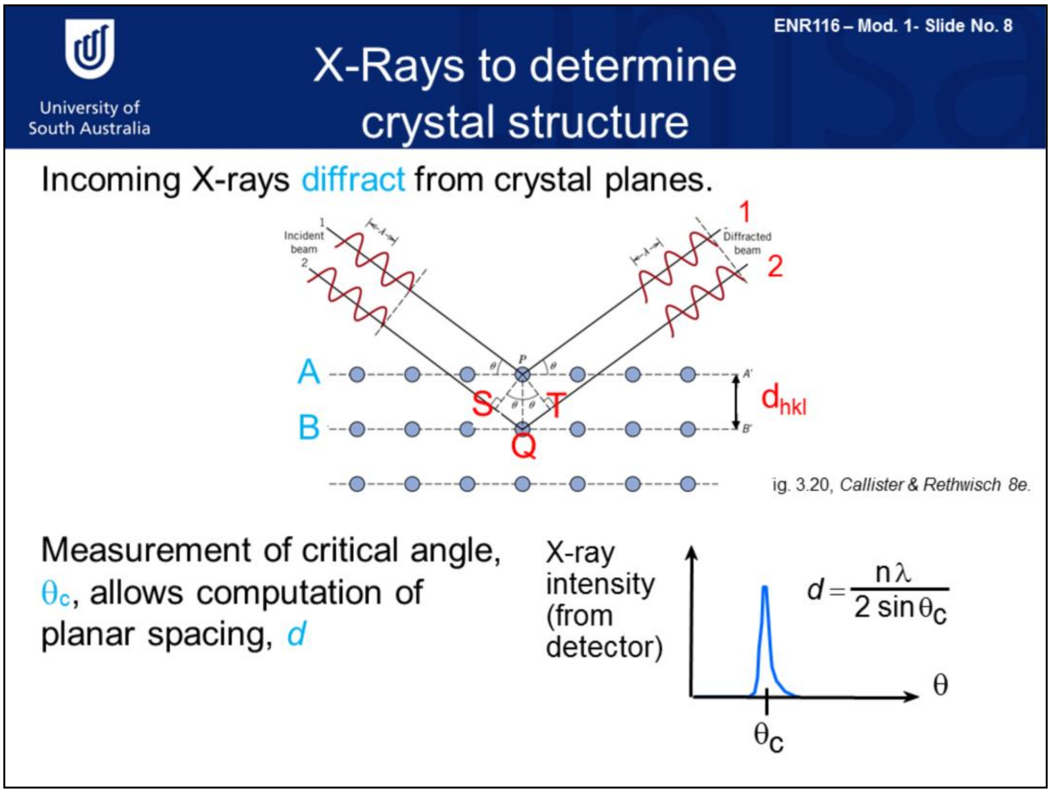
Destructive interference

Diffraction occurs to waves after interacting with a series of regularly spaced obstacles.

If the path length difference is a multiple of the wavelength, we observe Constructive interference

If the path length difference is an integral number of ½ wavelengths, we observe Destructive interference

Intermediate values of path length difference result in partial constructive interference.

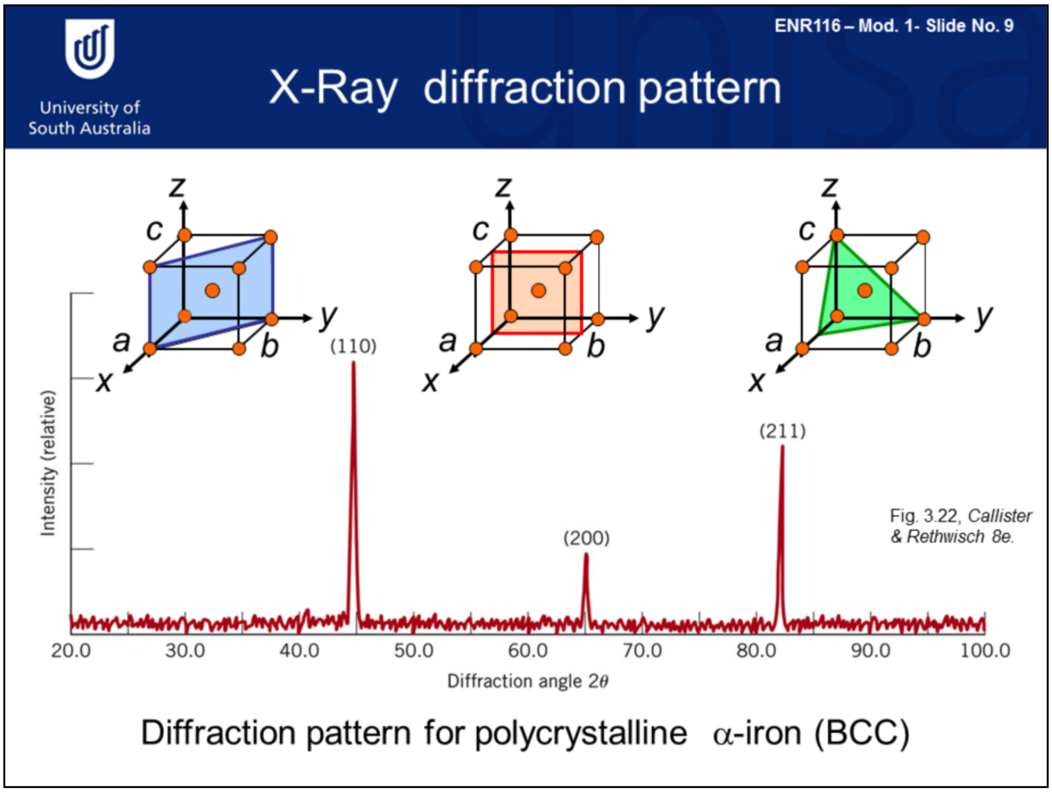


X-rays are used to determine crystal structure because their wavelength is similar to atomic spacing in solids

Incoming x-rays take different paths. The path length difference for beams 1 and 2 is SQ + QT

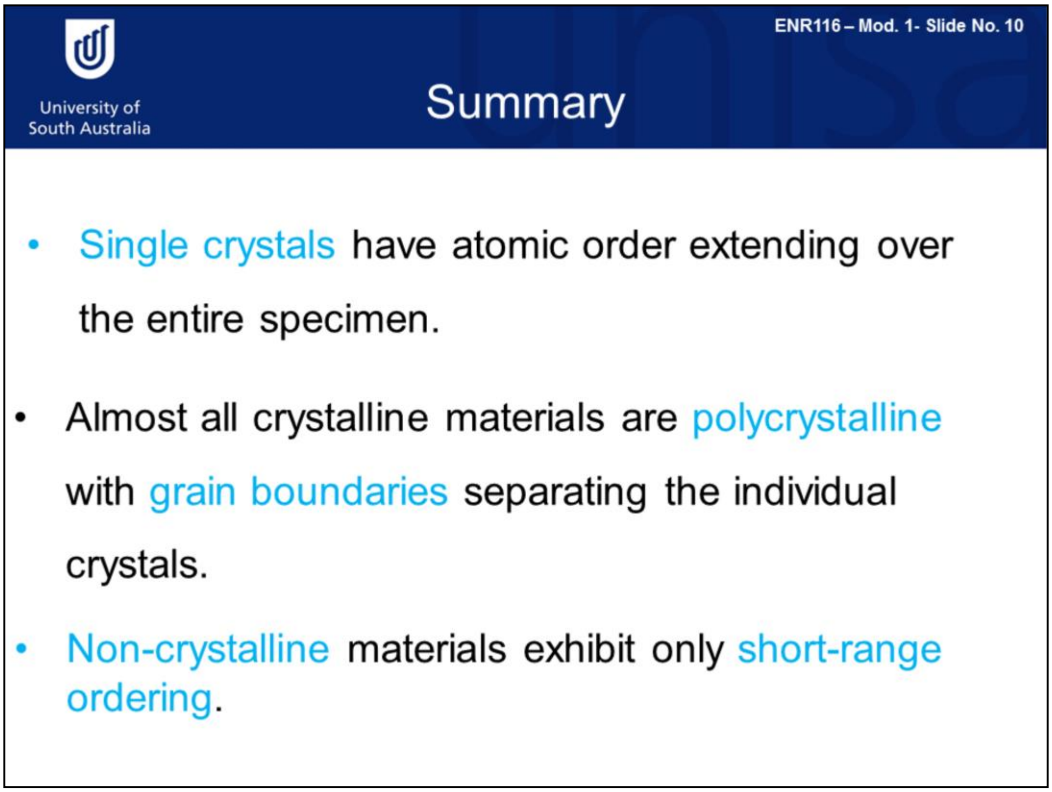
If SQ + QT is a multiple of the wavelength (Bragg's Law) then we observe Constructive interference

By changing the angle of incidence, when a peak is observed, the critical angle can be measured, and the planar spacing determined.



Polycrystalline iron shows 3 distinct peaks in the Diffraction pattern

Each peak is attributed to a different crystal structure within the material.



In Summary:

Single crystals have atomic ordering extending over the entire specimen

Almost all crystalline materials are polycrystalline with grain boundaries separating the individual crystals.

Non-crystalline materials exhibit only short-range ordering

Thank you