CRYSTALLOGRAPHY FOR MATERIALS SCIENTISTS

Overview

The study of crystal structures and crystal defects is absolutely central to the discipline of materials science and engineering. Although these topics are introduced in various undergraduate courses in materials science and engineering, the transition from metallurgy undergraduate courses to materials science and engineering courses over the last 40 years or so worldwide has meant that the number of contact hours for teaching crystallography as a subject has steadily diminished as more topics are included in materials science undergraduate curricula. Therefore, materials scientists often find that they have to learn the topics by themselves if they need an understanding of crystallography at and above the graduate level.

On completion of this intensive six day course, course participants will have an enhanced understanding of the principles behind the crystallography of perfect materials in relation to materials science, and also a deeper appreciation of the nature of point defects, line defects and planar defects in crystalline materials. In addition, lectures on the interpretation of X-ray powder diffraction patterns and electron diffraction patterns will complement the lectures on the crystallography of perfect materials. This will give course participants the confidence and background understanding to be able to read and understand research papers and research-level textbooks in these areas. Lectures will be complemented with problem solving sessions in which course participants will work through crystallographic problems with the help of the course organisers.

Date and Timing of the Course

December 5 – 10, 2016 (6 days × 4 hours each day)

Brief Outline of the Course:

<u>Perfect Crystals (8 hr lectures, 8 hr supervised tutorials)</u>

Monday December 5

Lecture 1:	9:30 – 10:30 a.m.	Lattice geometry and stereographic projections
Lecture 2:	11:00 – 12:00 a.m.	Point groups and space groups in crystalline materials
Tutorial 1:	2:30 – 4:30 p.m.	Problem solving session on lattice geometry, stereographic projections, point groups and space groups

Tuesday December 6

Lecture 3:	9:30 – 10:30 a.m.	Overview of common crystal structures in metals, ceramics, minerals and polymers
Lecture 4:	11:00 – 12:00 a.m.	Amorphous materials and special types of crystal-solid aggregates
Tutorial 2:	2:30 – 4:30 p.m.	Problem solving session on crystal structures and other forms of packing in three dimensions

Wednesday December 7

Lecture 5:	9:30 – 10:30 a.m.	Interpretation of X-ray powder diffraction patterns from single phase materials
Lecture 6:	11:00 – 12:00 a.m.	Interpretation of electron diffraction patterns from single phase materials
Tutorial 3:	2:30 – 4:30 p.m.	Problem solving session on X-ray powder diffraction patterns and electron diffraction patterns

Thursday December 8

Lecture 7:	9:30 – 10:30 a.m.	Tensors and representation quadrics
Lecture 8:	11:00 – 12:00 a.m.	Strain, stress, piezoelectricity and elasticity
Tutorial 4:	2:30 – 4:30 p.m.	Problem solving session on tensors of the second, third and fourth ranks

Imperfect Crystals (4 hr lectures, 4 hr guided tutorials)

Friday December 9

Lecture 9:	9:30 – 10:30 a.m.	Glide and texture
Lecture 10:	11:00 – 12:00 a.m.	Dislocations and dislocations in crystals
Tutorial 5:	2:30 – 4:30 p.m.	Problem solving session on dislocations including the proof of Diehl's rule and OILS rule for slip in c.c.p. and b.c.c. crystals

Saturday December 10

Lecture 11:	9:30 – 10:30 a.m.	Point defects and planar defects: twinning
Lecture 12:	11:00 – 12:00 a.m.	Martensitic transformations and crystal interfaces
Tutorial 6:	2:30 – 4:30 p.m.	Problem solving session on planar defects and including transformation of indices following a change of unit cell

Teaching Faculty

Dr Kevin M. Knowles is a Senior Lecturer in the Department of Materials Science and Metallurgy at the University of Cambridge, U.K. His research interests lie in the broad area of the relationship between microstructure, crystallography and properties of engineering materials, with research over the years spanning both metallic and ceramic materials. Current active areas of research are devitrite, the joining of engineering ceramics, twinning in low symmetry materials, zirconium MAX phases and the tensor algebra of the elastic moduli of crystals. He is Editor of *Philosophical Magazine* and an Associate Editor of *Philosophical Magazine Letters*. He is a world renowned expert in the field of crystallography and has recently co-authored the second edition of a book entitled *Crystallography and Crystal Defects* with Anthony Kelly and published by Wiley in 2012. The contents of this book, aimed at final year undergraduate students, graduate students and advanced researchers, will form the basis of a significant fraction of the lecture course content.

Course Coordinator

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Who can attend

- Engineers and researchers from manufacturing, service and government organizations including R&D laboratories wishing to improve or consolidate their knowledge of crystallography.
- Materials science, Physics, Chemistry and Engineering students at all levels (B.Tech. / M.Sc. / M.Tech. / Ph.D.) wishing to improve or consolidate their knowledge of crystallography.
- Faculty from academic and technical institutions who wish to improve or consolidate their knowledge of crystallography.

Registration Fees

Participants from abroad:	US $500
Industry/Research Organizations within India:	Rs. 10000/-
Faculty/Staff from Academic Institutes within India:	Rs. 5000/-
Students	
Ph.D.	Rs. 2000/-
PG & UG	Rs. 1000/-

The above fee includes all instructional materials, computer use for tutorials and 24 hr free internet facility. Participants will be provided with single bed accommodation on payment basis.