MS032.P01

A Materials Physics course at a PhD granting research university

Peter Moeck[1]

[1]*Portland State University, Portland, United States*
E-mail: pmoeck@pdx.edu

The course provides a thorough introduction to the very wide and diverse field of Materials Physics [1]. Geometric-structural and physical crystallography [2] are at the core of this field because they allow for the derivation of the physical properties of condensed matter. Point and space symmetries of crystals are first introduced in 2D and applied to data types that are used in electron crystallography. Fourier analyses and syntheses (as well as reciprocal space concepts) are also first introduced in 2D and then generalized up to 6D with special emphasis of the 3D case. This is followed by the discussion of point and space symmetries in 3D and a brief discussion of their utility in single crystal X-ray crystallography and discrete electron tomography. A few structural prototypes [2] are covered and their Bärnighausen trees derived on the basis of the International Tables for Crystallography Vols. A and A1. A wide range of 3D printed crystallographic models is utilized in hands-on class activities [3]. Following developments of the last two decades, crystallographic symmetries are treated as continuous features in order to gain deeper insight into structure property relationships. The symmetry principles of Neumann and Curie provide the bridge from crystal structures to the physical properties of materials [2]. Tensors are utilized as most effective mathematical representation of the anisotropy of physics properties [1]. Pseudo-symmetry, crystal defects, paracrystallinity, textures, modulated structures, and quasicrystals are also discussed. The laboratory component of this course is concerned with quantitative powder X-ray diffraction. All students receive a different powder mixture of some unknown crystal phases (but qualitatively know element content) and need to quantify its phase content by a Rietveld analysis.

[1] Newnham, R. E. (2005) Properties of materials, anisotropy, symmetry, structure, Oxford University Press. [2] De Graef, M. & McHenry M. E. (2012) Structure of Materials, An introduction to crystallography, diffraction and symmetry, Cambridge University Press. [3] Moeck, P. et al. (2014). J. Mater. Edu. 36, 77-96

Keywords: geometric-structural and physical crystallography, Bärnighausen trees, symmetry principles of Neumann and Curie