

research questions, collaborate with those having greater expertise, utilize crystallographic results as the basis for or validation of their own work, and critically review published structures or those being submitted for publication. Opportunities, challenges and pedagogical implications presented by these policies and cyber instruction will be discussed.

Keywords: teaching, policy, cyberinfrastructure

MS.11.4

Acta Cryst. (2008). A64, C31

Use of images from neolithic art, clip art, digital cameras, and MATLAB® in teaching crystallography

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Images illustrating symmetry are valuable in the teaching of crystallography. Unusual two-dimensional wall-paper patterns from Neolithic art collected by Prof. Slavik Jablan will be shown. Amazing illustrations of two-dimensional point groups and space groups have been constructed by students using clip art with programs such as Microsoft Paint. Digital cameras can be used to collect imaginative examples of crystallographic interest such as reflections in ponds, spiral-staircase screws, and footprints-in-the-sand glide planes. Advanced computer languages like MATLAB® can be used to create parametric figures such as spirals, seashells, and butterflies (T.H. Fay *Amer. Mat. Mon.* 96, 443, 1989) which then can be inserted in space groups. Illustrations will show teaching examples and student exercises, many from *Foundations of Crystallography with Computer Application* by Maureen M. Julian, CRC press 2008.

Keywords: crystallographic education, computer-aided instruction, symmetry

MS.11.5

Acta Cryst. (2008). A64, C31

Teaching crystallography: Approaches for non-crystallographers and non-native speakers in Asia

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The teaching of crystallography, as a cross-disciplinary science, is required in a variety of subject areas and at different academic levels. Some of the approaches and curricula of crystallography developed at a technological university in Asia, and given at the undergraduate or introductory level in Solid State Chemistry and Materials Science and Engineering, as well as at the post-graduate level in a one-semester course on Chemical X-ray Crystallography are reviewed. The needs of non-crystallographers, and even non-native speakers, can pose additional challenges for successful teaching and learning outcomes. The use of visual constructs and in-class exercises to develop understanding is thus emphasized. The fundamentals of crystallographic symmetry and both powder and single crystal diffraction can be tackled via case studies of increasing complexity, starting from 2D patterns and progressing through simple 3D inorganic structures to complex organic or protein molecular packing arrangements. At more advanced level the conceptual background seems best augmented by combination with experimental practice.

The Asian region has some of the most disparate levels of educational and scientific resources in the world. Many sizeable countries within it do not have even one single crystal X-ray diffractometer. A case is presented for the need of a workshop-based crystallographic school, with hands-on access to modern instrumentation, to promote and sustain crystallography in the less developed parts of the region.

Keywords: crystallographic teaching, inorganic and organic crystal structures, materials engineering teaching programme

MS.12.1

Acta Cryst. (2008). A64, C31

X-ray scattering studies of liquid-crystalline suspensions of anisotropic mineral nanoparticles

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Mineral liquid crystals are colloidal suspensions of anisotropic (disc-like or rod-like) mineral nanoparticles in a solvent, usually water. These suspensions form various types of liquid-crystalline nematic, lamellar, or columnar phases, depending on the particle anisotropy and concentration. Such phases combine long-range orientational order of the particles with either short-range positional order or long-range positional order in 1 or 2 dimensions. X-ray scattering is a very well suited technique to study these properties because it gives direct access to the nematic order parameter, and to the dimensionality and symmetry of the positional order. This will be illustrated by various examples: Suspensions of goethite (FeOOH) nanorods provide a very convenient system because it displays all the above-mentioned phases [1,2], sometimes coexisting in a single sample [3]. Besides, suspensions of natural clays will be used to describe the case of disc-like particles [4,5]. Moreover, if time allows, I will also show how the dynamic properties of nematic suspensions of rod-like nanoparticles can be probed by the rather new technique of X-ray photon correlation spectroscopy (XPCS).

[1] B.J.Lemaire et al, *Phys. Rev. Lett.*, 88, 125507 (2002).

[2] B.J.Lemaire et al, *Phys. Rev. Lett.*, 93, 267801 (2004).

[3] G.J.Vroege et al, *Advanced Materials*, 18, 2565 (2006).

[4] L.J.Michot et al, *Proc. Nat. Acad. Sci. USA*, 103, 16101 (2006).

[5] L.J.Michot et al, *Langmuir*, 24, 3127 (2008).

Keywords: liquid crystals, colloids, small-angle scattering

MS.12.2

Acta Cryst. (2008). A64, C31-32

Crystallography of 2D and 3D structures in liquid crystal amphiphiles and nanocomposites

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A combination of X-ray diffraction methods was used to study thermotropic phases of three groups of liquid crystalline materials. The different experimental and analysis techniques used will be illustrated on selected examples. Firstly, a wide range of T-shaped, X-shaped and π -shaped amphiphiles with three or four incompatible moieties were studied. A range of novel phases with 2D and 3D