School of Engineering and Information Technology

Murdoch University Materials Geometry Workshop

Complex Nanogeometries: Folded, Grown, Woven & Functional

Venue: McCusker Conference Center, Health Research Center, Discovery Drive, Building 390, South Street Campus (Carpark 8, see map on p 4)

Date: Monday May 18, 2015 from 14:00 - 17:30

14:00 Prof Bogdan Dlugogorski, Dean of School of Engineering and IT
Welcome

14:05 Prof Stephen Hyde, Australian National University
3D weavings via non-euclidean geometry & metal-organic frameworks

14:45 Prof Julian Gale, Curtin University
How complex can assembly of ionic materials from solution really be?

15:30 Coffee break

16:00 Dr Piotr Kowalczyk, Murdoch University
Cryogenic Distillation of Noble Gases Using Triply Periodic Minimal Carbon Surfaces

16:45 Dr Toen Castle, University of Pennsylvania
Making Structures using Kirigami

All are welcome to join in for dinner at 'Bread in Common', 43 Pakenham Street, Fremantle at 7:30pm. Please rsvp to g.schroeder-turk@murdoch.edu.au.

Contact Person and Information: Gerd Schröder-Turk (g.schroeder-turk@murdoch.edu.au)
Prof Stephen Hyde, Australian National University

3D weavings via non-euclidean geometry and metal-organic frameworks

An important metal organic framework (MOF) is the MOF-14 material [1]. We described its structure at the time as a mutual weaving of a pair of pto networks on the P surface [1] (a triply-periodic minimal surface). Since then, related MOFs have been found (MOF-388 [2], UTSA28 [3, LH image]). I will explore how these 3D structures are related to simpler planar layer MOFs, via 2d “orbifolds” that allow us to morph between 2d non-euclidean geometries. All examples are (generalised) “weavings”, whose systematic exploration is pretty clear from these examples.


Prof Julian Gale, Curtin University

How complex can assembly of ionic materials from solution really be?

It might imagined that combining two charged ions in aqueous solution to form an ionic crystal was one of the simplest chemical processes possible and something that should already be very well understood. However, in the case of formation of the mineral calcium carbonate from \( \text{Ca}^{2+} \) and \( \text{CO}_3^{2-} \), nothing could be further from the truth with the observation of polymorphism, polyamorphic precursors [1], and stable pre-nucleation species that seem to defy classical theories [2]. Given the significance of carbonate minerals for both carbon sequestration and biomineralisation, it is essential to try to understand what is really going in this seemingly complex system. To try to do this, the following relevant questions will be addressed using a combination of computer simulation and experimental techniques [3-5]:

– Why do ion pairs form?
– How does nucleation occur?
– Why do amorphous nanoparticles of CaCO$_3$ form before crystalline ones?
– How do steps on the surface of the most stable crystalline polymorph, calcite, interact with aqueous solution, and what is their protonation state?


Dr Piotr Kowalczyk, Murdoch University

**Cryogenic Distillation of Noble Gases Using Triply Periodic Minimal Carbon Surfaces**

In recovering of $^{20}$Ne from $^{20}$Ne-$^4$He mixtures, the separation by selective adsorption seems to be a very attractive alternative to costly and energy-intensive cryogenic distillation operations. However, in equilibrium-driven separations, a highly selective nanomaterial is a key to achieve the high adsorption selectivity of $^{20}$Ne over $^4$He. Triply periodic minimal carbon surfaces are novel carbon nanostructures with potential applications in cryogenic gas separation technologies. In this presentation, our recent theoretical results on $^{20}$Ne-$^4$He mixture adsorption and separation in lamellar carbon, Schwarz P-carbon, and Schoen G-carbon will be presented and discussed.

Dr Toen Castle, University of Pennsylvania

**Making Structures using Kirigami**

Complex 3D structures can be built by bending and folding a flat sheet, as is done in origami. This paradigm can be extended by cutting and gluing the sheet as well as folding, a process called “kirigami”. The principles manifest in manipulating a piece of paper can translate across many length scales (micro- to building-sized) limited only by fabrication methods. There is enormous scope to cut and fold in different ways so I’ll limit myself to cutting and folding on a hexagonal lattice in a way that maintains the intrinsic bond lengths on both the lattice and its dual lattice. It follows that a small set of rules is allowed, providing a framework for exploring and building kirigami.

Venue:
McCusker Conference Center
Health Research Centre
Building number 390 (marked by '35' on the map below)
Discovery Way
Murdoch WA 6150

Nearest car park: car park 8
Bus routes: 98, 99, 206, 207, 850, 851