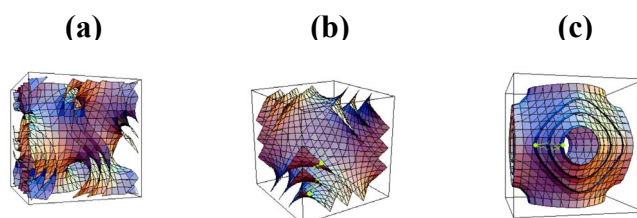


## Probing the Lamellar to Bicontinuous Cubic Phase Transition Using the Pressure Jump Technique

O.Ces, C. Conn, X. Mulet, R. H. Templer, J. M. Seddon and A. Squires  
*Department of Chemistry, Imperial College of Science, Technology, and Medicine,  
London SW7 2AY, U.K.*

J. Kraineva and R. Winter  
*University of Dortmund, Department of Chemistry, Physical Chemistry I, Otto-Hahn Strasse 6,  
D-44227 Dortmund, Germany*

Lyotropic liquid crystals of 1-, 2-, or 3-dimensional periodicity spontaneously assemble when biological amphiphiles are mixed with solvent under various conditions of temperature, pressure and hydration. The mesophases formed include the fluid lamellar ( $L_{\alpha}$ /1-D), hexagonal ( $H_I/H_{II}$ /2-D) and inverse bicontinuous cubic phases ( $Q_{II}$ /3-D). Biologically, the fluid lamellar phase is ubiquitous, being the structure upon which cell membranes are based. However the inverse bicontinuous cubic phases have become increasingly accepted as not only being present in many cell membranes, but as facilitating a number of vital cell processes including endo- and exocytosis, fat digestion and membrane budding as these involve changes in membrane topology. These cubic phases consist of a lipid bilayer draped on a mathematical surface known as the primitive (P/space group  $Im3m$ ), double-diamond (D/space group  $Pn3m$ ) or gyroid (G/space group  $Ia3d$ ) periodic minimal surface, subdividing 3-D space into two interpenetrating, but not connected, water networks (figure 1).



**Fig 1-Mathematical surfaces of the (a)  $Ia3d$ , (b)  $Pn3m$  and (c)  $Im3m$  phases.**

Previous studies of lyotropic phase transitions have concentrated on transformations between lamellar structures and between lamellar to inverse hexagonal structures, with remarkably little work being done on transitions involving cubic phases. A complete understanding of the physical processes governing such transitions however including the nature of any intermediates formed, and the mechanistic route taken, is essential if we are to further our knowledge of such fundamental cellular processes. As a result we have recently introduced the pressure-jump technique to investigate lyotropic phase transitions by studying the rate and mechanism of the transitions in 1-monoelaidin/ $H_2O$  and 2LA/DLPC/ $H_2O$  systems by monitoring the complete time evolution of these structural conversions. The use of pressure as a trigger mechanism has several advantages: 1) the solvent properties are not significantly altered, 2) pressure propagates rapidly meaning that equilibrium is achieved rapidly and 3) pressure-jumps can be both in the pressurisation and depressurisation directions. In addition biological lipid systems are inherently pressure-sensitive and use this variable as a mechanism of inducing phase transitions in their natural environment.