

Research Interests - William E. Price

My research interests are concerned primarily with physical properties, particularly mass transfer, in fluids and porous media such as polymers and foods. It spans both pure research, studying interactions in fluid mixtures and their effect on the properties and structure of the system and applied research targeted at specific, often industry-driven, goals. At present there are four areas in which these interests are being pursued:

Electromaterials Science

In collaboration with Prof. Gordon Wallace and other members of the [Intelligent Polymers Research Institute \(IPRI\)](#) I have been engaged for over 15 years in research developing novel nanostructured materials for a range of potential applications including artificial muscles, actuators, energy storage and conversion. This group is at the forefront of materials research and is the Central player in the ARC Centre of Excellence for Electromaterials Science in collaboration with Monash and St Vincent's Hospital. A major theme of this Centre is the use of nanostructured components, materials with new and enhanced chemical and physical material properties and assembly into nanostructured electromaterials. One major focus of this research has been using inherently conducting polymers (ICP), in both thin films and in composite materials. ICP have unique properties including high electrical conductivity, flexibility, low density and a diverse range of possible chemistries. In addition, these polymers change their redox state and their chemical and physical properties on application of external potential.

A major focus of my work has been the use of ICP as stationary phases and membranes or in composite materials, amongst others, to affect separations of complex mixtures. This is the basis of a new, exciting separations technology. The advantage of the conducting layer is twofold. Firstly the unique redox properties may be used to enhance transport of ions across the film - indeed selective transport of species may be turned on and off and modulated through electrical stimulation. Secondly the rich diversity of chemical moieties that may be incorporated into such conducting polymer films as counterions (or neutral species) enables a wide range of surface chemistries to be produced. The conducting polymer is able to act as a thin selective passive layer as well as having inherent conductivity and redox properties. These advantages make such materials a rich source for novel device and other applications, such as metal ion separation and recovery. Recent projects have been focused on metal recovery and in collaboration with Prof. Doug MacFarlane of Monash University, the use of ionic liquids for novel electrochemical processing.

Selected publications:

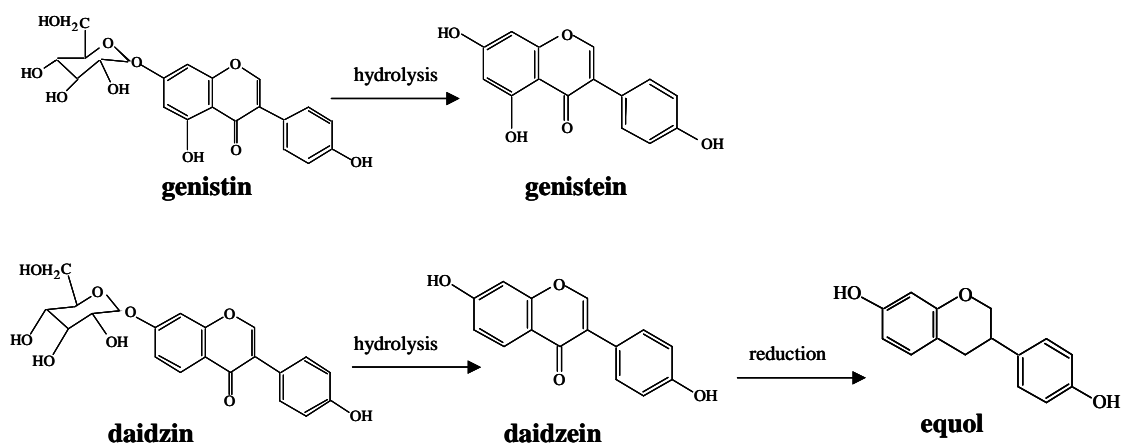
1. El Abedin, S.Z., et al., *On the electrodeposition of titanium in ionic liquids*. Physical Chemistry Chemical Physics, 2008. **10**: p. 2189-2199.

2. Ding, J., et al., *Electrochemical co-deposition of Tin+ phases with gold in ionic liquids*. *Physical Chemistry Chemical Physics*, 2008. **10**(38): p.5863-5869.
3. Ding, J., et al., *Induction of titanium reduction using pyrrole and polypyrrole in the ionic liquid ethyl-methyl-imidazolium bis(trifluoromethanesulphonyl)amide*. *Electrochemistry Communications*, 2008. **10**: p. 217-221.

Food Analysis and Food Processing

Mass transfer is often the rate-limiting step in extraction from foodstuffs. Experience has been built up in this area over nearly twenty years measuring the kinetics and equilibrium behaviour of solvent extraction from foodstuffs such as tea, coffee, citrus fruit and ginger. In addition, my research interest in tea and coffee processing has engendered another interest in extraction and analysis of food components, particularly ones that are bioactive ie have some biological action. At present there are two projects in progress.

Figure 1: Isoflavones – an example family of phytoestrogens



The first area is studying methods of analysis of phytoestrogens in foods and the bioavailability of these important compounds in humans. Soy and linseed products have high phytoestrogens contents, particularly isoflavanols and ligans. These compounds have been implicated in a number of studies to have significant health benefits. This

work is being carried out in conjunction with Dr. Phillipa Lyons-Wall of Department of Health Sciences, University of Wollongong.

The second area is that of chemical and physical changes during the processing of foods. Of particular interest of late have been studies on the effects of air and osmotic dehydration of temperate and tropical fruit. This builds on some developments in techniques previously. Osmotic dehydration is used as a pre-treatment to thermal / air drying to reduce the cost and time for drying and also sometimes to change the flavour and quality characteristics of the fruit. One major focus of the current work is on investigating how the uptake of sugars during the osmotic dehydration treatment modulates the chemical changes that occur during drying. . In addition, there is another focus aimed at identifying changes in volatile profile of the food during processing as a method of quality assurance and looking for markers of undesirable changes caused by for example, caramelisation or Maillard reaction. These interests utilizes SPME and GC/MS techniques for flavour analysis as well as HPLC analysis of carbohydrates.

Selected Publications

1. Larkin, T.A., L.A. Astheimer, and W.E. Price, *Dietary combination of soy with a probiotic or prebiotic food significantly reduces total and LDL cholesterol in mildly hypercholesterolaemic subjects* European Journal of Clinical Nutrition, 2009. **63**: p. 238–245
2. Larkin, T.A., W.E. Price, and L.A. Astheimer, *The key importance of soy isoflavone bioavailability to understanding health benefits*. Critical Reviews of Food Science and Nutrition, 2008. **48**: p. 538-552.
3. Nguyen, M. and W.E. Price, *Air-drying of Banana: influence of experimental parameters, slab thickness, banana maturity and harvesting season*. Journal of Food Engineering, 2007. **79**(1): p. 200-207.
4. Murray, T., et al., *Tissue Distribution of Lignans in Rats in Response to Diet, Dose – Response and Competition with Isoflavones* Journal of Agricultural & Food Chemistry, 2007. **55**(12): p. 4907-4912.

Analysis of trace pollutants in the environment

A recently completed project in collaboration with Prof. Andrea Schaefer of University of Edinburgh, formerly at UoW, arose through a successful DEST Innovation grant, Integrated Concepts for Reuse of Upgraded Wastewater in Australia (OZ-AQUAREC) which is part of a wider EU funded program. The EU AQUAREC project sought to coordinate water recycling efforts to overcome obstacles to implementation that are encountered worldwide, including in Australia. The central questions involves developing ways to manage the risks from pathogens and micropollutants, and in particular to deal with uncertainties; strategies for selecting and implementing technical options; appropriate quality water indicators; processes for user/public consultation; regulations, guidelines and best practice frameworks. The underlying goal was to move water provision systems towards sustainability, balancing the protection of water resources, economic and regional interests, and the interests of water users. Part of the program was focused at developing methodologies for the analysis of a number of classes of

trace pollutants in waste water, many of them of anthropogenic origin. These include hormones, pharmaceuticals, pesticides, plasticizers, detergents and phytoestrogens. These need to be analysed at very low levels to ascertain their extent in waste water and determine the ability of tertiary treatment processes in removing them, to enable the water to be reused. My interest in the area stems from work done on analyzing phytoestrogens and other bioactives from foods. My current work is focused on developing robust LC-MS techniques for the analysis of low levels of phytoestrogens in environmental samples.

Selected Publications

1. Kang, J., L.A. Hick, and W.E. Price, *Using calibrational approaches to compensate for remaining matrix effects in quantitative LC-ESI-MS_n analysis of phytoestrogens in aqueous environmental samples* Rapid Communications in Mass Spectrometry, 2007. **21**: p. 4065-4072.
2. Kang, J., L.A. Hick, and W.E. Price, *A fragmentation study of isoflavones in negative electrospray ionization by MS_n ion trap mass spectrometry and triple quadrupole mass spectrometry*. Rapid Communications in Mass Spectrometry, 2007. **21**: p. 857-868.
3. Kang, J., W.E. Price, and L.A. Hick, *Simultaneous determination of isoflavones and lignans at trace levels in natural waters and wastewater samples using LC-ESI ion-trap MS*. Rapid Communications in Mass Spectrometry, 2006. **20**: p. 2411-2418.

Dynamics in Complex Liquids and Mixtures

Experimental measurements of dynamic physical properties of complex liquids and mixtures are important in furthering our understanding of the structure of the fluid phase and also of mixing and phase separation phenomena such as detergency and micellisation. In addition, data such as transport properties as a function of temperature and pressure is needed for engineering applications. The concept of the hydrophobic interaction is of great importance in protein folding and stability, membrane formation through aggregation of biomolecules, molecular recognition and other phenomena. Hydrophobic effects play an important part in a variety of solution processes ranging from self-assembly process in solution, surfactant micelle formation in aqueous solution and detergency and other surface phenomena through kinetic solvent effects in aqueous solvent mixtures to the behaviour of natural gas hydrates.

A recent Dairy Australia funded project where hydrophobic interactions can play a major role, has concerned the structure and properties of milk proteins in solution. α S-Casein is a mammalian milk protein which has recently been shown to have chaperone-like properties. A chaperone protein is one that prevents self-assembly and uncontrolled aggregation of other proteins. Work in collaboration with Prof. John Carver, School of Chemistry and Physics, Adelaide has been investigating protein dynamics in solution using a variety of techniques including NMR.

Selected publication:

1. Ghahghaei, A., et al., *The effect of dextran on subunit exchange of the molecular chaperone alpha-crystallin*. Biophysica Biochimica Acta – Proteins and Proteomics, 2007. **1774**: p. 102-111.
2. Morgan, P.E., et al., *Casein proteins as molecular chaperones*. Journal of Agricultural and Food Chemistry, 2005. **53**(7): p. 2670-2683.

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