

## WHAT CAN THE TECHNOLOGY BE USED FOR? Customers and Applications

### 1. Solar Cells

The Economic Development Board of Singapore and the National University of Singapore have jointly established the Solar Energy Research Institute of Singapore (SERIS) in 2008 to boost Singapore's role in the booming solar energy sector. SERIS will focus on applied research in the field of photovoltaics and energy efficient buildings, including advanced characterization of various types of solar cells. SERIS' Characterization Laboratory is headed by Dr Bram Hoex and as the main tool he acquired the INPHAZE impedance spectrometer. A close collaboration is now ongoing between INPHAZE and SERIS to further develop the capabilities of the INPHAZE tool in the field of photovoltaics.

In Australia UNSW hosts one of the world's foremost photovoltaic research centers, headed by Prof Martin Green. INPHAZE has characterized photovoltaic cells produced by this group and shown some very interesting results. (See INPHAZE Solar Cells Application Note.)

INPHAZE is also cooperating with one of the key solar cell research groups in Germany, at the Max Planck Institute for Microstructure Physics in Halle.

### 2. Membranes and Membrane Fouling

Water desalination and reclamation plants are based on the use of reverse osmosis membranes (RO). Researchers at the University of Sydney have shown that the INPHAZE instruments are capable of distinguishing fine detail in these membranes, as well as detecting fouling of the membranes at a very early stage in the plant running cycle. (See publication of J. Kavanagh et al, 2009). This opens up an opportunity for a novel fouling detector for membranes and potentially large savings in energy usage and improved productivity.

Based on these preliminary findings, a major collaboration is commencing between INPHAZE and the Singapore Membrane Technology Centre (SMTC) headed by Professor Tony Fane at Nanyang Technological University.

### 3. Mineral Processing

It appears that the INPHAZE instrument can also be used for characterizing particles in mineral flotation, and this will be demonstrated in a new cooperation with the Ian Wark Research Institute in South Australia. INPHAZE is building a special sample chamber for this application.

### 4. Batteries

Batteries have become of great interest in the world-wide efforts to bring about more efficient energy usage. One of the challenges in R&D on batteries, including in fuel cells, is the optimization of the membranes used. Several of these R&D groups, including in Europe, have approached INPHAZE to see whether the system can be used to characterize their low impedance membranes. Collaborative projects have just commenced.

### 5. Bionics

INPHAZE is engaged in an ongoing research collaboration project with Australian hearing company Cochlear. Surface coatings are being tested with the goal of improving the Cochlear hearing implant devices even further.

### 6. Nanotechnology / Organic Thin Films

The research group of Prof Michael James at the Bragg Institute of ANSTO is a world leader in the study of thin films, surface coatings and self-assembled monolayers (SAMs). The key is to functionalize silicon wafers and other substrates for the development of biocompatible materials and in bio-sensing applications. (See publication of Wang et al, 2007)

A whole group of PhD students working at ANSTO are being trained to approach these materials employing a set of complimentary technologies: INPHAZE impedance spectroscopy, X-ray reflectometry and neutron reflectometry. To this end INPHAZE and ANSTO are designing and building a new sample chamber for use on the OPAL reactor of ANSTO, to simultaneously carry out impedance spectroscopy and neutron beam studies.

## 7. Polymers and Bio-Polymers

A visiting scientist at the University of Sydney from the USA, from Ohio State University, has recently shown that thin layers of polystyrene can be characterized efficiently with the aid of the INPHAZE instrument. (See publication of G. Ellis et al, 2009)

This line of work is now being extended to polyamines at the University of Sydney, in the research program headed by Prof Marcela Bilek and Prof Tony Weiss, to develop high-performance surface coatings. Their goal is to create biocompatible surfaces for medical devices. The INPHAZE spectrometer is being used for surface characterizations as the new materials are being tested.

## 8. Cell Membranes

At the Ian Wark Institute in South Australia, Dr Dusan Losic and his group are developing very interesting systems of nanopore and nanotube materials for applications in molecular separation, biosensing and drug delivery. They are using the INPHAZE spectrometer as one of their central characterization techniques to study molecular transport and the electrical properties of their new materials and devices.

Dr Losic has found that the INPHAZE impedance technique is particularly valuable for the study of biomimetic membranes as well as for the study of membrane-drug and membrane-protein interactions. These are stepping stones towards the worldwide efforts on bio-diagnostic devices for drug screening and drug discovery and biosensing.

Cell membrane work with the INPHAZE tool is also being carried out at ANSTO in the research group of Distinguished Researcher Prof Richard Banati. One of his PhD students has just started her research on hybrid lipid bilayers bound to self-assembled monolayers (SAMs) which themselves are bonded to silicon.

## 9. Cell Biology

Dr Guo Jun Liu is a Senior Research Fellow working with Prof Richard Banati and is using INPHAZE impedance spectroscopy to study the neuronal and glial cells in the central nervous system. The aim is a better understanding of neuronal diseases at the cellular level as well as drug design based on this understanding. Prof Banati, Dr Liu and INPHAZE have together designed a special sample chamber for cell biology studies, thereby adapting the INPHAZE system for cell biology work.

A protein binding feasibility study was undertaken by INPHAZE for Macquarie University to show that the binding of glycoprotein to bacteria could be studied effectively with the equipment. ARC funding is required to move this research forward.

INPHAZE researchers have also shown that the technology is valuable for the study of protein-protein interactions using the human protein tropo-elastin as a model. They conducted parallel measurements comparing a Biacore plasmon resonance instrument and an INPHAZE spectrometer. This work has shown that the INPHAZE equipment yields comparable structural information to the Biacore instrument, but additionally also provides valuable quantitative data on protein binding kinetics.

## 10. DNA

INPHAZE researchers have shown that the system can distinguish between single-stranded and double-stranded DNA (see publication of Chilcott et al, 2008). This work is about to be extended at the University of Sydney by Dr Ali Abbas and his team, with the goal of developing a new DNA biosensor designed specifically for forensic applications of human bone material and for the detection of genetic mutations.

## 11. Impedance Tomography

A key place in the world for the study of the human brain by means of tomography is at University College London in the group of Prof David Holder. One of the researchers of this group, Dr Alistair McEwan, has now moved to the University of Sydney and a major collaboration has commenced between the original English group and the new off-shoot in Sydney. The essence of this collaboration is impedance tomography carried out with the INPHAZE spectrometer. In this application the usual sample chamber will be replaced with a specially designed multiplexer.

In addition to the work on the human brain, INPHAZE and Dr McEwan are also investigating the possibility of an impedance tomography project to detect breast cancer.

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