STUDENT RESEARCHERS SHOWCASE INNOVATIVE SOLUTIONS TO ADDRESS REAL-LIFE ISSUES

Singapore, 16 March 2017 – A monitoring system that detects faults on LRT tracks; a nanostructure catalyst that can result in a renewable alternative source of energy; sunlight-activated larvicides to prevent mosquito-borne diseases; a diagnostic platform that can detect, and differentiate between, the dengue and Zika viruses; and the production of hydrogel micro-particles using droplet microfluidics.

These are among the breakthrough research projects that will be showcased at the **Polytechnic Student Research Programme (PSRP) Awards Ceremony 2017** on **22 March** at Ngee Ann Polytechnic.

The ceremony will be graced by Guest-of-Honour Prof Jackie Ying, Executive Director, Institute of Bioengineering and Nanotechnology, A*STAR. During the ceremony, a total of 10 outstanding research projects – two from each polytechnic – received the Best Project Awards, in recognition of the students' research efforts.

Launched in 1997, the PSRP is aimed at nurturing students in R&D through an immersion in a scientific and engineering research environment. Working in teams of up to six members, the students get the opportunity to undertake their final-year projects under the guidance of experts at local universities and research institutes.

For more information on some of this year's projects, please see Annex 1.

We would like to invite you (together with a photographer or camera crew) to attend and cover the PSRP Awards Ceremony. Interviews with students can be arranged.

Date: 22 March, Wednesday

Time: 1.30pm – 4.30pm

Venue: Music Box, Block Seventy3, Ngee Ann Polytechnic

Map: http://bit.ly/2m1whJu

Programme

2.00 pm	All guests to be seated Welcome Address by Mr Clarence Ti, Principal, Ngee Ann Polytechnic
2.05 pm	Speech by Guest of Honour, Prof Jackie Ying, Executive Director, Institute of Bioengineering & Nanotechnology, A*STAR
2.15 pm	Project Presentations by Students
3.10 pm	Presentation of Awards
3.30 pm	Tour of Exhibits
3.50 pm	Tea Reception

Issued on behalf of the five polytechnics by:

<u>Ngee Ann Polytechnic</u>

Ms Prema V
Corporate Communications Office
DID: +65 6460 7353
Email: prema@np.edu.sg

Nanyang Polytechnic

High Performance Nanowire Array Catalyst that Splits Water to Produce Hydrogen – a Clean, Renewable and Cost-Effective Alternate Energy

Concerns about climate change and exhaustible sources of fossil fuels have led to the emerging need for alternate and sustainable energy sources and carriers. One such alternate and promising energy source is hydrogen, which has the highest specific energy density among any known fuels and no carbon dioxide emissions. Electrolysis of water to produce hydrogen is an attractive method but efficient catalysts are required to promote this process. However, state-of–the-art catalysts are scarce and more expensive.

In this project, we developed an inexpensive core/shell nanostructure catalyst as it has more surface area to improve efficiency to produce hydrogen. The core/shell structure is able to offer more active sites and improve the overall electrode conductivity, which leads to excellent catalytic performance for hydrogen production. More importantly, the layer of titanium dioxide in the catalyst strengthens the stability of the structure. This unique core/shell catalyst shows a promising practical application for the future.

System for Regular Surveillance of Dialysis Fistula to Allow Early Detection of Stenosis

According to the Ministry of Heath, Singapore has the fourth highest incidence of kidney failure in the world. While dialysis is an option, its success rate depends largely on the proper function of the fistula. Fistula – a graft connecting an artery to a vein – is needed as needling points for dialysis. It enables blood to be drawn out efficiently into the dialysis machine at high flow rate, and subsequently returned to the body. The health of the fistula is the key determinant on the effectiveness of dialysis to remove tonics from the blood.

Fistula failure problems are the most common cause of hospitalization and clinical assessments are usually done when the fistula is not functioning properly. A good blood flow in fistula is about 900ml/min. Fistula, which is constructed using a normal blood vessel as graft, is not used to the high blood flow. This may result in the narrowing of the fistula which is also known as stenosis. When stenosis is not detected at an early stage, complete blockage of the fistula may occur.

A patient is given the following two options when the fistula fails due to severe stenosis:

1.   Construct another fistula on another site. This option requires operational cost, and the number of sites that the fistula can be constructed is limited. Also, it takes time for the fistula to mature before it can be used as needling points for dialysis.

2.   Perform declotting and ballooning. However, the higher the severity of the stenosis, the lesser the success rate of this procedure.

Hence, to combat the problem of fistula failures, our team has developed a device using non-invasive sensors for regular monitoring of the dialysis fistula. This device can be used at dialysis centers and operated by non-clinical staff. The data generated by our device aims to detect early warnings of fistula failure and allow clinicians to provide timely clinical intervention for higher survival and better quality of life for dialysis patients.

Ngee Ann Polytechnic

Condition Monitoring of Railway Tracks with Soft and Stretchable Sensors

This project focuses on the research, design, integration, and testing of a low-cost and non-invasive prototype structural health monitor for the rail tracks of the Light Rail Transit (LRT) system in Singapore. Comprising novel sensor mounts and a stretchable sensor, the prototype structural health monitor detects surface faults by the sensor's changing length, which appear as capacitance changes. These signals are transmitted via Bluetooth to a smartphone application for real-time measurement. Repair works can then be targeted at specific sections of the rail track, thus improving train reliability.

While the prototype has been undergoing trial runs on an isolated test track, long-term monitoring is proposed as the next step to detect faults using software methods. By comparing a predetermined number of signals, a fault can be deduced to have deteriorated if a certain portion of the averaged graphs exhibit gradually increasing or decreasing amplitudes.

Automated Prediction of Premature Delivery Using Uterine Hysterogram Signals with Empirical Mode and Wavelet Packet Decomposition Techniques

Preterm birth, or birth before the 37th week of pregnancy, remains a major problem in obstetrics. While not all premature babies experience complications, being born too early can cause short-term and long-term health problems. It is therefore crucial to be able to accurately detect preterm labour before 37 weeks of the gestational age.

Currently, a uterine electro hysterogram (EHG) can be used to detect preterm labour. However, visual observation and manual interpretation of EHG signals at the time of emergency may be subjective and lead to errors. A solution to this problem is to use a computer-based detection system which can provide fast and accurate detection of premature delivery using uterine EHG signals in conjunction with machine learning approaches. The proposed automated preterm detection system has been shown to achieve an accuracy, sensitivity, and specificity of 96.25%, 95.08%, and 97.33%, respectively, in the detection of preterm labour. These promising results show that the proposed algorithm can be extended to gynecology departments in hospitals to predict normal or preterm delivery in pregnant women.

Republic Polytechnic

Novel sunlight-activated larvicides for effective vector control against mosquito-borne diseases

Global incidence of mosquito-borne diseases (e.g. dengue, malaria, chikungunya, Zika) has grown dramatically in the last decade, with more than 700 million cases yearly resulting in over one million deaths. Since vaccines against mosquitoe-transmitted virus and parasites are still lacking, control of the mosquito vector population is the most effective strategy currently available.

Laviciding is an effective mosquito control technique as it targets larvae and pupae that are confined within their aquatic habits. However, there are concerns associated with the currently available and registered larvicides for mosquito control. They include toxicity and environmental pollution, degradation by environmental factors as well as increased resistance in mosquitoes due to prolonged use.

To address these concerns, there is a need to establish a new class of larvicide and develop a novel formulation to complement existing tools and increase the scope of dengue vector control.

Sunlight-activated larvicides are considered new-generation larvicides with the advantages of being lethal and effective, harmless to non-translucent organisms and allowing little chance for mosquitoes to develop resistance since this class of larvicides target multiple sites for killing.

The team has developed novel sunlight-activated larvicides that effectively kill Aedes larvae at low concentration while being relatively non-toxic for other aquatic organisms. These novel larvicides can be used in mosquito control programmes by applying them to mosquito breeding and potential breeding sources in rotation with other existing larvicides.

In-Situ Healing for Aircraft Composite Repair

The FYP team from Republic Polytechnic's School of Engineering has conducted intensive experimental work to develop a rapid and effective in-situ healing method for the repair of internal defects in damaged composite aero-structures. This research was conducted in collaboration with Newcastle University in Singapore.

Reproducible damages with an average diameter of 25mm and 50mm were created on several 16-ply and 24-ply carbon-fiber specimens. The internal characteristics of the pristine, damaged and repaired specimens were assessed using 3 different methods of non-destructive testing (NDT).

It was found that the carbon nanotube premixed Nanoforce-100 can recover the highest compression strength in the repaired samples among all the tested low-viscous healants. This mixed healant has ideal density and viscosity which aids the infiltration into the damaged internal area of the composite plates. Several repair methodologies and procedures such as the low-viscous resin infusion and the double bagging vacuum system have been developed specifically for this research. Apart from the Nanoforce-100, other healants, particularly Epotek-301 healant have been tested on the samples to determine the highest repair efficiency.

After conducting several mechanical strength assessments, particularly compression-after- impact (CAI) tests, it was concluded that the most efficient method for the repair of composite internal cracks and damages is resin injection with assistance from the vacuum chamber and the use of Nanoforce-100 healant.

<u>**Singapore Polytechnic**</u>

Multiplex detection and differentiation of Zika and Dengue infections by isothermal amplification-lateral flow technology

Zika virus (ZIKV) and Dengue virus (DENV) are flaviviruses transmitted by the Aedes mosquito. Given the recent emergence of ZIKV infections in Singapore, the likelihood for co-circulation of both viruses in the local and regional context is high as both viruses are transmitted by the same mosquito species. In addition, infections from ZIKV and DENV present with similar clinical symptoms, such as fever, headache, muscle and join pain, fatigue and rash. Hence, precise and reliable diagnosis is a relevant diagnostic issue to be addressed. Fast and reliable methods to detect and distinguish between ZIKV and DENV would contribute greatly towards efficient and adequate patient care. This project aims to develop a PCR-like lateral flow diagnostic platform for the detection and differentiation of ZIKV and DENV in a point-of-care setting.

Underwater Image Enhancement Technology
The enhancement of underwater images has been a growing area of interest in the field of research for

marine life and underwater environments, as well as underwater photography. However, many underwater images suffer both from discolouration and lack of clarity, which result in the deterioration of the image's colour and detail. We propose an effective method for enhancing the colour, clarity and brightness of underwater images to make them appear more realistic while also bringing out their detail. The experimental results show that our algorithm is capable of adapting well to a wide range of underwater environments.

Temasek Polytechnic

High efficient production of hydrogel micro-particles using droplet microfluidics
Hydrogel micro-particles are useful tools in the pharmaceutical industry and in life science research. This project aimed to develop methods for highly efficient production of hydrogel micro-particles using droplet microfluidics.

Protocols for microfluidic device fabrication, using economical acrylic plastic material and laser engraving methods, were developed. Different factors affecting hydrogel droplet formation, including the flow rate and the geometry of the chip design, were studied.

The results show that the micro-particles generation rate has improved from tens of particles to more than 500 particles per minute using a design with flow-focusing and physical constraint nozzle structures. The particle generation rate is significantly higher than the rates reported for most hydrogel micro-particle generation methods presented in scientific publications.

Machine Learning on Smart Home Distribution Board (Smart DB) Architecture
Smart DB leverages analytics and the Internet of Things to derive detailed information on power usage by appliances in a household. Using this information, they can offer smart home services such as home monitoring and appliance safety. However, load identification and disaggregation pose a challenge towards such ambitions.

The main finding of this research project is the detection of changes in reactive and real power in appliances. This leads to the disintegration of resultant power factors into component power factors. Using this finding, the additional feature of load identification and disaggregation can be achieved. The additional derived dimension enables the filtering of candidate appliances to increase the accuracy and speed during the identification and disaggregation stage.

When combined with Machine Learning, the raw data captured by Smart DB can be disaggregated and further classified into individual appliance states such as 'on', 'off' or transitioning into a different state (e.g. 'standby').