**ARC DISCOVERY PROJECTS 2017**

UOW researchers were awarded 16 DPs, totalling $5.3 M.

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A/Prof Jun Chen; $296,500 – Redox-Gel Integrated Electrode for ThermoCells - Body Heat to Electricity

This project aims to synthesise flexible redox gel-electrolyte interpenetrated electrodes for an eco-friendly prototype wearable thermo-electrochemical cell that can power body-worn low-power wearable electronics. Wearable devices in the future are expected to include products related to personal wellness and healthcare and medical technology. These devices require a sustainable power source (without having to change a battery) for real time monitoring/communication. Turning body-heat into electricity by wearable thermo-electrochemical cells may provide a solution. The project could also contribute to the mitigation of greenhouse emissions.

Prof Shi Xue Dou; Dr Yi Du; Dr Xun Xu; A/Prof Germanas Peleckis; $513,000 - Two-dimensional Plasmonic Heterogeneous Nanostructures for Photocatalysis.

This project aims to design and explore novel two-dimensional heterogeneous photocatalysts that can convert solar energy into usable chemical energy through in-depth investigation of the correlation between surface plasmonic resonance and photocatalytic activities on the atomic level. A new strategy of heterogeneous engineering and in-situ investigation of atomic-level photocatalytic dynamics will be the key elements in this research, which is expected to yield several novel full-solar-spectrum photocatalysts. The project will contribute to the understanding of the processes and mechanisms underlying photocatalysis, as well as laying a practical foundation for usable, stable, and durable photocatalytic applications.

Dr Susanna Guatelli; $363,000 - A new, specialised approach to understand nanoparticle radiosensitisation

This project aims to develop new knowledge through a better understanding of physics interactions of particles in compounds with sub-micron size. Research on radiosensitisation by sub-micrometre sized nanoparticles (NPs) is hot worldwide because it could treat cancer, but the physical/physico-chemical/biological mechanism of radiosensitisation is unclear because no physical models describe particle interactions at nanometre scale in solid state nanometre sized objects. This project will develop and evaluate specialised physics models to describe particle interactions in NPs and help optimise nanoparticle technology. It will develop expertise in Australia in physics modelling for nanomedicine and other applications of nanotechnology exposed to radiation (e.g. telecommunications, aviation and space).

Prof Zai Guo;  Dr Konstantin Konstantinov;  $493,500 - Potassium ion batteries for large scale renewable energy storage

The project aims to develop potassium ion batteries for renewable energy storage and conversion. Potassium ion batteries could be the most promising choice for large-scale electrical energy storage, particularly for renewable energy sources and smart electrical grids, due to their low cost, natural abundance and the advantages of potassium compared to lithium/sodium ion batteries. This study will research the electrochemical reactions and charge transfer pathway of electrode materials with excellent potassium ion storage performance. This project is expected to develop high performance potassium ion batteries and advance the prominence of Australia in the global renewable energy market.

Dr Zhenguo Huang;  Prof Hua Liu;  Dr Haibo Yu;  $391,000 - Liquid-phase hydrogen carriers for energy storage and delivery

This project aims to overcome hydrogen storage and delivery issues by developing liquid-phase hydrogen storage materials with high hydrogen capacity, exceptional stability and that do not change phase during hydrogen evolution. This project will build on the recent synthesis of strategically important hydrogen storage compounds. The innovative liquid-phase hydrogen storage and delivery technology will enable effective usage of established liquid fuel distribution techniques and infrastructure throughout the country. The project would benefit renewable energy, chemical, and manufacturing industries, where new employment opportunities would be created.

Prof Daniel Hutto;  Dr Michael Kirchhoff;  Prof Shaun Gallagher;  $263,000 - Minds in Skilled Performance: Explanatory Framework and Comparative Study

This project aims to develop an explanatory framework to characterise states of mind necessary for skilled performance, and show how intelligence and emotion affect performance. The theoretical grounding of skilled performance is controversial. This project will use and refine core ideas from enactivist approaches to embodied cognition to address philosophical challenges that block understanding of its basis. The project will draw on Phenomenology, Pragmatism and Japanese "do". clarifying and recontextualising what they have to offer to contemporary thinking about skilled performance. Large-volume gradient materials: manufacturing and deformation mechanism.

A/Prof Cheng Lu;  Dr Hailiang Yu: $300,000 – Large-volume gradient materials: manufacturing and deformation mechanism

This project aims to develop a low-cost and high productivity process to produce large-volume metals with high strength and good ductility, suitable for engineering application. Ultrafine grained (UFG) materials and nano-grained (NG) materials are usually strong, but not very ductile. This project will use an accumulative skin-pass rolling (ASPR) technique to fabricate the metallic strips with

gradient structure. The numerical simulations developed in the project are expected to contribute to understanding the deformation mechanism of gradient materials.

Prof Allen Nutman; $270,000 -Engineering planetary habitability: Earth's critical first billion years

This project aims to establish the critical physical-chemical factors in the early surface environment and tectonic regime that supported early life and continuing habitability. Life was established on Earth within the first billion years of its 4.56-billion-year history. This project's integrated geological and geochemical study will investigate this period's rare sedimentary and volcanic record, including the oldest fossiliferous sequences discovered recently, to show how the early Earth's chemistry supported life and evolution. The project expects to enhance understanding of why life prospers on some habitable zone planets but not on others.

A/Prof Sarah O' Shea: $152,903 - Capitals and Capabilities: Rethinking higher education persistence

This project aims to address the issue of early departure from university. Many students leave higher education and disproportionate numbers are from educationally disadvantaged groups, including first-in-family learners. Too often, the individual learner is 'blamed' for this departure and perceived as deficit in necessary knowledge. This project extends previous research into how first-in-family students manage and engage with higher education. Expected outcomes include knowledge about university persistence behaviours and a capabilities informed framework to design and implement future retention strategies.

Prof Elena Pereloma; Dr Azdiar Gazder; $270,000 - Establishing the deformation mechanisms of metastable titanium alloys

This project aims to understand the response of deformation-induced products in metastable titanium alloys to external loading. Metastable titanium alloys are mechanically tuneable because they can readily twin and phase transform under load during forming or in service. This project will develop a crystal plasticity model that accounts for these deformation mechanisms. These new alloys are expected to make titanium a viable lightweight alternative for components in the aerospace and transport industries, with the weight savings helping reduce overall energy consumption.

Prof Anatoly Rozenfeld; Dr Marco Petasecca; A/Prof Michael Lerch; $357,000 - Development of radiation detectors to better understand ion interactions

This project aims to build a Heavy Ion Therapy Research and Treatment Centre in Australia. Understanding how ions interact with matter and their radiobiological effectiveness (RBE) is important. The project will introduce an Australian detector technology platform to research ion interaction physics and their RBE. It will develop radiation detectors for ion measurement with a

wide energy range, including a practical RBE quality assurance tool with submillimetre spatial resolution. The proposed Australian radiation detection technology is expected to improve understanding of the scientific mechanisms underpinning the radiobiological effectiveness of heavy ion radiation.

A/Prof Ngamta Thamwattana; $248,499 - Modelling optimal electromaterial structures for energy applications

This project aims to develop new mathematical and modelling approaches to determine optimal configurations and parameters for material structures created from three-dimensional printing of combined metals and electromaterials. Electromaterials are needed for sustainable energy, but solving coupled-systems of highly nonlinear governing equations is needed for optimal control of spatial arrangement and composition in nano and micro-structural domains. Dealing with this mathematical complexity is critical to developing high efficiency energy generation and gas storage systems. This is expected to enhance transport mechanisms within electrochemical devices and create opportunities for industry to use electrofunctional materials.

Prof Kiet Tieu; Dr Hongtao Zhu; $401,500 - A novel tribological approach to improve surface quality of Silicon steel

This project aims to design a lubricant composite where multiple additives work in synergy and perform at high temperatures. In hot rolling of silicon and electrical steels, significant surface defects of red scales, severe work-roll wear and high friction are problems for traditional lubricant which cannot perform effectively under extreme thermal/loading conditions. The new lubricant is expected to eliminate red scale defects, reduce oxidation and rolling force, improve surface quality and extend roll service life.

Prof Xiaolin Wang; Dr Zhi Li; A/Prof Zhenxiang Cheng; Dr Yi Du; $372,500 -Atomically thin superconductors

This project aims to explore two-dimensional superconducting materials and elucidate the origins of their superconductivity. High temperature superconductivity in single layer iron-based superconductors offers a platform for exploring superconductors with even higher critical temperature (Tc) and has aroused great hope of understanding the underlying mechanisms for high Tc superconductivity. This project is expected to introduce physics and materials, leading to a better understanding of the two-dimensional superconducting phenomenon and the discovery of physical phenomena for new electronic devices.

Dr Tao Yu;  A/Prof Lip The: $280,000 -Hybrid Multiple-Tube Concrete Columns Incorporating Composite Materials

The project aims to investigate the behaviour of and design hybrid multiple-tube concrete columns, a form of column. These columns allow the use of small circular high-strength steel tubes, readily available in the market, to suit the specific needs of construction projects of various scales. In the column, a durable outer tube made of fibre-reinforced polymer (FRP) composites protects steel tubes, and their high yield stress can be fully exploited through section configuration. The new column is expected to enable wider, safer and more economical use of FRP and high-strength steel, and meet demands for resilient civil infrastructure.

Prof Song-Ping Zhu;  $369,000  - The role of liquidity in financial markets

This project aims to develop a theory which models the effect of liquidity on option prices under different market conditions. Economic or financial crises are inevitable and affect economics. During or after a major financial crisis, market liquidity usually becomes risky and needs to be studied. Through both empirical and theoretical explorations, this project will quantify and measure liquidity risk and its effect on the options markets. It will develop a framework to help market regulators manage illiquidity, enhance the efficiency of option trading in illiquid markets and help in the detection of market manipulation.