

Research Assessment Exercise 2020

Impact Overview Statement

University: The Hong Kong University of Science and Technology

Unit of Assessment (UoA): 9-Chemistry

Total Number of Eligible Staff in the UoA: 24

(1) Context

This Unit, the Department of Chemistry, focuses on a broad range of research, involving **materials chemistry, organometallic chemistry, organic synthesis, and environmental chemistry**. It emphasizes projects likely to lead to positive, long-term societal impact in diverse areas, with major impacts extending to *industry, scientific research, medicine, human health, and the environment* through *pollution monitoring and public policy*. The main non-academic users are government agencies in Hong Kong and mainland China that are responsible for the environment, water quality, and food safety; healthcare professionals using new technologies based on novel materials; pharmaceutical and chemical manufacturers and suppliers; enterprises related to the solar cell, semiconductor, and photovoltaic industries, and lab analysts and other professionals involved in testing and product development. Examples include:

Atmospheric chemistry: J Yu's research on aerosol particulates in Hong Kong and the Pearl River Delta, which has informed public policy on control of atmospheric pollutants, achieving impact on policy, the environment and human health.

Toxicology studies, led by S Chan, which identified aristolochic acids as a major contributor to endemic Balkan nephropathy, a severe kidney disease affecting 25,000 people in Eastern Europe, achieving impact on human health and medical practice. Other studies by Chan's group enhance food safety through monitoring toxicity in foods, benefiting food manufacturers and the general public, with impact on the economy and human health.

Drug design and formulation, where J Sun, R Tong, W Dai and I Williams have been developing and testing synthetic and semi-synthetic compounds for pharmaceutical applications, including resistance to existing drugs controlling malaria and tuberculosis, with impact on human health, and the economy for individual companies and countries.

Display materials and devices, with C Tang, the father of organic light-emitting diodes (OLEDs), leading research on the design of nano-materials for improved display technology, an emphasis on environmentally friendly material design (J Halpert), and impact for industry, the economy and environment.

Photovoltaic and battery technologies: H Yan's breakthrough organic based solar-cell devices have set new benchmarks, and rejuvenated this field. Novel electrochemical design of batteries (G Jia, Q Chen) for energy storage complement this. Combined, these approaches can lead to societal impact, assisting in new energy sources and reduction of fossil fuel emissions.

Bio-imaging materials: B Tang's discovery of the Aggregation Induced Emission (AIE) phenomenon has had wide-ranging bio-imaging applications, with impact on health and healthcare through disease diagnosis and treatments (theranostics), food safety, and forensics, as well as economic impact through spin-off companies, and research and product development globally, through the availability of AIE materials.

(2) Approach to impact

Our research achieves impact through an approach that **i)** begins with *focusing on research that addresses major societal problems and needs*, such as air pollution, new pharmaceutical and medical treatments, and demand for renewable energy; **ii)** addresses these problems through *multidisciplinary and cross-university collaboration across disciplines*, and *other universities* in and outside Hong Kong. For example, the Atmospheric Chemistry group collaborates with A Lau (Civil Engineering) and J Fung (Mathematics) within HKUST and overseas universities (e.g. University of Gothenburg, Sweden); **iii)** may involve *contracts* with government agencies and industry, e.g. Yu's work with the HKSAR Government's Environmental Protection Department, Macao government, and government-

sponsored Guangdong-Macao-Hong Kong Regional Cooperation Program for Monitoring PM_{2.5}, and the Environment; **iv**) utilizes *cutting-edge University facilities*, such as the HKUST Air Quality Research Supersite Facility and Environmental Testing Laboratory, which provide important platforms for achieving impactful research, for collaboration, and conducting contracted research; **v**) pursues *knowledge transfer* by leveraging HKUST's Technology Transfer Center, which supports researchers to protect intellectual property (IP) through patent applications, and transfer technology through licenses to industry and spin-off companies.

The UoA has been highly successful in its patents and IP, with J Halpert, S Yang, and H Yan's development of photovoltaics resulting in over 20 patents by 2018-19, including one licensed to science and technology giant Merck, while seven of Halpert's US patents have been licensed to Samsung. B Tang's discovery and development of AIE materials has led to more than 100 patent applications in China, the US, and EU (as of 2018-19), as well as many commercial collaborations through the setting-up of the Chinese National Engineering Research Center (CNERC) for Tissue Restoration and Reconstruction at HKUST, and four spin-off companies (two at HKUST, one in Shenzhen, one in Singapore). Several other groups pursue synthesis and methodologies for drug targets or pharmaceutical natural products, building strong connections with pharmaceutical companies and granting licenses for their IP (e.g. Pfizer, Merck).

(3) Strategy and plans

The Unit will continue to support faculty in translational research and actively seek to strengthen the UoA's approach to impact over the next review period in the following ways:

Innovation and Technology Fund (ITF) support: We aim to expand our recent successes in securing applied projects through the ITF and enhance industry collaborations.

Extending research infrastructure: We have facilitated the expansion of B Tang's group to around 100 researchers, comprising postgraduate students, post-docs, and visiting scholars, through provision of additional lab space, equipment, consumables' budget, and administrative assistance for enabling further pursuit of AIE research, including translational applications. Likewise, H Yan and J Halpert's move to commercialize their optical devices will be assisted by a new 400m² lab in HKUST Fok Ying Tong Research Institute in Nansha, Guangdong.

HKUST new campus: With the UoA's research aligning with the Advanced Materials thrust area at the forthcoming HKUST Guangzhou, the campus will be used as a platform for research and industry collaboration in mainland China,

Targeted recruitment: Strategic faculty hiring is set to strengthen our ability to achieve impact, for example, the recent appointment of Y Huang, who will add impetus to our drug design programs, strengthening links with the pharmaceutical industry in the Greater Bay Area; and new hires in data analytics who can drive further collaborations, as well as insights into the large body of data collected by J Yu and her Atmospheric Chemistry group. Further hires in the chemical biology area will reinforce these efforts.

Dissemination of the Unit's work is also a priority through local, national, and global outreach, and with the assistance of the University's communications team.

(4) Relationship to case studies

The **Tang and Lam case** on AIE luminogen smart materials is a home-grown success story based on Tang's discovery of the AIE effect. It illustrates how our combined approach of cutting-edge facilities and human resources; academic and industry partnerships (e.g. with I Williams and X Huang; Liu, NUS, Singapore; and Guangzhou Yingzhou Law Enforcement Technology Ltd (GYLET)), and knowledge-transfer mechanisms through patents, licenses, and spin-off companies, has enabled applications, with economic and healthcare impacts, among others. The **Yu case**, on tracking air pollution in Hong Kong and the Pearl River Delta, shows how our collaborative approach, through contracted research with government agencies, led directly to the research being used to inform government policy and regulation on emissions, thereby addressing a major societal and environmental challenge in the region.