RESEARCH INSTITUTE FOR SUSTAINABLE URBAN DEVELOPMENT (RISUD)

News Article for RISUD Emerging Frontier Area (EFA) Scheme

		Name	Department
1.	**Principal Investigator**:	Yi JIANG	CEE
2.	**Name of EFA:**	Nanotechnology, Environment, and Urbanization Nexus	
3.	**Project Title:**	New paradigm of water separation membranes	

4. **Annual Progress/Achievement (*in layman's language, no more than two A4 pages, pls attach photos*)**

By 2050, 6.5 billion people are projected to be living in urban areas, which then will account for more than two-thirds of the world's population. According to a recent report by CLSA Research, 8 of the 11 Great Bay Area (GBA) cities are already as dry as the Middle East (Guangzhou, Shenzhen, Hong Kong, Macao, Zhuhai, Zhongshan, Foshan, and Dongguan). The 8 cities' per capita water resources fall well below the World Bank's Water Poverty Mark, yet they account for 92% of the GBA's GDP in 2018. The development of innovative water treatment technologies is critical to the sustainable development of the GBA and beyond.

Membrane separation is regarded as the most important unit process in the next-generation water and wastewater treatment facilities. A membrane acts as a selective barrier, which allows water to pass through but stops other constituents, such as salts (reverse osmosis), organic matters/bacteria (ultrafiltration), particles (microfiltration), and so forth. In spite of its technological advantages, the current hurdle for the large scale application of membrane separation is its high cost and inherent technical flaws, which can be solved by developing a new paradigm of low-cost, high-performance, tailorable water separation membranes.

This EFA project aims at developing a new paradigm of membranes that have novel composite structures, by incorporating new functional materials (i.e., carbon nanomaterials and biopolymers) using advanced manufacturing methods (e.g., 3D printing). In the third year of the project implementation, significant progress has been made to achieve such goal. Among many exciting new results obtained, here we highlight one research output:

Graphene oxide membranes/filters have attracted significant research attention in the past decade due to its outstanding separation performance. However, instability of graphene oxide (GO) membrane caused by water-induced effects (e.g., swelling) and poor interfacial adhesion to substrate has largely limited its separation performance and long-term applications (e.g., potential GO leakage risks). To address this issue, unlike conventional approaches such as chemical cross-linking, we demonstrated, as a proof-of-concept, a magnetically ultra-stabilized GO-based membrane filter (Figure 1). The GO nanosheets decorated with *in-situ* formed Fe_3O_4 nanoparticles are firstly assembled into a membrane filter *via* vacuum filtration. The filter is subsequently placed in a magnetic field (≤ 0.50 T) created by a permanent magnet and tuned by a customized porous support embedded with magnetizable microparticles. The GOF membrane filter remains intact under harsh ultrasonic destabilization (≥ 20 min duration, 144 W power, 45 kHz frequency) and turbulent hydrodynamic conditions (e.g., crossflow velocity 30 cm/s for at least 7 days), without any deterioration of permeation or rejection performance. Our experimental and theoretical studies highlight the indispensable role of the magnetizable support in achieving such ultra-stabilization, which increases the magnetic flux density gradient and thus the magnetic force by almost one order of magnitude. The GOF membrane filter not only has separation performance comparable to commercial ultrafiltration membranes, but also enables effective inactivation of waterborne pathogens (e.g., *E. coli*). This simple strategy that magnetically stabilizes functional engineered nanomaterials on a substrate surface opens up new opportunities for developing nano-enabled filters, with the minimized leakage and health risks, for point-of-use water purification.

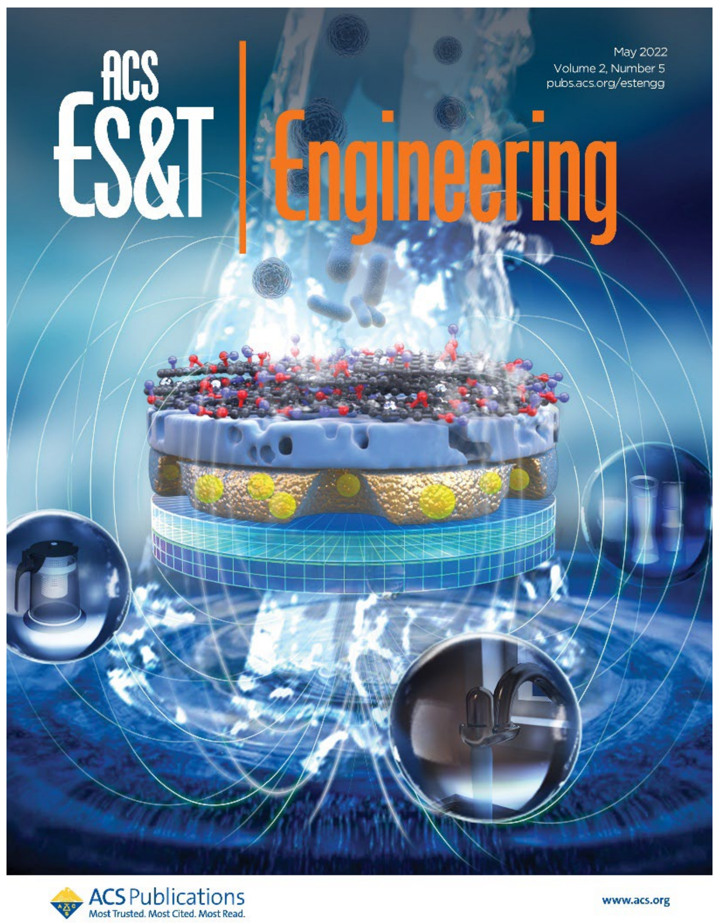

Figure 1. The research work on graphene oxide filter ultra-stabilized in a magnetic field was featured in the supplementary cover of the journal ACS ES&T Engineering.

The successful project outcomes, like the invented technologies and know-how, will help the building/upgrading of drinking water and wastewater treatment facilities in Hong Kong (and the rest of the world) in the future.