Environmental Research, Technology Demonstration and Conference Project

ECF Project:	ECF 2017-81
Project Title:	Development of an energy-saving coating system for sustainable building envelope
Principal Investigator:	Professor Jian-Guo DAI, Department of Civil and Environmental Engineering, The Hong Kong Polytechnic University
Total Approved Grant:	$1,299,240 (ECF & WWGF: 50/50)
Duration:	2/4/2018 to 1/10/2020
Project Status/Remarks:	Completed
Project Scope:	In Hong Kong, approximately 15% of the total electricity consumption is used to cool buildings, indicating that there is a big potential for optimizing the energy efficiency of the building envelope. The building envelopes in Hong Kong are mainly composed of reinforced concrete while the solar reflectance of concrete is approximately 0.4, resulting in a relatively high building surface temperature and consequently increasing the building heat gain and the energy consumption for cooling in summer. In addition, the ageing and aesthetics of buildings are also important issues drawing increasing attention and the deterioration is usually relevant to the water tightness of the building envelope. This project aims to develop a multifunctional coating system for improving the durability and sustainability of concrete building envelope. The system will be featured with the energy-saving, waterproofing and self-cleaning characteristics. The development proposed in the project consists of two steps work - 1. laboratory investigations on the optical and physicochemical properties of the proposed coating system, including the solar reflectance, hydrophobicity and anti-biofouling property; and 2. field exposure evaluation of two model rooms implemented with the developed multifunctional coating system. The project completion will lead to a highly efficient energy saving coating system which contributes to a more sustainable building environment.
Summary of the Findings/Outcomes:	Air conditioning cools down buildings to keep the comfort of human beings inside. However, it leads to excessive electricity consumption, creation of urban heat islands, green-gas emission as well as thermal pollution. In this project, the project team developed an innovative and eco-friendly low cost coating that could keep the building surface cooler than the surrounding ambient air without any electricity input under direct sunlight. The coating was comprised of conventional building materials, including titanium dioxide nanoparticles, fluorescent microparticles, and glass microspheres that were engineered to reflect most of the sunlight hitting the building, minimizing its heat absorption while simultaneously re-emitting infrared

	radiation. The coating was tested on the surface of a model concrete building in the Greater Bay Area. Through this efficient heat exchange with the sky, daytime cooling was enhanced while nighttime cooling was suppressed. The building's internal temperature was maintained at around 23 ℃, even when the outside temperature varied from 24 ℃ to 31 ℃ during the day. The artificially accelerated weathering test, equivalent to exposing the coating to the outdoors for 2 years, showed that the overall cooling performance degrades negligibly within this time frame. Such robustness in unfavorable weather conditions is critical for extending the developed coating to real-world building cooling applications. The new design concept significantly broadens the scope of materials selection, and further reduces building cooling costs. This new coating has great potential for commercialization, enabling a sustainable, passive cooling technology that could help to fight climate change and the global energy crisis.