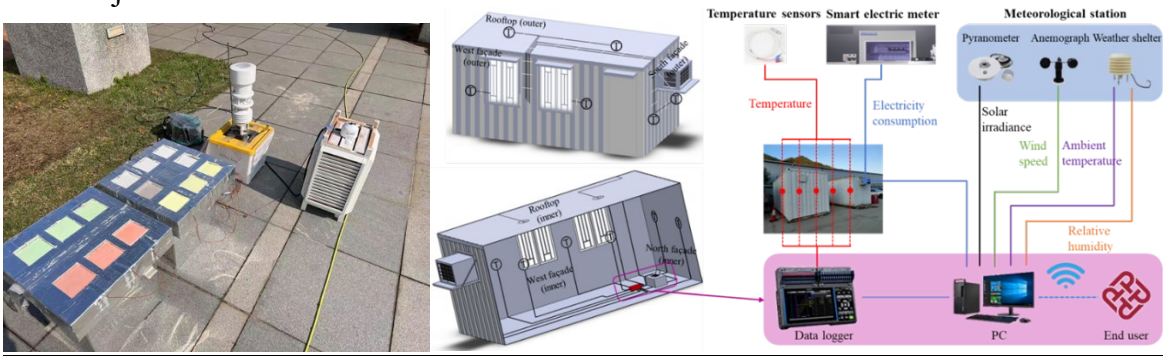
News Article for RISUD Interdisciplinary Research Scheme

		Name	Department
1.	**Principal Investigator**:	Prof. Jian-Guo Dai/ Prof. Vivien Lu	CEE/ BEEE

3. **Project Title:** Multiple Functional Sub-ambient Daytime Radiative Cooling Coating for Sustainable Built Environment

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

Global warming has increased the ambient temperature and the frequency of extreme heat events. Overheating of indoor/outdoor built environment has a severe impact on human thermal comfort and health as well as the energy consumption for air-condition cooling. To reduce the surface temperature of a body, passive radiative cooling (PRC) coating, which exhibits low solar absorption and preferential emission at specific wavelengths corresponding to atmospheric windows, is an attractive option due to its advantages in free-energy consumption and low carbon emission. As a breakthrough of the PRC technology, sub-ambient daytime radiative cooling (SDRC), has emerged recently. It turns the cold of outer space into a renewable resource and can realize a cool surface which temperature is well below the ambient environment under direct sunlight without consumption of any energy. Thus, SDRC technology has opened a new exciting avenue for the global energy efficiency. The interdisciplinary research team proposed for this three-year project aims to further develop the above-mentioned SSRC coating technology for improving the sustainability of built environment, including developing semi-transparent SSRC coating for window applications, inorganic SSRC coating for pavement applications, and polymeric SSRC coating for cooling textiles, based on an in-depth understanding of the underlying scientific mechanisms. During the first year, the project team has arrived at the following three major achievements:



(a) Developed colored coating (2) Field tests in collaboration with EMSD in Tung Chung

Fig.1 Colored radiative cooling coating developed by the research team

(1) Colored radiative cooling coatings have been developed to weaken the possible light pollution arisen from the super-white coating and address the aesthetical issues (Fig.1). Different from the frequently adopted colored pigment solution that may compromise the radiative cooling effect, fluorescent materials have been used to induce the Stokes shift effect and re-emit the absorbed light to photons at longer wavelengths, so as to weaken the

solar heating introduced by coloration. Bilayer structures combining a white bottom layer and a top-colored layer have been applied to improve both solar reflectance and coloration. The developed bilayer colored coating was found to exhibit soft colors while achieving subambient cooling with temperature drops of up to 1.5 ℃ under Hong Kong subtropic weather. In addition, the research team has conducted year-round pilot tests in collaboration with EMSD to demonstrate the field performance of the developed radiative cooling coatings in Tung Chung and Meiwo (**Fig.1**) and found that the radiative cooling coating could save the building energy by more than 20%.

(2) The research team collaborated with CityU to extend the applications of radiative cooling coating in skin electronics (**Fig.2**). A generic thermal management strategy by using an ultra-thin, soft, radiative-cooling coating (USRC), which allows to cool down the temperature in skin electronics through both radiative and non-radiative heat transfer, achieving temperature reduction greater than 56 °C, has been developed, leading to an alternative pathway towards achieving effective thermal management in advanced skin interfaced electronics for multifunctionally and wirelessly operated healthcare monitoring.

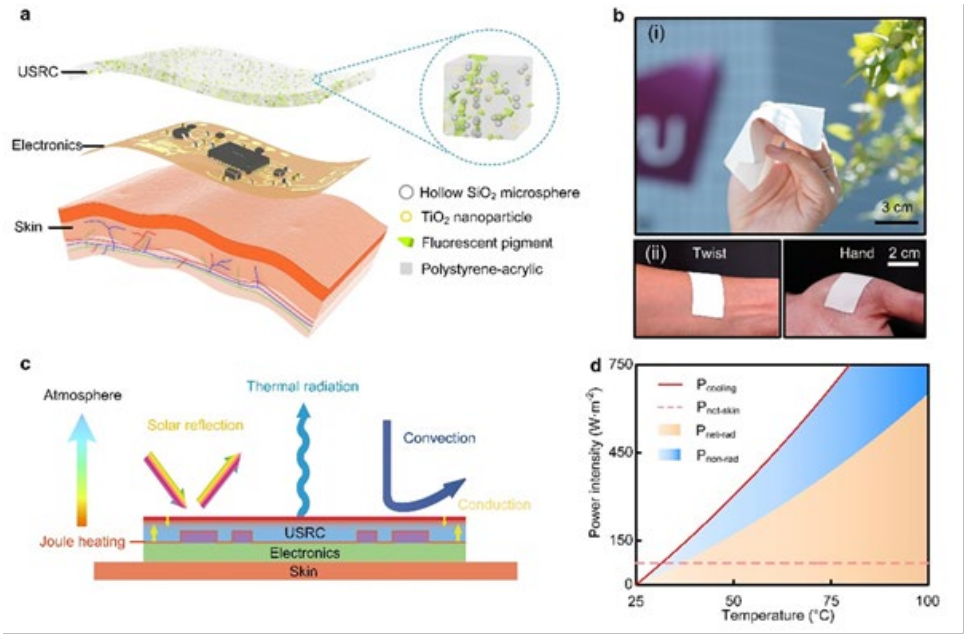


Fig.2 Ultra-thin, soft, radiative cooling coating for advanced thermal management in skin electronics (in collaboration with Co-I Prof DY Lei at CityU of Hong Kong)

(3) An inorganic geopolymer-based radiative cooling coating using red mud, incorporating varying sizes of TiO_2 and hollow glass beads, has been developed. The developed colored coating demonstrates its radiative cooling capability in reducing the surface temperature by harnessing the potential of red mud, and a maximum temperature reduction of 15.9 ℃ under the climate of Hong Kong was achieved when applied on asphalt pavement. The skid resistance, abrasive resistance and adhesion strength of the developed coating could meet the requirements of standards, indicating a great potential for pavement applications.