X-REPORTS IN THERMAL SCIENCE AND ENGINEERING

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Introduction to X-Reports

In recent years, the thermal science and engineering field has greatly expanded and now overlaps with other branches of science, such as physics, material science, biomedical science, nanotechnology, big data, and artificial intelligence. High-level interdisciplinary research demands closer connections and cooperation among global researchers working on a wide range of subjects. Webcam meetings enable global scholars to easily come together to discuss and cooperate on these crucial topics. The X-Reports aim to invite distinguished professionals from various disciplines and countries to give cutting-edge/breakthrough lectures on an interactive platform to encourage new ideas and promote innovations in thermal science and engineering.

5th X-Report

Prof. Christos N. Markides

Imperial College London, U.K.

Title: Exploring the synergies and potential of integrated hybrid photovoltaic-X solar technologies

Time: 15:30-17:30 pm, Nov. 21 (Beijing Time), 2020

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Abstract

"Making solar energy economical" is widely recognized as a global engineering grand challenge with the potential to enable the transition to a clean and sustainable energy future. By far the highest global growth and new investment in renewable technologies is being experienced by the solar sector. Although solar energy can be used to deliver multiple useful energy vectors, most solar technologies are designed for either electrical power generation or hot water provision. In fact, solar systems are projected to deliver the majority of the world's electricity by 2050. An interesting aspect of photovoltaic (PV) panels in particular, is that they are limited in terms of space utilization as a consequence of being typically less than 20% efficient in delivering electricity from the sun's incident energy. Most of the incident solar energy (>70%) is dissipated as heat in the solar cells, thus increasing their operating temperature and leading to a deterioration in their electrical performance.

This considerable quantity of thermal energy, which would otherwise be lost to the environment and wasted, can be harvested and utilized effectively by advanced solar technologies, here referred to as 'hybrid PV-X', that integrate and use synergies in two or more underlying recovery and conversion processes to generate heating, cooling, power and/or clean water with an efficiency that is higher than separate, standalone systems. For example, in PV-thermal (PV-T) collectors, heat is removed from the PV cells by attaching a thermal absorber to the bottom the cells, thus simultaneously producing electricity and useful thermal energy from the same aperture area with a total efficiency (electrical plus thermal) in excess of 70%. The thermal output is usually limited to 60-80 °C, which can be used for domestic hot water or air heating for households or commercial use.

In order to unlock a wider range of applications driven by higher-temperature thermal energy, PV-X solar collector designs have been recently proposed in which spectral-splitting approaches have been applied in order to enable the delivery of useful heat at much higher temperatures, along with other useful energy vectors if this is required by the end user, while not sacrificing the electricity output of the PV cells. In this talk, we will present the underpinning principles of hybrid PV-X solar technologies, recent advances from the material to the system levels, and discuss their potential, along with the challenges and opportunities of further developing these technologies.