Abstract

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Direct thermal charging cell for low-grade-heat-to-electricity conversion

Shien-Ping Feng
The University of Hong Kong, Pokfulam Road,Hong Kong.

Abstract

Low-grade thermal energy is abundantly available in the form of waste heat or in the environment.1, 2 Current technologies using liquid-based thermo-electrochemical cells (TECs) is both cost-effective and scalable for low-grade heat harvesting, and their temperature coefficient (mV/K) is one order of magnitude higher than that of solid- state thermoelectrics.3, 4, 5 The research on TECs has mainly focused on the exploitof thermal gradient or thermal cycle, but the potential of these approaches has been limited by the poor energy conversion efficiency or the need of external electricity. We invent a new direct thermal charging cell (DTCC) for low-grade-heat-to-electricity conversion under an isothermal condition without the aid of the thermal gradient across two electrodes or the thermal cycle.6 The DTCC consists of graphene oxide (GO)/platinum nanoparticles (PtNPs) cathode and polyaniline (PANI) anode and an aqueous Fe^{2+}/Fe^{3+} electrolyte, which can be thermally charged in the open circuit condition. Under isothermal operation, the pouch cell configuration of DTCC with a short distance between two electrodes can be employed for improving electrolyte conductance and rapid heating. Notably, the thermal voltage is generated based on thermo-pseudocapacitive reaction at the GO-electrolyte interface, demonstrating a very high temperature coefficient of 5.0 mV/K and the DTCC exhibits the energy conversion efficiency of 5.19% at 70oC (39.6% of Carnot efficiency). The great applicability of this new thermo-electrochemical system has been demostrated on supplying power for an electrochromic smart window by immerimg DTCCs in a hot water and lightening up an organic light emitting diode by placing DTCCs on a running compressor.

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Biography

Dr. Shien-Ping Feng is currently working at the Department of Mechanical Engineering at The University of Hong Kong, Pokfulam Road, Hong Kong doctoral fellow at the Mechatronic Engineering.

