



## Direct Thermal Charging Cell for Low-Grade-Heat-to-Electricity Conversion

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### Abstract:

Low-grade thermal energy is abundantly available in the form of waste heat or in the environment.<sup>1, 2</sup> 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.<sup>3, 4, 5</sup> The research on TECs has mainly focused on the exploit of 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.<sup>6</sup> The DTCC consists of graphene oxide (GO)/platinum nanoparticles (PtNPs) cathode and polyaniline (PANI) anode and an aqueous Fe<sup>2+</sup>/Fe<sup>3+</sup> 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 70°C (39.6% of Carnot efficiency). The great applicability of this new thermo-electrochemical system has been demonstrated on supplying power for an electrochromic smart window by immersing DTCCs in a hot water and lightening up an organic light emitting diode by placing DTCCs on a running compressor.

### Biography:

Shien-Ping Feng is an Associate Professor in the department of Mechanical Engineering at Hong Kong University. He received his Ph.D. in chemical engineering from National Tsing-Hua



University (2003-2008), and was a postdoctoral associate at MIT (2009-2011) prior to his appointment at Hong Kong University. He was a principal engineer, section manager and technical manager at Taiwan Semiconductor Manufacturing Company (2001-2008), and a deputy director at Tripod Research Center (2008-2009). His current research is focused on electrochemical processing and interfacial characterization of nanostructured materials, and their applications on energy conversion and storage

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