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Energy, Sustainability, and Climate Change

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This special issue on "Energy, Sustainability, and Climate Change" presents 11 peer-reviewed journal papers including three reviews from outstanding authors worldwide. These novel studies cover various topics related to energy, sustainability, and climate change such as thermal management, batteries for energy storage, energy harvesting, and solar energy conversion.

Thermal management improves the efficiency of systems or prevents unnecessary energy consumption. In particular, controlling the temperature of systems in various applications, ranging from smart buildings to the human body (e.g., to cool down hot system or vice versa). Improving heat flow controllability, insulation or conduction of the heat can reduce the energy consumption for temperature control.

This special issue presents a research article and a review of how to manage heat flow of the system to control the temperature with minimum energy consumption. Pooi See Lee and co-workers (article 2100172) demonstrated inkjet printing to fabricate a scalable electrochromic smart window (900 cm^2). It allows ~60 % optical contrast within several tens of seconds with long optical transmittance retention. Up to 42.3 % heat gain reduction on sunny days is expected to save 28.9 % of cooling load to maintain an indoor temperature of 25 °C. Lei Wei and co-workers (article 2100168) reviewed the fundamental principle of radiation cooling and how metamaterials are used for radiative cooling. Then, they introduced micro and nanostructured fiber fabricated by thermal drawing techniques for large-scale manufacturing of metafibers for radiative cooling. Finally, they reviewed the various potential applications of textiles for personal cooling.

Batteries play a key role in tackling sustainability and climate change. The high energy density of a battery is essential for eco-friendly electric vehicles. As the electric vehicle market grows, further improvement of fast charging, cost, and safety of a battery is required as well as its higher energy density for longer traveling distances. Large scale batteries mitigate the intermittency of renewable energy sources. To meet the various demands of large-scale energy storage such as low cost and safety, many kinds of electrochemical systems and materials have been suggested. This special issue presents two research articles and a review about the next generation batteries to meet the above demands. Jason B. Harper, Dong Jun Kim, and co-workers (article 2100164) investigated the electrochemical stability of aluminum metal anodes in ionic liquid electrolytes. Rechargeable aluminum batteries are considered as one of the promising large scale and cost-effective energy storage systems. This study used X-ray computed tomography to identify deterioration of the surface morphology of the aluminum metal anode upon reversible electrochemical deposition/dissolution of aluminum. It reveals the formation of "dead aluminum", which causes cell failure after repeated cycle. Yi Yu and co-workers (article 2100160) studied the various factors of electrochemical liquid cell for in-situ transmittance electron microscopy (TEM) for successful operation of the cell during observation. The four common problems in electrochemical liquid cell experiment for in-situ TEM observation are the tube residual, contamination of the chips, bubbles trapped in the cell, and unstable open circuit potential. The understanding of these problems will improve the success rate of the observation of the electrochemical cell in in-situ TEM and help to understand microscopic behavior of the battery electrode materials. Vipin Kumar and co-workers (article 2100157) reviewed sulfur cathode electrodes for high energy density rechargeable batteries. Sulfur provides this specific capacity (~1675 mAh g^{-1}) and low cost for its high natural abundance (~953 ppm) as a next generation battery electrode. The review presents various usages of sulfur cathodes with high capacity metal anodes such as sodium, magnesium, and aluminum, with the deeper insights of the electrochemical performance of metal–sulfur based electrochemical systems as post lithium-ion batteries.

This issue presents three papers about various energy harvesting. Seok Woo Lee and co-workers (article 2100176) present an electrochemical system for low-grade heat harvesting and improvement of thermopower using tuning of hydration entropy of ions. The mixing of organic molecules in an aqueous electrolyte changes the hydration status of cation. It causes change of dehydration entropy and improves thermopower when the cation is electrochemically intercalated into the ion hosting electrode material. This study provides important parameters to determine thermopower of electrochemical low-grade heat harvesting and insights on how to improve it. Tzu-Yin Liu, Han-Yi Chen, and co-workers (article 2100163) introduce *Trapa natans* husk (TNH) to obtain low-cost nanoporous carbons for microbial fuel cells (MFCs). Its better bacterial adhesion and electrochemical activities allows higher average power density than commercial activated carbon electrodes. This study demonstrates the utilization of TNH for supercapacitors for energy storage. TNH electrodes provide biofriendly high-power sustainable energy generation and storage. Jiaqing Xiong and co-workers (article 2100161) review utilization of cellulose for sustainable

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DOI: 10.1002/aesr.202200031

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triboelectric nanogenerators (TENGs). At first, it summarizes the general information of cellulose such as sources, structures, and its modification. In the second part, more specific properties of cellulose are introduced for TENG applications. Finally, various demonstrations of TENGs using cellulose and its performance evaluation is introduced. This review will provide insight on how natural resources can be utilized for kinetic energy harvesting.

The origin of most of the energy sources is radiation from the sun. So, it is very important to utilize the light to reduce carbon emission from fossil fuels and slow down climate change. The last three papers in this issue introduces how to utilize light in various way. Raju Kumar Gupta and co-workers (article 2100162) investigated modification of TiO_2 for degradation of pharmaceutical pollutants under visible light irradiation. The pharmaceutical industry produces chemical pollutants in wastewater. Hence, it is important to treat them with high efficiency. This paper introduces a simple hydrothermal method to synthesize defective TiO_2 spheres and demonstrates how the modified TiO_2 is working as a highly efficient photocatalyst to decompose pharmaceutical pollutants. Deqian Zeng, Wee-Jun Ong, and co-workers (article 2100210) reported highly efficient photocatalytic H_2 generation using a metal selenide semiconductor photocatalysis with tunable energy band structures. Metal selenide semiconductors in photocatalysis are suffering from low activity and poor stability. The balancing between the bandgap and the conduction band potential of $Zn_{0.5}Cd_{0.5}Se$ allows more photogenerated electrons and faster charge carrier separation efficiency. It provides a new strategy of synthesis of metal selenide for various photocatalytic applications. Im Doo Jung, Il Jeon, and co-workers (2100155) studied environmentally friendly organic dopants for carbon nanotube-based planar heterojunction silicon solar cells. Doping of lactic acid on carbon nanotube film achieves large decreases of sheet resistance with long term stability. The antireflection effect of lactic acid noticeably improves efficiency.

This issue could not be made without the authors' contribution of research article and review papers. We hope that this issue sheds light on various frontiers related to energy, sustainability, and climate change and adds to the effort in solving the current challenges in these fields.

Acknowledgements

P.S.L. acknowledges the support by the Singapore-HUJ Alliance for Research and Enterprise (SHARE), Campus for Research Excellence and Technological Enterprise (CREATE), Singapore, National Research Foundation, and Academic Research Fund Tier 1 Grant. No. RG64/21, Ministry of Education, Singapore. S.W.L. acknowledges the support by Academic Research Fund Tier 2 from the Ministry of Education, Singapore under Ref. No. MOE2018-T2-1-045.

Author contributions

P.S.L. and S.W.L. wrote the draft and revised it together. Both authors gave approval to the final version of the manuscript.

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