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Editorial: Energy materials based novel solar thermal applications

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Editorial on the Research Topic
Energy materials based novel solar thermal applications

Introduction

With increasing apprehensions over global warming and environmental issues, the need to develop renewable energy is becoming more critical to secure our future energy needs. Solar energy is the most abundant source of energy and is easily accessible. However, making efficient use of solar energy is not an easy task. Energy materials, especially in their micro and nanoscale, have an excellent potential for absorbing, transferring, and storing solar energy when they are dispersed in an aqueous medium embedded on a surface. Various applications relevant to heat transfer, energy conversion, and storage have increasingly used nanoparticles due to their ability to absorb, store, and carry heat. However, successful deployment of materials in energy harvesting and storage applications must also consider some of the very fundamental challenges, including but not limited to sedimentation, entrainment, stability, and life of these potential energy materials. This Research Topic is designed to attract original research and review articles on AI based solar energy optimization, challenges, innovative applications and numerical studies in materials for energy capture, transfer, and storage to have a safe future in terms of solar energy utilization.

This Research Topic of 'Frontiers in Energy Research' has managed to attract and compile 11 high quality original research and review articles from passionate researchers and academicians from prestigious institutions in Australia, South Korea, China, Qatar, Pakistan, Korea, Saudi Arabia, Egypt, Oman, United Arab Emirates, Uganda, and Brazil. The guest editors are indebted to all the contributing authors to make this Research Topic successful. Figure 1

FIGURE 1
Integration of energy materials for novel solar thermal, PV and PVT applications.

Solar PV system evaluation and performance improvement

The integration of solar energy with the existing conventional electrical and thermal systems is revolutionizing to ensure the availability and augment the performance of the system to combat the exponentially increasing energy demands. Khan et al. proposed a systematic allocation of energy resources using the slice-based mechanism in a smart grid environment. This need-based approach is used to allocate energy resources not only helps save energy resources for future use but also improves the life of the power grid and is validated on real time conditions. Asim et al. presented an experimental validation of the numerical model used for the performance prediction of solar photovoltaic cells. They considered the varying and constant coefficients with the incident angle of the solar radiations in the energy balance equations to obtain the time-based electrical power of the solar cells. The model data of electrical power based on the optical-thermal model and classical thermal model was experimentally validated for the installed solar PV system.

The dust particles in the air keep accumulating on the surface of the PV panels and thus result in a reduction in their efficiency. Tamoor et al. investigated the impact of dust pollutants on the performance of PV systems and concluded that the efficiency of PV systems with dusty surfaces is reduced by up to 10.68% and must be taken care of while deciding the targets for solar electric power in the regions with higher levels of particulate matter.

Razzaq et al. explored that energy consumption in buildings can be reduced by 34% and the carbon footprints can be lessened by 32. 8 metric tons per year by retrofitting an existing building and integrating solar energy to make it a net zero energy building. An indirectly edited study by Khan et al. on exciting deep learning and ensemble learning mechanism for early detection of severe acute respiratory syndrome was published in a sister journal. Syed et al. conducted yet another interesting research to boost the photocatalytic efficiency of solar cells using carbon quantum dots to scatter the Sun radiations for higher current density.

Performance of solar thermal collectors

Solar thermal energy can be used more conveniently than solar electric energy and has even higher conversion efficiency. Using nanosized energy materials in solar thermal collectors has revolutionized this side of solar energy. Farhan et al. conducted an experimental investigation of a hybrid nanofluid based non-tracking compound parabolic solar collector. They explored that the collector efficiency can be enhanced up to 31.5% by suspending various energy materials of nanoscale and their hybrids at different volume concentrations and flow rates.

Ditta et al. interestingly integrated a solar thermal collector with the desiccant indirect evaporative system to produce a cooling effect for a dehumidified place. The integration resulted in a maximum efficiency of 56% at a maximum cooling capacity of the system at 4.6 kW. Rehman et al. outlined an inclusive review of the performance improvements of microchannel heat sinks through various techniques including the shapes of the microchannels, flow conditions, numerical methods, and the materials for the manufacturing of these channels.

Energy materials and photovoltaic-thermal hybrid systems

A solar photovoltaic system can be combined with a solar thermal system for an integrated performance gain. Such work is conducted by Usman et al. where they enhanced the efficiency of thermophotovoltaic (TPV) cells based on various design configurations by deploying existing photon recycling technologies. Using magnesium oxide as a spectral filter with a back surface reflector, they attained an efficiency of 35% of the TPV system at 2,200 K emitter temperature. Martins et al. exhibited an interesting numerical work on the integration of compound parabolic solar concentrators based hybrid photovoltaic-thermal (PVT) system to generate electricity during the day and night times combating the intermittency of solar energy. It was concluded that a backup of 1 h and 20 min can be set up for the hybrid cycle to generate 1,580 W power at 2,600 rpm and evaporation temperature of 80°C using R245fa as working fluid and urea-NaCl mixture for thermal energy storage in the absence of Sun.

Conclusion

Solar energy together with energy materials has enormous potential to meet exponentially increasing energy demands. This Research Topic sums up 11 high quality articles on emerging technologies to integrate solar energy into new and existing systems for augmented performance. The articles

present various technologies and applications of novel energy materials to harness solar energy for thermal and electric energy needs. Despite the high rated benefits of solar energy and nanomaterials, challenges like intermittency of solar potential, low efficiency of PV systems, high costs, and instability of the energy materials over prolonged times are to be taken care of for efficient deployment of solar energy.

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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