frontiers | Frontiers in Energy Research

EDITORIAL
published: 10 May 2022
doi: 10.3389/fenrg.2022.921533

Editorial: Scalable Nanostructured Thin Films for Efficient Solar Energy Harvesting

Yang Li[1]*, *Feng Yan*[2], *Xiuqiang Li*[3] *and Feng Cao*[4]

[1]Department of Mechanical and Aerospace Engineering, The Hong Kong University of Science and Technology, Hong Kong SAR, China, [2]Department of Metallurgical and Materials Engineering, The University of Alabama, Tuscaloosa, AL, United States, [3]Key Laboratory for Intelligent Nano Materials and Devices of Ministry of Education, Institute for Frontier Science, Nanjing University of Aeronautics and Astronautics, Nanjing, China, [4]School of Science, Harbin Institute of Technology, Shenzhen, China

Keywords: solar energy, selective absorber coatings, solar cells, smart windows, steam generation

Editorial on the Research Topic

Scalable Nanostructured Thin Films for Efficient Solar Energy Harvesting

Solar energy with the largest abundance among all renewables has been widely harvested through various technologies including solar-thermal conversion, photovoltaics, and solar chemical processes. The harvested clean energy has powered the world in numerous fields, including space heating and cooling, desalination, electricity generation, and fuel production. Since 2010, the total installed capacity of solar modules and solar-thermal panels has rapidly increased and reached more than 707 MW by 2020. However, the share of solar energy in global primary energy consumption is only 1.1% in 2020. In this context, it is urgent to accelerate the large-scale deployment of current solar technologies and develop new solar harvesting processes.

Nanostructured thin films have been widely used in solar technologies, enabling high-efficiency, stable, and versatile solar energy harvesting devices. On the one hand, emerging solution-processed thin-film solar cells based on nanostructured materials such as halide perovskites and organic components have recently been intensively investigated due to their low cost and great scalability. On the other hand, solar-thermal energy conversion, which is a historic and widely used technology, benefits from spectrally selective absorbers based on nanostructured thin films, which are key components in solar thermal systems to maximize the conversion efficiency. In addition to selective absorbers, functional nano-structured thin films play important roles in specific solar thermal applications, such as steam generation, solar harvesting windows, anti-icing, and catalysis. In particular, nanostructured thin films with great scalability are highly desired to further push the largescale deployment of solar technologies forward. This research topic features three review papers and two research papers that focus on selective solar absorber, solar steam generation, and smart windows, which aim to further promote the development of solar technologies.

In this research topic, a research article contributed by Wang et al. (DOI: 10.3389/fenrg.2021.787237) developed an all-ceramic selective solar absorber based on ultra-high temperature ceramics ZrC and the quasi-optical microcavity (QOM) optical structure. The fabricated all-ceramic absorber exhibited a high solar absorptance of 96.4% and a relatively low thermal emittance of 0.16. Moreover, the absorber can maintain its superior performance even at 900°C in vacuum for 100 h. Another research article contributed by Shi et al. (DOI: 10.3389/fenrg.2021.795261) demonstrated a SiO_2/Si_3N_4/SiO_2/ITO/Cr multilayer selective solar absorber. The ceramic-based selective absorber achieved a high solar absorptance up to 90% while keeping a relatively low infrared emittance around 50% for temperature change between 600 and 900°C. Most importantly, it was potentially stable at high temperatures even in ambient air without the need for vacuum generation. The two all-ceramic absorbers with excellent performance in both spectral selectivity and thermal stability are

OPEN ACCESS

Edited and reviewed by:
Michael Folsom Toney,
University of Colorado Boulder,
United States

Correspondence:
Yang Li
ylidn@connect.ust.hk

Specialty section:
This article was submitted to Solar Energy, a section of the journal Frontiers in Energy Research

Received: *16 April 2022*
Accepted: *25 April 2022*
Published: *10 May 2022*

Citation:
Li Y, Yan F, Li X and Cao F (2022) Editorial: Scalable Nanostructured Thin Films for Efficient Solar Energy Harvesting. Front. Energy Res. 10:921533. doi: 10.3389/fenrg.2022.921533

highly desirable in high-temperature solar thermal technologies, such as concentrating solar power. A mini-review paper contributed by Wang (DOI: 10.3389/fenrg.2021.789917) summarized the recent progress in selective solar absorbers, especially the all-ceramic absorbers, and presented an outlook for their structural design strategies.

In addition, interfacial solar steam generation has attracted intensive research interest due to its high energy conversion efficiency, low cost, and environmental compatibility. However, most interfacial solar steam generation devices suffer from salt clogging in the water channels and on the water/air interface. In this research topic, a review contributed by Yu et al. (DOI: 10.3389/fenrg.2021.721407) summarized state-of-the-art research on various salt-resistive materials and structures. Four representative anti-salt clogging strategies were presented and compared in detail. On the other hand, smart windows that regulate the transmitting of solar energy into the building by changing the optical spectra of glasses have been another hot topic. A review paper contributed by Wang et al. (DOI: 10.3389/fenrg.2021.800382) surveyed the recent advance of thermochromic materials for smart windows in terms of operation, performance, and potential for commercialization. This mini review can help both laymen and experts have a quick access to the breakthroughs and the challenges in this area.

In summary, five articles in total from the United States and China were collected to show the recent advances in scalable nanostructured thin films for efficient solar energy harvesting. This research topic covers the selective solar absorbers for solar-thermal conversion, salt-resistive structures for solar steam generation, and thermochromic glasses for smart windows, which are all research hotspots in solar technologies. We believe that these articles will be helpful for the rapid development and wide deployment of solar energy harvest and conversion technologies.

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.