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ADVANCES IN NUMERICAL MODELLING OF MULTIPHASE TRANSPORT PHENOMENA IN HIGH-TEMPERATURE SOLAR THERMAL SYSTEMS

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ABSTRACT High-flux solar irradiation obtained with optical concentrators is a viable source of clean process heat for high-temperature physical and chemical processing. Traditionally, the progress in concentrating solar thermal technologies has been driven by advancements in concentrated solar power, in particular in the context of large-scale dispatchable power generation. Solar thermochemistry is concerned with direct thermochemical production of chemical fuels and materials processing, without intermediate electricity generation, promising high energy conversion efficiency. In this presentation, recent advances in numerical modelling of multiphase transport phenomena in high-temperature solar thermal systems are discussed. Two types of multiphase flows recently investigated for efficient collection, conversion and storage of concentrated solar energy are focused on: (1) particle–gas flows featuring polydisperse particle transport under direct concentrated solar irradiation, and (2) boiling sodium flows. Governing equations and numerical solution methods are elaborated along with selected results obtained for free-falling particle and liquid sodium solar receivers. Examples of on-sun demonstration and pilot systems and the potential for improving the efficiency of solar energy collection, conversion and storage processes are discussed.

SHORT BIOGRAPHY Wojciech Lipiński is a professor at the Cyprus Institute. He obtained his Master of Science degree in Environmental Engineering from Warsaw University of Technology (2000), doctorate in Mechanical and Process Engineering from ETH Zurich (2004), and habilitation in Energy Technology from ETH Zurich (2009). He previously held academic positions at ETH Zurich (2004–2009), the University of Minnesota (2009–2013), and the Australian National University (2013–2021). Prof. Lipiński's research interests encompass optical, thermal and chemical aspects of solar energy science and technology. His basic research focuses on advances in transport and reactive flow phenomena, in particular for problems with significant radiative transfer effects. His applied research primarily underpins developments in concentrated solar thermal energy for power generation, processing of fuels and materials, and environmental separations. Prof. Lipiński is currently serving on editorial boards of *Solar Energy*, *Journal of Quantitative Spectroscopy and Radiative Transfer*, and *Thermopedia*. He is involved, among others, in the International Centre for Heat and Mass Transfer, the Eurotherm Committee, and the American Institute of Chemical Engineers.