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EDITORIAL

Solid oxide fuel cells and electrolysis cells: selected aspects, novel materials and challenges

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Technologies using solid oxide fuel cells (SOFCs) and solid oxide electrolysis cells (SOECs) are already mature enough, which makes it possible to consider them as an important part of the future hydrogen production and hydrogen-based electric power generation. The advantages of SOFCs include a high energy-conversion efficiency, a possibility to recover exhaust heat, flexible modulability, environmental safety, and fuel flexibility including the prospects to directly operate on light hydrocarbons and biogas. The former advantages are also characteristic for SOECs used to produce high-purity hydrogen from steam. Important applications of SOFCs/SOECs combined with the chemical energy storage systems are related to balancing of the power-generation and consumption peaks, which is often necessary for solar, wind and nuclear power plants. The SOFC and SOEC technologies may also find a number of other environmentally friendly applications. For instance, SOECs can be used for CO_2 electrolysis, enabling carbon dioxide conversion into value-added chemicals and reducing emissions in the atmosphere. The SOFC-based power and heat cogenerators can be used for utilization of the calorific waste gases produced by industry and municipal solid waste landfills, again decreasing environmental threats.

This brief introduction explains a permanent attention and a high priority given by the editorial team of the Journal of Solid State Electrochemistry to most aspects of SOFCs/SOECs developments, including interdisciplinary scientific and technological fields. Since its foundation in 1997, the Journal publishes a great number of reviews and research articles dealing with solid oxide electrolytes, SOFC/SOEC electrodes and electrochemical reaction mechanisms, modelling of the electrochemical cells and devices on their basis, short- and long-term tests, poisoning and degradation phenomena, and construction components such as sealants, current collectors and catalysts. In fact, the first issue of the Journal was started by a comprehensive review on the history of solid oxide fuel cells [1]. This publication inspired a series of surveys centered on the research and developments of oxygen ion conductors in the former Soviet Union, when a variety of SOFC/SOEC materials and their electrochemical behavior were reviewed [2–5]. Numerous reviews published during the same decade are not directly related to SOFCs/SOECs but contribute to deeper understanding of the key physicochemical processes, important methodological approaches and other solid oxide electrolyte appliances. These include, in particular, diverse diffusion and electron transfer concepts [6–8], metal oxidation and corrosion [9], solid-electrolyte sensors and relevant interfacial phenomena [10, 11]. One should separately note several methodological reviews centered on the oxygen isotope exchange and diffusion analysis [12], coulometric analysis using solid oxide electrolytes and related techniques [13, 14], epitaxial thin-film deposition for SOFC fabrication [15], non-Faradaic electrochemical modification of catalytic activity [16], and ammonia synthesis in SOEC-type reactors [17]. Continuing this publication strategy in 2000s and 2010s, significant emphasis was also given to the conventional and novel electrode materials for SOFCs/SOECs, their transport properties, relevant defect interactions and electrochemical performance [18–22]. Other specialized surveys in this area were focused on the glass-ceramic sealants for fuel cell applications [23], carbon-fueled SOFCs as a direction in the developments of direct carbon fuel cells [24], and SOFC degradation mechanisms [25]. All these reviews are now included in the respective collection prepared by the editorial team [26].

In connection with the collection of reviews, the present topical issue of the Journal contains a selection of experimental and computational works reflecting recent trends and challenges in the field of SOFC/SOEC developments. The

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focus was placed, first of all, on materials science-related aspects, including the studies of oxygen ion- and proton-conducting solid oxide electrolytes, mixed ionic-electronic conductors, catalysts, and perovskite/like compounds promising for the use in electrode systems. The aspects regarding to the cell architectures, fabrication methods and operation regimes were addressed as well. Having presented a brief introduction to this collection of reviews and new topical issue, the editorial team trust that the readers may find the contents interesting and stimulating.

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