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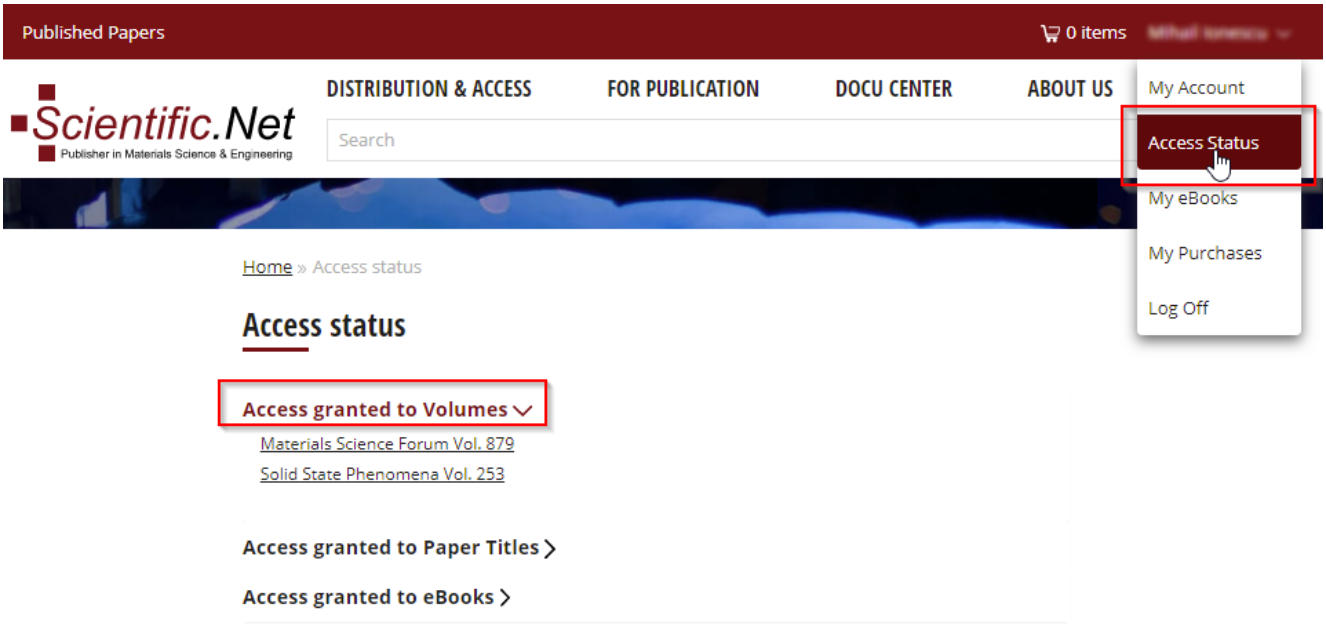

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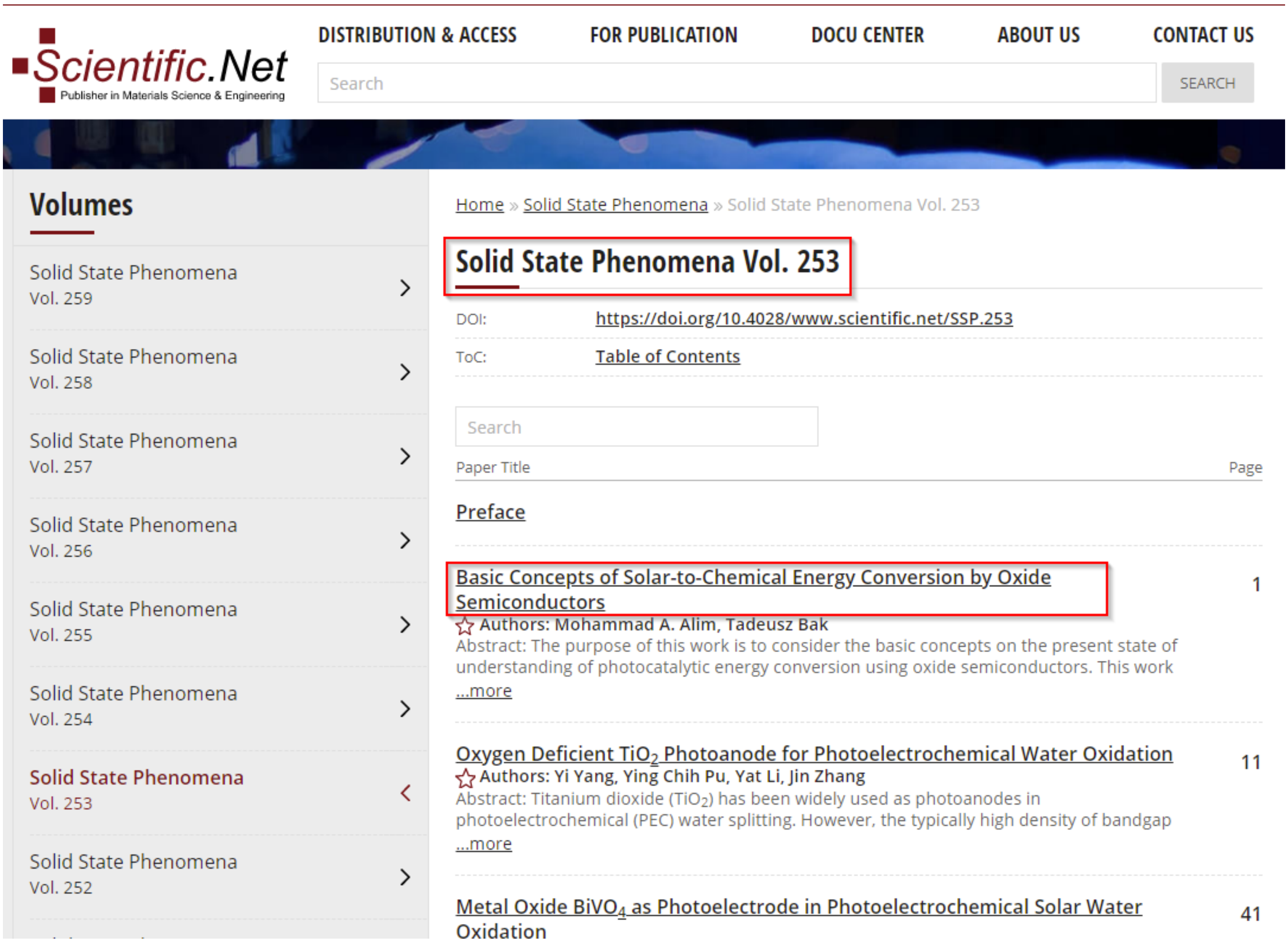

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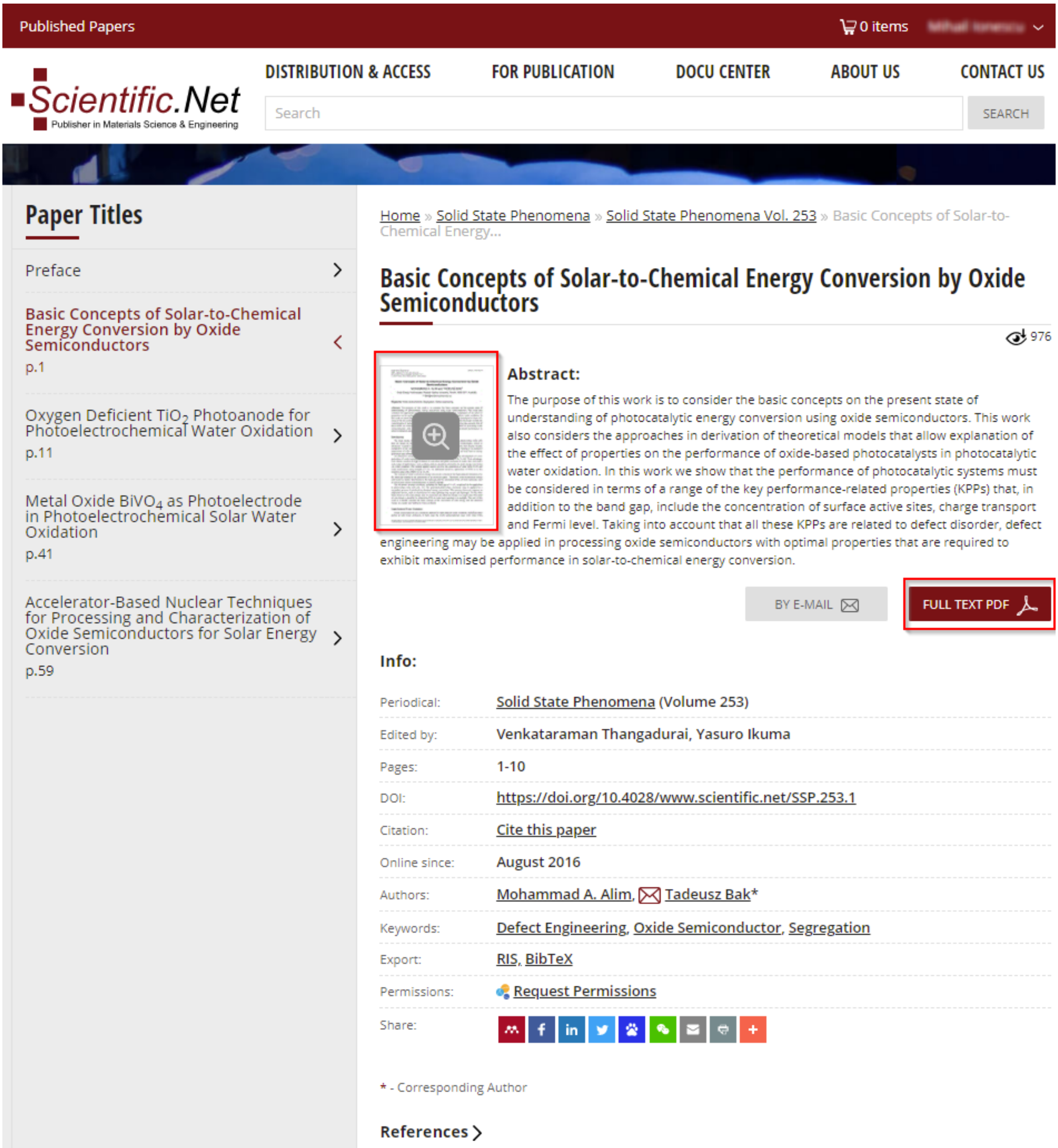

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Basic Concepts of Solar-to-Chemical Energy Conversion by Oxide Semiconductors

976

Abstract:

The purpose of this work is to consider the basic concepts on the present state of understanding of photocatalytic energy conversion using oxide semiconductors. This work also considers the approaches in derivation of theoretical models that allow explanation of the effect of properties on the performance of oxide-based photocatalysts in photocatalytic water oxidation. In this work we show that the performance of photocatalytic systems must be considered in terms of a range of the key performance-related properties (KPPs) that, in addition to the band gap, include the concentration of surface active sites, charge transport and Fermi level. Taking into account that all these KPPs are related to defect disorder, defect engineering may be applied in processing oxide semiconductors with optimal properties that are required to exhibit maximised performance in solar-to-chemical energy conversion.

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Info:

Periodical:	Solid State Phenomena (Volume 253)
Edited by:	Venkataraman Thangadurai, Yasuro Ikuma
Pages:	1-10
DOI:	https://doi.org/10.4028/www.scientific.net/SSP.253.1
Citation:	Cite this paper
Online since:	August 2016
Authors:	Mohammad A. Alim, Tadeusz Bak*
Keywords:	Defect Engineering, Oxide Semiconductor, Segregation
Export:	RIS, BibTeX
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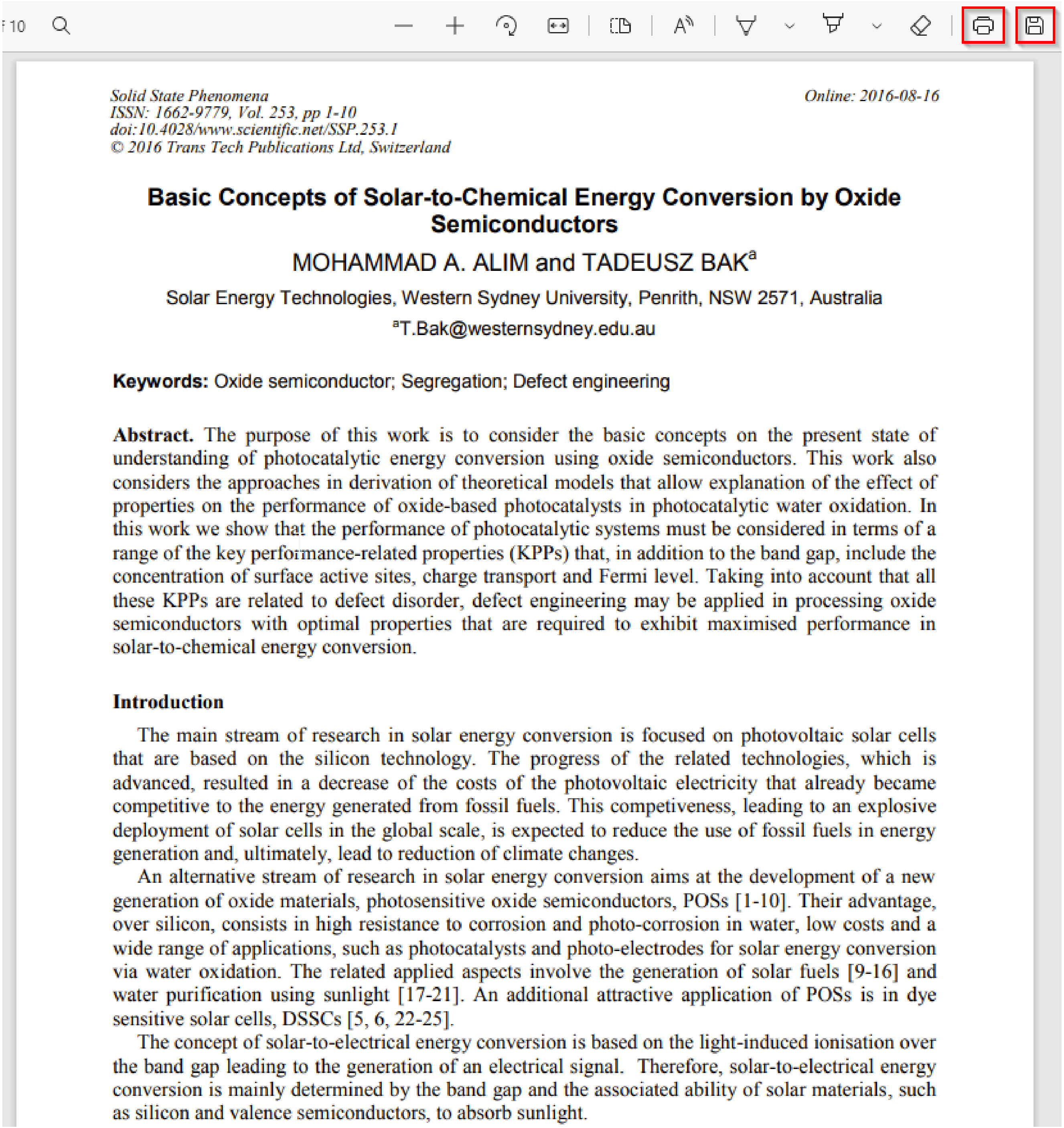

Solid State Phenomena
ISSN: 1662-9779, Vol. 253, pp 1-10
doi:10.4028/www.scientific.net/SSP.253.1
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Online: 2016-08-16

Basic Concepts of Solar-to-Chemical Energy Conversion by Oxide Semiconductors

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Keywords: Oxide semiconductor; Segregation; Defect engineering

Abstract. The purpose of this work is to consider the basic concepts on the present state of understanding of photocatalytic energy conversion using oxide semiconductors. This work also considers the approaches in derivation of theoretical models that allow explanation of the effect of properties on the performance of oxide-based photocatalysts in photocatalytic water oxidation. In this work we show that the performance of photocatalytic systems must be considered in terms of a range of the key performance-related properties (KPPs) that, in addition to the band gap, include the concentration of surface active sites, charge transport and Fermi level. Taking into account that all these KPPs are related to defect disorder, defect engineering may be applied in processing oxide semiconductors with optimal properties that are required to exhibit maximised performance in solar-to-chemical energy conversion.

Introduction

The main stream of research in solar energy conversion is focused on photovoltaic solar cells that are based on the silicon technology. The progress of the related technologies, which is advanced, resulted in a decrease of the costs of the photovoltaic electricity that already became competitive to the energy generated from fossil fuels. This competiveness, leading to an explosive deployment of solar cells in the global scale, is expected to reduce the use of fossil fuels in energy generation and, ultimately, lead to reduction of climate changes.

An alternative stream of research in solar energy conversion aims at the development of a new generation of oxide materials, photosensitive oxide semiconductors, POSs [1-10]. Their advantage, over silicon, consists in high resistance to corrosion and photo-corrosion in water, low costs and a wide range of applications, such as photocatalysts and photo-electrodes for solar energy conversion via water oxidation. The related applied aspects involve the generation of solar fuels [9-16] and water purification using sunlight [17-21]. An additional attractive application of POSs is in dye sensitive solar cells, DSSCs [5, 6, 22-25].

The concept of solar-to-electrical energy conversion is based on the light-induced ionisation over the band gap leading to the generation of an electrical signal. Therefore, solar-to-electrical energy conversion is mainly determined by the band gap and the associated ability of solar materials, such as silicon and valence semiconductors, to absorb sunlight.

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