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ORIGINAL PAPER

Modern Aspects of Energy and Materials

Stephen John Clarson[1,2]

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Abstract Silicon (Si) plays a central role in the emerging energy technologies of the twenty first century. Silicon is directly involved in energy production, in energy storage, in energy distribution and in energy utilization. Silicon also plays a role in control systems, in energy network management, in energy related information technology and in all aspects of risk assessment & risk management as they apply to the supply of energy and to the use of energy. Various themes from the above topics are described herein.

Keywords Solar power · Photovoltaics · Batteries · Sustainability · Risk assessment · Risk management · Energy · Silicon · Silica · Silicones · Silanes · Life

1 Introduction

Without energy (in all of its various forms) there would be no life on Earth. As the population of humans on this planet grows, then mankind faces challenges of how to generate, of how to store, of how to transmit and of how to utilize energy (see Fig. 1).

✉ Stephen John Clarson
stephen.clarson@uc.edu

1 Rhodes Hall, Clifton Avenue, Cincinnati, OH 45221, USA

2 Wycliffe Hall, Banbury Road, Oxford, OX2 6PW, UK

As silicon and oxygen are so abundant in the Earth's crust, one can present the case that silicon (Si) is the most important and the most sustainable element of the ***Periodic Table*** [1]. As the portfolio of available energy systems grows, silicon-based energy technologies are playing an increasingly important role in providing solutions to mankind's energy needs. With this in mind, Iacono and Clarson [2] reviewed ten articles [3–14] that had been published in ***SILICON*** in the time period 2009-2014. These articles were ones that had covered various aspects of silicon-based energy technologies (see Fig. 2).

2 Energy and Materials I

In the special issue of ***SILICON*** from 2015 entitled ***Energy and Materials I***, thirteen contributions were published that covered various aspects of silicon-based materials and of silicon-based technologies for energy applications [15–27]. These energy systems were principally based upon silicon solar cells (see Fig. 3).

3 Energy and Materials II

In this second ***SILICON*** special issue on ***Energy and Materials***, the fifteen articles presented herein cover silicon solar cell systems [28–38], silicon battery systems [28, 29, 40] and radiation effects on silicon-based materials [28, 41–43]. They are each briefly reviewed in this concise overview. An obituary of a dear colleague is also included at the end [44]. The contents of the fifteen ***Energy & Materials*** articles are introduced below.

Fig. 1 The Sun sending mankind its energy in the Winter season as seen in Ohio, USA. (Photograph by Dr. Stephen John Clarson)

4 Solar Cells

Srinivasan and Ramaswamy [29] report a computational study which addresses melt fluctuations during the solidification process that is used for producing multi-crystalline silicon (mc-Si) for solar cell applications. Al-Taay, Mahdi, Parlevliet and Jennings [30] report on the structure, surface morphology and photovoltaic properties of silicon nanowire p-n solar cells. The efficiencies were found to depend on the catalysts used. The Zn-catalyzed SiNW solar cells showing an efficiency of 1.01 % and the Au-catalyzed SiNW solar cells showing an efficiency of 0.67 %. Ahmadiv and and Pala [31] report on the optical properties of parabola nanocones having a cover layer of crystalline silicon (c-Si) and an Ag core. These materials were designed to be antireflective layers in photovoltaic and in solar cell applications. Rayerfrancis, Bhargav, Ahmed, Bhattacharya, Chandra and Dhara [32] report on the DC magnetron sputtering of aluminium doped zinc oxide (AZO) thin films for transparent conduction oxide (TCO) and back reflector applications with silicon solar cells. The AZO back reflector material was seen to increase the solar cell efficiency from 6.4 % to 7.8 %. El-Amin [33] reports on the acid etching of multicrystalline silicon (mc-Si) using $HF/HNO_3/H_2O$ for the texturing of silicon solar cell materials. After acid etching, an improvement of the short circuit current and of the conversion efficiency was observed. El-Amin [34] reports on thin film solar cells that were fabricated using vacuum

Fig. 2 Energy from the Sun encounters a snow covered home in Ohio, USA. The home is equipped with a solar panel array on the roof. (Photograph by Dr. Stephen John Clarson)

evaporation. The SnO_2-p/n-Si solar cells had a maximum response in the wavelength range 0.8-1.1µm. El-Amin and Zaki [35] report on silicon dioxde / titanium dioxide films grown by wet and dry thermal oxidation onto textured multicrystalline silicon solar cells. The aim was to improve the light trapping and energy conversion of the devices, while also reducing manufacturing costs. Sharma, Chaudhary, Dwivedi, Sudhakar and Kumar [36] report on modeling that addresses the efficiency of amorphous silicon solar cells (a-Si:H). Wu, Chen, Ma and Dai [37] report on a low temperature hydrogenation method which is related to the Siemens process. Li, Ban, Bai, Zhang and Chen [38] report on the purification of metallurgical grade silicon (MG-Si) by growing silicon dendrites from an alloy of MG-Si with gallium.

5 Batteries

Mizumo, Nakashima and Ohshita [39] report on the preparation of solvent-free polymer/LiTFSA materials and their ionic conductivities were determined. Wang, Hou, Zhang, Li, Wu, Liu and Hu [40] report on an anode material for lithium-ion battery applications. Spray drying was used to prepare composite microspheres of carbon nanotubes with silicon nanoparticles.

6 Radiation Effects and Risk Assessment

Marzouk, El-Bhatal and Morsi [41] report on the effect of ^{60}Co gamma ray irradiation upon glass compositions having ionic cerium as a dopant material. Rayan, Elbashar and

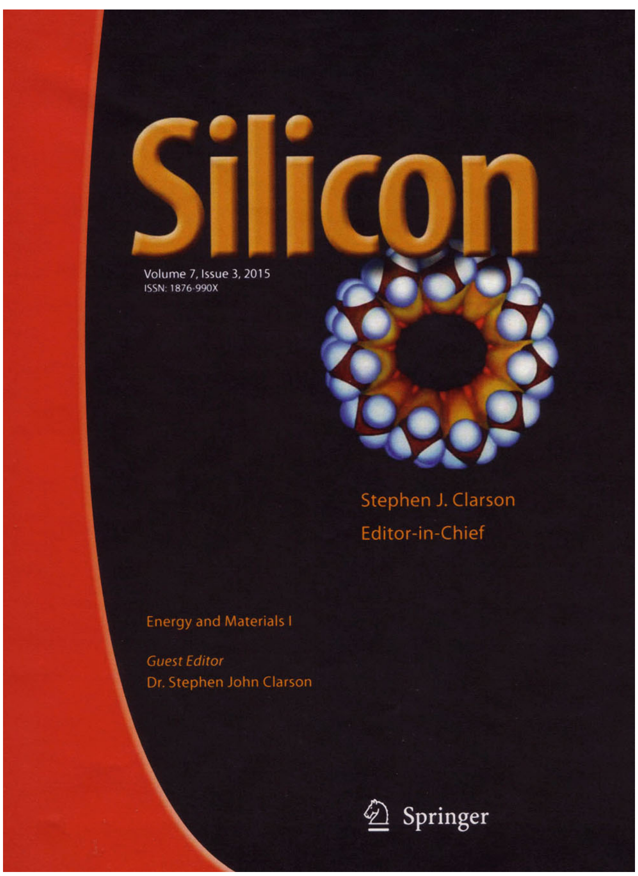

Fig. 3 The cover of the ***Energy and Materials I*** special issue of the journal ***SILICON*** as it was published by ***SPRINGER*** in 2015

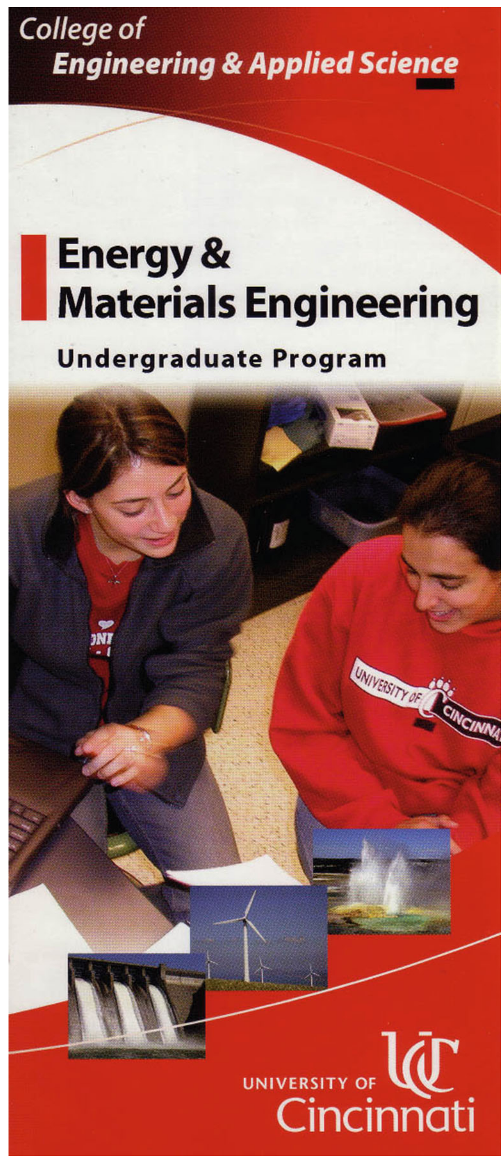

Fig. 4 An exciting ***Energy and Materials*** education curriculum and the cover of a higher education course prospectus booklet

Rashad [42] report on the properties of glass compositions and structures for human eyewear protection applications. El-Alaily, Abdallah, Sabrah and Saad [43] report on the properties of borosilicate glass samples for the immobilization of low-level radioactive materials.

7 Energy and Materials Education

The introduction of an ***Energy and Materials*** curriculum for our university students at the BS level (see Fig. 4) adds an exciting educational aspect to this important field of science and engineering [44].

8 Concluding Remarks

It is hoped that this collection of articles is of interest to the readers of ***SILICON*** community and that it serves to attract more educators and researchers into the growing field of ***Energy and Materials***.

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