HYDROGENATION EFFECT ON THE PHOTOVOLTAIC PERFORMANCE OF COPPER OXIDE BASED P-TYPE DSSC

Melinda Vajda[1, 2], Daniel Ursu[1], Cristina Mosoarca[1], Narcis Duteanu[2], Marinela Miclau[1]

[1] *National Institute for Research and Development in Electrochemistry and Condensed Matter, Dr. A. Păunescu-Podeanu Street 144, 300569 Timisoara, Romania*
[2] *Politehnica University Timisoara, Piata Victoriei Street 2, 300006 Timisoara, Romania*
e-mail: melinda.vajda@student.upt.ro

Abstract

Justified by 20% of the theoretically predicted power conversion efficiency (PCE) of DSSCs (dye-sensitized solar cells), along with their low production cost, transparency and flexibility [1,2], an extensive research has been focused on DSSCs. In order to improve the efficiency and to augment the commercialization of DSSC, the idea of tandem-DSSCs has been proposed by its theoretical photon to energy conversion efficiency of over 40% [3]. The development of tandem cells is conditioned by a further progress in *p*-type DSSCs which still have a limited efficiency of ~2%, far below *PCE* of their *n*-type counterparts [4].

Hydrogenation has emerged as a novel approach to effectively modify the properties of crystalline solids, which has been able to introduce important structural changes improving their optical, photocatalytic and electronic properties. Hydrogenation of photoanodes has proved to be an effective method to improve the performance of *n*-type dye-sensitized solar cells (DSSCs). Based on unfavorable assumptions given by the theoretical simulations [5,6], no hydrogenation of photocathodes (nickel, delafossite or copper oxides) and its effect on the conversion efficiency of in *p*-type DSSCs are reported. While the theoretical works have addressed the study of the electronic structure of hydrogenated Cu_2O, our experimental work aims to highlight the features of hydrogenated Cu_2O/dye interface which are critical in DSSC and still unexplored. We report the beneficial effect of hydrogen in Cu_2O on anchoring of the dye leading to an improvement by 98% for J_{SC} and thus, improving the solar energy conversion efficiency of *p*-type DSSC. Even in 2% H_2 atmosphere, the significant increase in J_{SC} had demonstrated the suitability of hydrogenation in the case of *p*-type semiconductors as an effective and low-cost way to augment the efficiency of *p*-DSSCs.

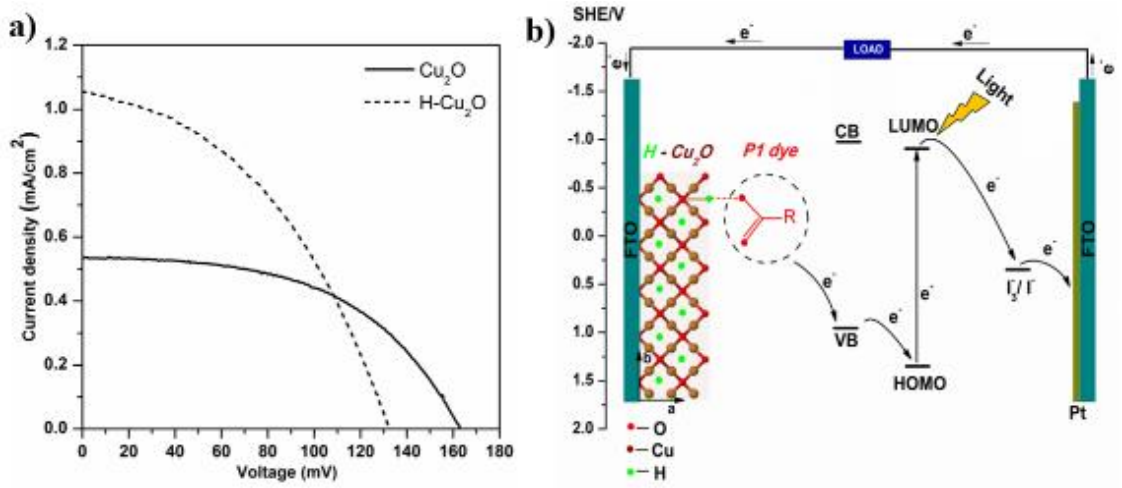

Figure 1. a) J-V curve of the *p*-type DSSC based on Cu_2O and H-Cu_2O photocathodes; b) Schematic energy diagram of the DSSC composed of the H-Cu_2O photoelectrode on FTO, a Pt counter electrode, P1 dye and the I_3^-/I^- redox couple**.**

Acknowledgements
This work was supported by a grant of the Romanian National Authority for Scientific Research and Innovation, the project number PN 19 22 01 03, within PNCDI III.

References
[1] H.J. Snaith HJ. Advanced Functional Materials, 20 (2010)13-19.
[2] A. Hagfeldt, G. Boschloo, L. Sun, L. Kloo, H. Pettersson, Chem Rev.110 (2010) 6595–6663.
[3] F. Odobel, Y. Pellegrin, E.A. Gibson, A. Hagfeldt, A.L. Smeigh, L. Hammarström, Coordination Chemistry Reviews, 256 (2012) 2414-2423.
[4] F. Odobel, L. Le Pleux, Y. Pellegrin, E. Blart, Acc Chem Res. 43 (2010) 1063-1071.
[5] D.O. Scanlon, G.W. Watson, Phys Rev Lett. 106 (2011) 186403.
[6] A. Larabi, A. Mahmoudi, M. Mebarki, M. Dergal, Condensed Matter Physics. 22 (2019) 23702.