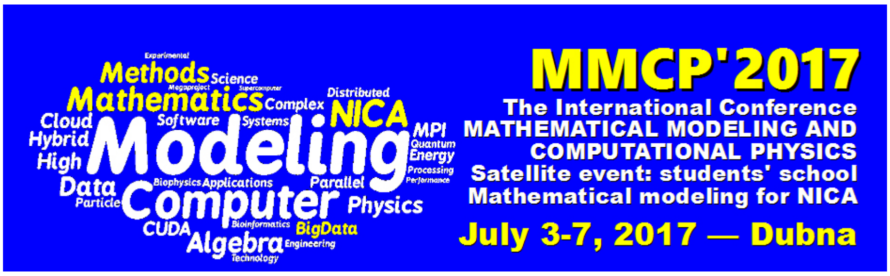

Contribution ID: **79**

Type: **not specified**

Modeling hysteretic effects in perovskite solar cells

Thursday, 6 July 2017 13:45 (15 minutes)

Dynamic J-V hysteretic effects [1] are consistently described by the dynamic electrical model (DEM) introduced in Ref. [2]. DEM explains the dependence of the hysteresis amplitude and short circuit current on the bias scan rate. It also reproduces the current overshoot experimentally observed in the reverse characteristics and its dependence on bias pre-poling. The basic assumption is that the rather slow ion migration process (typically in the order of seconds) governing the time evolution of the polarization charge is described in the single relaxation time approximation, however the steady state polarization charge being a bias dependent quantity. Using DEM we obtain the time dependent solution of the coupled differential equations that govern the dynamic J-V characteristics. Furthermore, analytical extensions are considered.

We investigate here the dynamic J-V characteristics of perovskite solar cells obtained by successive spin-coating deposition of TiO_2 thin and meso-porous layers, $CH_3NH_3PbI_{3-x}Cl_x$ mixed halide perovskite and spiro-OMeTAD on comercial glass/FTO substrate, with Au electrodes [3]. We report the occurrence of normal hysteresis (NH) and inverted hysteresis (IH) in the J-V characteristics in the same device structure, the behavior strictly depending on the pre-poling bias (Vpol).

Using a three step measurement protocol, which includes the stabilization of the open circuit bias (Voc), bias pre-poling at Vpol for a time interval tpol, followed by a reverse-forward scan starting from Voc as actual measurement, we introduce a unified description of the dynamic hysteresis, which can be tuned from NH (Vpol>Voc) to IH (Vpol<0) [4]. We also analyze comparatively reverse-forward and forward-reverse scans, with different pre-poling conditions. In this context we discuss the conditions for a correct evaluation of the solar cell power conversion efficiency (PCE).

References:

[1] H. J. Snaith, A. Abate, J. M. Ball et al., J. Phys. Chem. Lett. 5, 1511 (2014).

[2] G.A. Nemnes, C. Besleaga, A.G. Tomulescu et al., Sol. Energy Mater. Sol. Cells 159, 197 (2017).

[3] C. Besleaga, L.E. Abramiuc, Viorica Stancu et al., J. Phys. Chem. Lett. 7, 5168 (2016).

[4] G.A. Nemnes, C. Besleaga, Viorica Stancu et al., J. Phys. Chem. C, DOI: 10.1021/acs.jpcc.7b04248 (2017).

Primary author: Dr NEMNES, George Alexandru (Horia Hulubei National Institute for Physics and Nuclear Engineering, 077126, Magurele-Ilfov, Romania ; University of Bucharest, Faculty of Physics, MDEO Research Center, 077125 Magurele-Ilfov, Romania)

Co-authors: Ms PALICI, Alexandra (National Institute of Materials Physics, Magurele 077125, Ilfov, Romania); Prof. MANOLESCU, Andrei (School of Science and Engineering, Reykjavik University, Menntavegur 1, IS-101 Reykjavik, Iceland); Dr BESLEAGA, Cristina (National Institute of Materials Physics, Magurele 077125, Ilfov, Romania); Ms DOGARU, Daniela Emilia (National Institute of Materials Physics, Magurele 077125, Ilfov, Romania); Dr ANGHEL, Dragos Victor (Horia Hulubei National Institute for Physics and Nuclear Engineering, 077126, Magurele-Ilfov, Romania); Dr PINTILIE, Ioana (National Institute of Materials Physics, Magurele 077125, Ilfov, Romania); Dr TORFASON, Kristinn (School of Science and Engineering, Reykjavik University, Menntavegur 1, IS-101 Reykjavik, Iceland); Dr LEONAT, Lucia Nicoleta (National Institute of Materials Physics, Magurele 077125, Ilfov, Romania); Dr PINTILIE, Lucian (National Institute of Materials Physics, Magurele 077125, Ilfov, Romania); Dr ILKOV, Marjan (School of Science and Engineering, Reykjavik University, Menntavegur 1, IS-101 Reykjavik, Iceland

; Icelandic Heart Association, Holtasmari 1, IS-201 Kopavogur, Iceland); Dr STANCU, Viorica (National Institute of Materials Physics, Magurele 077125, Ilfov, Romania)

Presenter: Dr NEMNES, George Alexandru (Horia Hulubei National Institute for Physics and Nuclear Engineering, 077126, Magurele-Ilfov, Romania ; University of Bucharest, Faculty of Physics, MDEO Research Center, 077125 Magurele-Ilfov, Romania)

Session Classification: Mathematical methods and application software for modeling complex systems and engineering (III)