

Modeling CuS– CdSe Solar Cell S-Shaped I-V Characteristics

Oleg Olikh, Bogdan Polonsky
Taras Shevchenko National University of Kyiv, Ukraine

64/13, Volodymyrska Street, Kyiv 01601, Ukraine,
phone: +380673169020, *e-mail*: olikh@univ.kiev.ua

The process of designing practical photovoltaic applications calls for the availability of dc lumped-parameter equivalent circuit models. The electrical characteristics of thin film $\text{CuS}_{1.8}\text{--CdSe}$ solar cell are more complex than conventional photovoltaic devices; varying from an ideal 'J' shape to a non-ideal 'S' shape with a 'kink' in the current-voltage (I-V) plot when under illumination – see Fig.1. Our work is focused on the determination of the proper equivalent model of CuS–CdSe structure by using the I-V characteristics, which have been measured over a temperature range 290-340 K.

The model, proposed in [1], was chosen as an initial approximation. The experimental I-V characteristics were fitted by the exact closed form analytical solution, which uses the Lambert W function [2]. To avoid the risk of numerical overflow in the calculation, the solution was rewritten by using the $g(x)$ function [3]. The analysis has been shown that i) the effect of series resistance must be omitted for illuminated I-V plot; ii) dark I-V characteristics are fitted by the conventional single diode model quite enough – see Fig.2. The temperature dependencies of the shunt resistances and the both saturation currents and ideality factors of the diodes were determined.

- [1] F. A. de Castro *et al.*, IEEE J. Sel. Top. Quantum Electron **16**, 1690 (2010)
- [2] B. Romero, G. del Pozo, B. Arredondo, Solar Energy **86** 3026–3029 (2012).
- [3] K, Roberts, S. R. Valluri, arXiv preprint arXiv:1601.02679 (2015)

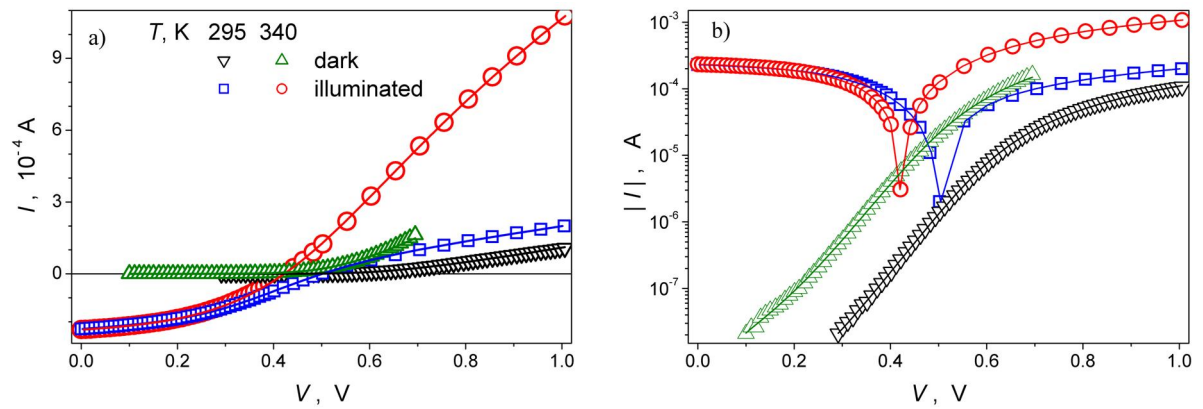
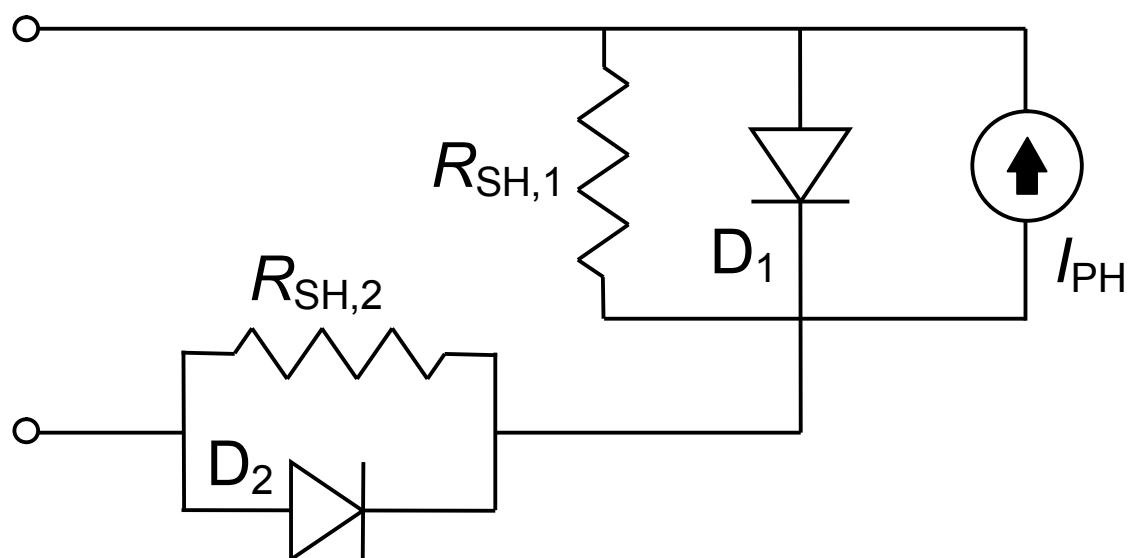


Fig.1. The dark (triangles) and illuminated (circles and squares) I-V curves for CuS-CdSe solar cell at different temperatures. The experimental (marks) and fitted (solid lines) results are presented.



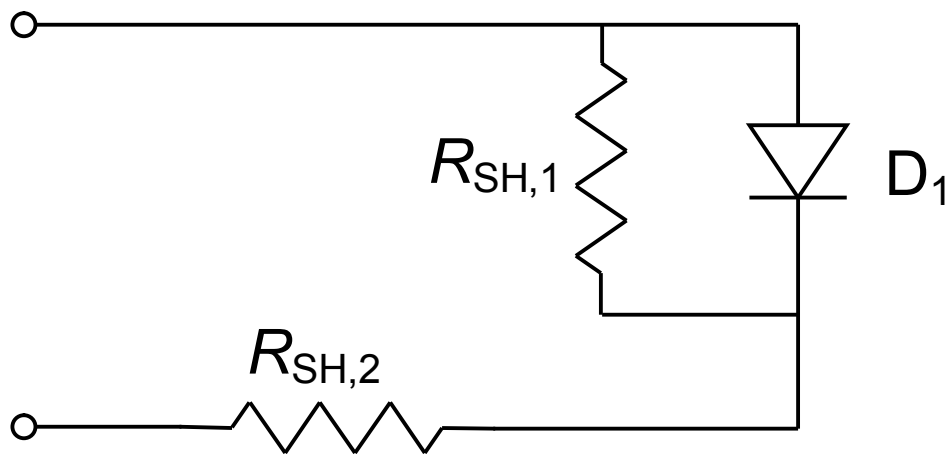


Figure. Temperature dependencies of tunneling parameter $\alpha = d(\ln I)/dV$ (a), series resistance (b) and barrier height (c). The measurements were taken before UST (curves 1, squares), immediately after UST (curves 2, circles), and after UST and ~75 h room temperature storage (curves 3, triangles).