**SUMMARY**

Title of PhD thesis: “Thin-film solar cells based on titanium oxide and copper oxide structures”.

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This doctoral thesis presents research relating to the construction of new types of thin-film photovoltaic (PV) cells - devices based on semiconductors, titanium oxide and copper oxide. A thematically coherent series of publications presents theoretical calculations obtained using simulation tools that are based on self-constructed models and the results of practical experiments leading to the production of such devices.

The first stage of the work is a review and analysis of the literature, which revealed the current state and global achievements in the field of layer composition, structure, and material properties depending on the technology used for their implementation. It presents the detailed physical and chemical properties of copper oxides and three varieties of titanium oxide – anatase, rite, and brucite, as well as a list of all the PV devices manufactured so far on based these compounds. It presents their production methods, methods used for constructing the contacts, and the electrical parameters of light-sensitive PV structures.

In the second stage of the work, theoretical models are proposed and computer simulations of $TiO_2$/CuO and $TiO_2$/$Cu_2O$ cells are performed using the Solar Cell Capacitance Program (SCAPS) program. The goal of the simulations was primarily to theoretically verify of the potential of the PV structures based on titanium oxide and copper oxide, and to compare the results obtained with those in the literature. The energy conversion efficiency obtained in the SCAPS program for an ideal structure was: 22.4% for $TiO_2$/CuO and 13.7% for $TiO_2$/$Cu_2O$. In addition, analyses were performed to determine the effect of the operating temperature and the contact material, as well as the effect of defects on the energy efficiency of the cells. On the basis of capacitance-voltage (C-V) simulations, the Mott-Schottky characteristic was plotted and the built-in voltage ($V_{bi}$) determined.

In the next step, the parameters of the processes determined on the basis of simulations and reports in the literature allowed us to produce the first titanium oxide and copper oxide PV cells using a reactive direct current magnetron sputtering method with physical vapor deposition equipment from PREVAC.

However, the first prototypes exhibited no PV effect due to the inadequate material parameters of the layers. Therefore, in the next stage, detailed studies of single layers of titanium oxide, copper oxide, and PV structures were performed. The properties were

evaluated by X-ray diffraction (XRD). The morphology, cross-sections, EDS spectrum, the topography, roughness and optical properties were analyzed. In addition, the current-voltage (I-V) and capacitance- voltage (C-V) characteristics were measured for the structures based on titanium oxide and copper oxide. These tests allowed us to determine the process parameters at which it is possible to obtain a functional PV device. The process parameters of the structures were modified and improved according to the experimental results. As a result of this work, a $TiO_2$/CuO cell exhibited a PV effect with the following maximum parameters: open circuit voltage $V_{OC}$ = 0.14 V, short circuit current $I_{SC}$ = 0.06 , fill factor FF = 27%, and an energy conversion efficiency of $\eta$ = 0.24%.