SYNTHESIS AND INVESTIGATION OF ORGANOMETALLIC PRECURSORS USED FOR LAYERS FORMATION OF INORGANIC SEMICONDUCTORS

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Nowadays, usage of fossil fuel supplies about 85% of world's electricity power demands. The products of fossil fuel burning, such as carbon, nitrogen and sulfur oxides, negatively affect human's health and cause change of climate [1]. Therefore, more and more attention is payed to development and use of renewable energy sources. One of the most attractive alternatives is photovoltaic systems, which use sun as free and endless source of energy [2].

Current silicon based solar cells, reach efficiencies as high as 25%, but requires complicated production technology and especially pure silicon [3]. In recent years perovskite solar cells (PSC) attract more and more attention, during just few years efficiency of energy conversion was improved from 3.9% to 22.1%. These devices are based on perovskite, which benefits from simple synthesis, inexpensive precursors, sufficiently high conductivity and intensive, wide range light absorption [4]. Hole transporting materials (HTM) play important role in perovskite solar cells and directly affect both energy conversion efficiency and stability. At this moment, the best results have been achieved using organic HTMs (for example spiro-OMeTAD), however, due to necessity to use additives, such as *tert*-butylpyridine or LiTFSI salt, these devices suffer from degradation and offer relatively poor thermal and UV stability [5]. Additionally, organic HTMs usually require expensive and complex synthesis as well as use of aggressive or sensitive reagents [6].

Inorganic hole transporting materials usually offer better thermal stability, superior conductivity, can be used without dopants and generally are cheaper than organic analogues. Copper (I) thiocyanate demonstrate great potential, high hole mobility, good thermal stability and low price. Recently, perovskite solar cells, with CuSCN as HTM, exceeded 20% energy conversion efficiency. On the other hand, CuSCN is insoluble in most common organic solvents, used for solar cell's layers formation, therefore fabrication of PSCs becomes more complicated [7].

In this work organometallic CuSCN complexes were synthesized using different organic ligands. These organometallic precursors have relatively low thermal stability and thermally decompose to CuSCN and volatile organic ligand which evaporates during the layer formation step (**Fig. 1)**.

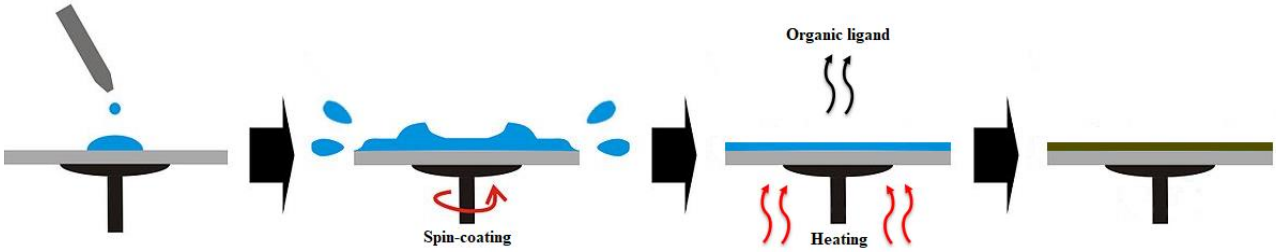

Fig. 1. The formation of CuSCN layer by spin-coating and heating

The solution of organometallic complex is deposited on the substrate via spin-coating. Afterwards, the complex decomposes under heating, organic part slowly evaporates and pure CuSCN layer is received.

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[1] Nazeeruddin MK. In retrospect: twenty-five years of low-cost solar cells. *Nature* 2016, 538 (7626), 463-464.
[2] Green MA. Third generation photovoltaics: ultra-high conversion efficiency at low cost. *Prog Photovoltaics Res Appl.* 2001, 9(2), 123–135.
[3] Smith DD, Cousins PJ, Masad A, Waldhauer A, et.al. Generation III high efficiency lower cost technology: Transition to full scale manufacturing. *Proc. 38th IEEE Photovoltaic Specialists Conf.* (PVSC) 2012, 001594-001597.
[4] Yang WS, Park BW, Jung EH, Jeon NJ, Kim YC, et.al. Iodide management in formamidinium-lead-halide–based perovskite layers for efficient solar cells. *Science*. 2017, 356 (6345), 1376-1379.
[5] Chen J, Park NG. Inorganic Hole Transporting Materials for Stable and High Efficiency Perovskite Solar Cells. *J. Phys. Chem. C*. 2018, 122 (25), 14039−14063.
[6] Krüger J, Plass R, Cevey L, Piccirelli M, Grätzel M, Hach U. High efficiency solid-state photovoltaic device due to inhibition of interface charge recombination. *Appl. Phys. Lett.* 2001, 79, 2085–2087.
[7] Arora N, Dar MI, Hinderhofer A, Pellet N, Schreiber F, et.al. Perovskite solar cells with CuSCN hole extraction layers yield stabilized efficiencies greater than 20%. *Science* 2017, 358 (6364), 768-771.