СИСТЕМИ РОЗРОБЛЕННЯ ТА ПОСТАНОВЛЕННЯ ПРОДУКЦІЇ НА ВИРОБНИЦТВО. ІНДУСТРІЯ 4.0.
СУЧАСНИЙ НАПРЯМОК АВТОМАТИЗАЦІЇ ТА ОБМІНУ ДАНИМИ У ВИРОБНИЧИХ ТЕХНОЛОГІЯХ

Матеріали II Міжнародної науково-практичної конференції
(м. Суми, 22–26 травня 2017 року)


Суми
Сумський державний університет
2017
3D PRINTING OF NANOINKS BASED ON THE METAL AND SEMICONDUCTOR NANOPARTICLES

Dobrozhan O.A., PhD student; Salohub A.O., student; Znamenshchikov Y.V., j.s.r.; Kononov O.K., student; Opanasyuk A.S., professor
Sumy State University, Sumy

Nowadays, we observe the transition for creation of the domestic and industry objects from the traditional methods involving the assembling of the different parts obtained by cutting, molding or otherwise to the additive manufacturing which refers to the object formation by using a layer-by-layer deposition of the versatile materials (metals, plastics, glasses, and so on) in the one 3D printing technological process. In the electronics, the attention should be given to the especially perspective technology, that is 3D ink printing of inks based on the metal nanoparticles (Ag, Cu, Sn) to obtain the printed circuit boards, charge-collecting contacts of thin-film solar cells and its connections with the external loads. Moreover, the inks based on the semiconductor materials (Cu$_2$ZnSn(S,Se)$_4$, ZnO) are the promising for the use in the sensitive elements of photoconverters, thermoelectric generators, transparent electronics, gas sensors, and touchpads.

In comparison to the traditional chemical methods (etching) for the creation of electrical circuits, sensitive elements in the devices of optoelectronics, sensorics and thermoelectrics, 3D printing ink technology is the low-cost method which allows to print the objects/elements with the desired forms and dimensions in short time period. With the goal of the formation of such elements, we have modified the earlier assembled 3D printer by the replacement of the standard printing head with one that allows the ink printing on substrates of different types. The majority of components for the new head were printed by using the standard 3D printer.

In this work, the Ag, Sn, Cu, ZnO, Cu$_2$ZnSn(S,Se)$_4$ nanoparticles with the hydrophilic ligands, such as polyvinylpyrrolidone, ethylene glycol, sulfur ions were synthesized by the colloidal technique. The inks were developed by the placing of synthesized colloidal nanoparticles in the matrix of high molecular weight synthetic polymer, polyvinyl alcohol. Furthermore, the morphological (shape and size), structural (phase composition, coherent scattering domain size) and optical (absorption coefficient, optical density, band gap) properties of the synthesized materials were investigated. The choice of high molecular weight polymer and ligands is allowed us both to use the water as an environmentally friendly solvent and to apply the low annealing temperatures, $T_a < 523$ K, needed to get rid of unwanted chemical substances.

The possibility to control the mass weight of nanoparticles in the high molecular weight matrix opens the ways for the altering of physical-chemical properties of inks and functional properties of 3D printed objects.