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3D PRINTED FUNCTIONAL MATERIALS BASED ON OPTICALLY ACTIVE CELLULOSE NANOCRYSTALS FOR PRODUCTS PROTECTION

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3D printing is recognized as a powerful tool to develop complex geometries for a variety of materials including nanocellulose. This work is dedicated to 3D printing using hybrid nanomaterials based on Cellulose Nanocrystals and Carbon dots (C-dots) as inks. Such inks are biodegradable and biofriendly and can be used for security printing and for creating of biosensors.

Introduction. 3D printing is an emerging technology and in recent years has attracted increased attention as one of the cheapest additive technologies for creating various objects. 3D printing brings great benefits to object fabrication comparing to other techniques, including complex geometry of the produced objects, lower material consumption, and fast manufacturing processes. 3D printing is used to create a wide range of things using a variety of materials, ranging from industrial objects, such as turbine blades or jewelry, to biological tissues, such as the cornea of the eye, artificial heart valves, and others.

One of the most popular and inexpensive classes of printing materials are polymers such as polylactic acid (PLA), acrylonitrile butadiene styrene (ABS) and nylon, but they can release volatile organic compounds and ultrafine aerosols during manufacturing and processing, that can be harmful to humans. This fact is an incentive for the development of low-emission and less toxic, biodegradable materials for 3D printing, especially for biomedical applications.

Much attention has been paid to the development of printed biopolymer composites with improved performance characteristics. Natural polymer hydrogels such as collagen, alginate, chitosan and hyaluronic acid have been used to prepare scaffolds using 3D printing and have shown good results. Cellulose is also an example of a natural polymer. 3D printing of cellulose-based materials makes it possible to produce 3D objects from a cheap, natural, biodegradable source. Nanocellulose hydrogels exhibiting shear thinning properties can be considered extruded precursors for 3D printing. In this case, we paid attention to the cellulose nanocrystals and possible ways of modification to expand potential areas of their application.

Cellulose nanocrystals are elongated crystals obtained by hydrolysis of wood or other plant materials. Since this material is biocompatible, biodegradable and sourced from a wide range of renewable sources, it can be used in medicine, industry and other fields. Also, cellulose nanocrystals are capable of forming gels under the influence of various factors.

Main part. In this work, it is proposed to use material based on cellulose nanocrystals and synthesized "in situ" C-dots as modifying agents to create promising inks for security 3D printing. C-dots were synthesized on the surface of cellulose nanocrystals by several methods, the relation of the physical and optical properties of the resulting composites was investigated depending on the synthesis conditions. Hybrid materials with different optical properties and hydrogels suitable for extrusion 3D printing were obtained. It has been shown that such 3D printed structures can be used to protect various products.

Conclusion. Optically active hybrid nanomaterials based on modified cellulose nanocrystals have been synthesized. Such hybrid materials exhibit optical properties in different spectral ranges and can be used to protect products and to create sensors.

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