**Hydrothermal synthesis of cellulose phosphate composites, modified with Europium and Gadolinium compounds**

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Rare-Earth Elements (REE) have 4f-electrons, which provides great physico-chemical and optical properties to be used in the biomedical field. For example, gadolinium is widely used as MRI contrast and europium compounds are luminescent bioimaging agents. Based on antibacterial and antioxidant properties of REE, researchers created nanoenzymes with this element to treat cancers and prevent DNA damage.[1] Recently, scientists created prosperous biopolymers composites with REE, which causes less cytotoxicity.[2] They show the convenient rates of degradation with good mechanical properties and enhance both properties of polymers and of REE as well. Nowadays, scientists investigate new composites based on modified biopolymers with REE for diagnosis and treatment applications.

The goal of this research is to synthesize luminescent composites based on cellulose phosphate, modified with layered europium and gadolinium trihydroxides and hydroxochlorides. At first, we synthesized cellulose phosphate, by mixing microcrystalline cellulose, dissolved in hexanol, with phosphorus pentoxide and phosphoric acid at 30℃ for 2 days. Next, we hydrolysed europium chloride or gadolinium nitrate hexahydrate with ammonia water at pH=7.0. Obtained precipitates were treated at 120℃ in hydrothermal conditions for 1 day and dried at 60℃. Layered hydroxychloride and hydroxynitrate were obtained at high concentrations of Cl‑ and NO3-, respectively. The same procedures were applied to one-pot synthesize cellulose/REE composites.

About 4.6% cellulose units were modified with phosphate groups, as were measured by conductometric titration. Through XRD, we successfully found the crystalline index of cellulose phosphate decreased to 48%; besides, the structure of hydroxide europium clearly corresponded to that given in the database. While the XRD patterns of layered Eu hydroxychloride and Gd hydroxynitrate are in accordance with the literature. Then, under the UV-light, composites with europium hydroxide showed white luminescence, while with hydroxychloride-red. The luminescence spectra of Eu composites demonstrated the transitions between 4f-4f and 4f-5d, which depends on synthesis methods.

[1] Singh. A. et al. Green synthesis of metallic nanoparticles as effective alternatives to treat antibiotics resistant bacterial infections: A review//Biotechnology Reports. 2020. Vol. 25.

[2] Bezerra. R. D. S. et al. Development of new phosphated cellulose for application as an efficient biomaterial for the incorporation/release of amitriptyline//Int J Biol Macromol. 2016. Vol. 86