Materials Today: Proceedings 31 (2020) 584–587

Contents lists available at ScienceDirect

Materials Today: Proceedings

journal homepage: www.elsevier.com/locate/matpr

Several features of producing polyelectrolyte-based nanolayers by the multi-layer assembly

Alyiya Ospanova, Balzhan Savdenbekova, Zhanar Kubasheva *, Balnur Baltabayeva, Nikolay Uvarov

Al-Farabi Kazakh National University Faculty of Chemistry and Chemical Technology, Almaty 050000, Kazakhstan

ARTICLE INFO

Article history:
Received 4 May 2020
Received in revised form 15 June 2020
Accepted 2 July 2020
Available online 13 August 2020

Keywords:
Nanofilms
Multi-layer
Coating
Medical implants
Polyelectrolytes

ABSTRACT

NaCMC/chitosan and PAA/Chitosan nanofilms were prepared by the LbL method. Silicon plates, medical orthopedic titanium and steel implants were chosen as substrates. The surfaces of the solid carriers were pre-treated depending on nature. Surface preparation is one of the essential and major steps in producing an active surface to produce uniform nanolayers in the form of multilayers. Samples of the obtained nanofilms were examined by atomic-force microscope (AFM), spectral ellipsometer, scanning electron microscopy (SEM) and contact angle determined. The effect of concentration on film quality and thickness has been studied.

Selection and peer-review under responsibility of the scientific committee of the 6th International Russian-Kazakhstan Conference "Chemical Technologies of Functionals Materials".

1. Introduction

Various types of nano dimension thin films are increasingly used to produce nanocomposite materials with certain physical and chemical characteristics. In the early 1980 s, a film self-assembly technique was developed based mainly on covalent or coordination bonding of the matrixes of the certain classes of organic compounds. These compositions did not lead to the widespread application of this technique [1]. Besides, the quality of these films was poor and it was not possible to use them as a carrier of the intended properties. This, in turn, led to the development of new technology for the production of high-quality films, covering the entire spectrum of solutions of both inorganic and organic polyelectrolytes, and even the use of colloidal solutions. Layer-by-Layer (LbL) assembly was first developed by Decher and coworkers for the surface functionalization of solid bodies in the early 1990 s [2]. This method is based on the sequential application of two different molecular layers to flat solid substrates to form polylayers.

The universality and simplicity of the method make it possible to use such films in various fields: antibacterial coatings of implants, for delivery of medicines in the body, manufacture of biomedical materials, food storage system of products, etc. [3–8]. The method has been actively used in recent decades and all brand new modifications are added annually to the already existing list: immersion, moisture removal, roll-to-roll, centrifugation, calculated saturation, immobilization, high gravity, spraying, electrodeposition, magnetic assembly, electrical coupling, etc. [9].

Despite the simplicity of the method, several problems arise in the process of producing nanofilms, which should be taken into account when developing the method of producing multilayers with the necessary physical and chemical characteristics. This is primarily the preparation of the surface on which the films are to be applied and the effect of the pH of the solutions on the quality of the films and their composition. This article presents the results of the preparation of the surface of medical-biological implants and silicon plates as carriers of antibacterial films, and the effect of concentration on the growth of chitosan, carboxymethylcellulose, and polyacrylic acid-based films.

2. Materials and methods

2.1. Characterization materials

The objects of the study were poly (ethylenimine) linear (PEI, MW = 10 kDa), poly (acrylic acid) (PAA, MW = 1.8 kDa), low molecular weight chitosan (CS, MW = 50–190 kDa, degree of deacetylation (DD) 75–85%), Na-carboxymethyl cellulose (NaCMC, MW = 700 kDa). All reagents from Sigma Aldrich. Moreover, acetone, ethyl alcohol (96%), sulfuric acid (98%), sodium hydroxide, hydrogen peroxide (37%). The substrates which were used are

* Corresponding author.
E-mail address: bekisanova@gmail.com (Z. Kubasheva).

https://doi.org/10.1016/j.matpr.2020.07.070
2214-7853/
Selection and peer-review under responsibility of the scientific committee of the 6th International Russian-Kazakhstan Conference "Chemical Technologies of Functionals Materials".