EFFECT OF BIOLOGICALLY ACTIVE POLYMER COMPOUNDS ON THE SUPRAMOLECULAR STRUCTURE OF POLYVINYL ALCOHOL FILMS

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The supramolecular structure of polyvinyl alcohol films containing the proteolytic enzyme protease C, polyhexamethyleneuguanidine salt as antimicrobial, and sodium alginate and/or tetraborate was investigated by electron microscopy and differential scanning calorimetry. The plasticizing effect of the biologically substances and determining effect of the conformation of polyhexamethyleneuguanidine salt on the supramolecular structure of polyvinyl alcohol films was demonstrated.

The current generation of medical dressings differs from their predecessors primarily because they are based on nontraditional polymers for this area. In creating new wound coverings, instead of cellulose stock, other natural and synthetic polymers — alginate, gelatin, collagen, chitosan, polyvinylpyrrolidone, polyvinyl alcohol, polyethylene oxide, etc., are being increasingly used. An important change in the form of the dressings should also be noted: in many cases, preference is given to granulated sorbents, hydrogels, films, and sponges [1].

Incorporation of drugs in the polymers becomes a trend in recent developments. Attempts were made to create polymer forms and composites which would ensure desorption of biologically active substances from them. Thermodynamic compatibility and consideration of the diffusion factor are important aspects in characterizing them. Diffusion of ionicogenic molecules of drugs from hydrophilic media takes place more rapidly than from nonpolar lipophilic media [2]. For this reason, drug-containing hydrogel particles are incorporated in the structure to ensure desorption of biologically active agents from a silicone membrane [3]. The rate of desorption of drugs of different molecular weights from a hydrogel matrix could be controlled by varying its physical parameters — the porosity and thickness [4]. The biologically active additives themselves can also affect the structure and properties of material containing immobilized drugs. Investigating the correlation of the supramolecular structure of the polymer vehicle and the transport properties of the film and the dependence of these properties on the type of biologically active substance will allow predicting the pharmacokinetic properties of the material.

In studying the properties of different materials for medical applications (fibre and film) fabricated from composites based on polyvinyl alcohol (PVA) containing biologically active substances, we established the dependence of the kinetics of desorption of the antimicrobial (AM), inactivation of the immobilized enzyme, degree of swelling, and vapor permeability of the films on the composition of the composite and advanced a hypothesis concerning the effect of the structure of the polymer matrix on the biological activity of the materials [5-9].

We investigated the supramolecular structure of polyvinyl alcohol films containing the proteolytic enzyme protease C, a polymeric antimicrobial — polyhexamethyleneuguanidine salt (PHMG), and in some cases, modifying additives — sodium alginate (Alg) and/or sodium tetraborate.

As we showed previously in [7, 10], the initial viscosity of the PVA spinning composites varied markedly when their composition was changed. The type of PHMG salt has a large effect on the initial viscosity of the solution. When PHMG hydrochloride [PHMG(C)] is used, the initial viscosity decreases to a smaller degree than for PHMG phosphate [PHMG(P)],

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Fig. 1. Dynamic viscosity of spinning composites of different composition vs. shear rate gradient and temperature. Content (in %): PVA 9; ethanol 10; AM 0.1 (2-5); protease C 0.1% (2-5); Alg 1 (5); sodium tetraborate $0.7 \cdot 10^{-3}$ (4), $0.4 \cdot 10^{-3}$ (5). Temperature (in °C): 25 (1-5), 40 (1'5').

Fig. 2. Photomicrographs of the cross section of PVA films with biologically active substances. a, b, c) samples 2, 4, and 5 in Table 1.

which is due to the conformational differences in the macromolecules of the AM. Both polymers degrade the structure of the PVA solution, forming new structures which are characterized by lower activation energy of viscous flow and differ from each other. Addition of sodium alginate to the system, which causes rearrangement of the enzyme complex with PHMG(P) and formation of particles of different composition and structure, and consequently also the structure of the polymer composite, levels this difference. Addition of a crosslinking reagent — sodium tetraborate — on the contrary increases the initial viscosity of the spinning solutions [7].

As the data in Fig. 1 show, the shape of the flow curves is a function of the character of the PHMG salt added to the spinning solution. For systems with PHMG(P), the region of non-Newtonian flow is attained at a lower shear rate than for