APPLICATION OF CAPACITIVELY COUPLED RF DISCHARGE PLASMA FOR STERILIZATION OF POLYMER MATERIALS USED IN OPHTHALMOLOGY

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Introduction

The low temperature plasma treatment is one of known approaches for modification of polymer materials surfaces used in biomedical applications [1-4]. The plasma treatment is carried out for changing adhesive properties of the surface, for formation of barrier layer decreasing large molecules diffusion from polymer material itself into surrounding tissues and in the opposite direction and for production of active sites on the surface for grafting of biomolecules. Also plasma treatment produces the effective surface cleaning too. The result of the treatment is the enhancing of materials biocompatibility. The plasma treatment in Capacitively Coupled Radio Frequency Discharge can be successfully used for enhancing the biocompatibility of polymer materials used in ophthalmology [4]. The aim of the present work is investigation of sterilization effect of the plasma treatment used for enhancing of polymers materials biocompatibility.

Experiment

The sterilization effect of Capacitively Coupled RF Discharge plasma treatment of contact lenses was investigated. There were used two types of polymer: highly hydrophylic polymer with water content 76% (Navelen-76®) and polymethylmethacrilate (PMMA). These types of polymers are widely used for production of soft and rigid contact lenses and for artificial intraocular lenses.

There was used RF generator with frequency 13.56 MHz in experiments. The pressure of Ar in discharge chamber was up to 1 Torr. The plasma parameters were measured by means of Langmuir probe with high value of input RF impedance (up to 200 kOm) [5]. There were developed two types of Ion Energy Analyzers to measure energy distribution and current density of ions exerting the surface. The first one is the grid analyzer analogous to [6], the second is cylindrical capacitor with electric field separating ions with different energies [7]. There were measured ion fluxes with mean energy from 20 to 100 eV (depending on the RF electrode voltage) exerting the sterilizing surface. There were fluxes of metastable particles, UF radiation on the sample surface too. The electron concentration and electron temperature were 10^{10} cm^{-3} and $2 \div 3$ eV respectively in experiments.

The principal stages of experimental investigations were:

1. Lenses infection by pathogen microorganisms which are the most dangerous in ophthalmology: *Staphylococous aureus, Bacilis subcilis,* and *Fungus p. Candida.*

2. The infected samples treatment in RF discharge plasma (the control set of the samples was not exerted by plasma).
3. Bacteriological analysis of treated and control sets of the samples. The number of samples infected by every type of microorganism were 12 (6 in control set and 6 in treated set).

Besides there was investigated the sterilization effect dependence on the time of soft contact lenses plasma treatment. These lenses were infected by *Staphylococous aureus* in this case. The duration of the treatment was 2, 6, 20, 60, 120, and 360 seconds. The total number of tested samples was 48. There was an increase of the number of *Staphylococous aureus* microorganism in the case of control set in nutrient medium. There was a sterilization effect only at 360 seconds duration of plasma treatment. This duration of the treatment was defined for all further experiments. There was growth in nutrient medium of the number of microorganisms in all control (untreated by plasma) experiments with soft and hard contact lenses. There was not growth in nutrient medium of the number of microorganisms in all cases of hard contact lenses treated by plasma. Such results were obtained for soft contact lenses infected by *Staphylococous aureus* and *Bacilis subcilis* too. There was a growth of the microorganisms number in nutrient medium in case of plasma treatment of soft contact lenses infected by *Fungus p. Candida* in 33% of experiments.

There was demonstrated the possibility of effective sterilization by RF discharge plasma of a set of polymer materials used in ophthalmology. The best results were obtained for hard contact lenses. There was perfect sterilization in this case. There were not perfect sterilization in some cases of soft contact lenses treatment. It may be caused by porous structure of the external layers of this material and limited thickness of the sterilization layer.

References

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