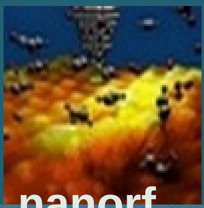

Nanocoatings help materials to become part of a living organism

Russian researchers have developed via nanotechnologies new methods for getting biocompatible surfaces for medical implants. Polymers for vascular transplantology are covered by carbon clusters to achieve preferential adsorption of blood proteins without the risk of thrombosis, and titanic implants for prosthetic dentistry are processed to increase their compatibility with bone tissue.

Contemporary medicine needs biocompatible materials to produce various types of implants. High claims are laid to their quality, therefore, specialists are constantly looking for methods to increase biocompatibility. Some of such methods were developed by Anatoly Alekhin, Doctor of Engineering, and his colleagues from the Moscow Institute of Applied Physics in cooperation with the Federal State Unitary Enterprise - Research Institute of Physical Problems named after F.V. Lukin and the Limited Liability Company “Konmet”.

One of the tasks being solved is to increase hemocompatibility (compatibility with blood) of medical polymers, which are used in cardiovascular surgery. To this end, carbonic nanostructures (in the form of clusters, fullerenes, nanotubes) have recently been applied to the surface of material. Russian specialists have followed the same way. They studied in detail the mechanism for carbonic coating formation to obtain its required properties.

The Russian researchers dealt with low density polyethylene (LDPE), 60 micrometers thick, and polyurethane (PU) “Vitur”, 150 micrometers thick – both polymers being applicable in medical practice. To modify surfaces, cluster carbon was applied upon them via the impulse-plasma precipitation method. Specialists have earlier received evidence that carbonic coating in the form of continuous film does not provide good results as fibrinogen molecules but not albumin molecules are absorbed on the continuous film to a larger extent.

The fibrinogen molecule, its size being about 50 nm, is 4 to 5 times larger than albumin molecules (about 9 nm). When planted upon the initial surface, fibrinogen molecules occupy practically the entire area. If carbonic clusters of required sizes are applied to the polymer surface, they screen part of the surface, and large molecules lack “landing” place. In this case, albumin molecules are adsorbed on the sections free of carbon. Such material prevents thrombosis.

It is necessary to secure that the areas between carbonic clusters did not exceed dozens of nanometers in size. The researchers managed to achieve that when using pulse mode for plasma application of carbonic coating. In contrast to continuous precipitation, this allows to regulate nanocoating growth process by changing carbon vapor supersaturation degree. By specifying certain operational parameters of the process, the required surface relief can be obtained. The coating properties depend on the quality of pulses of carbon plasma generator and their repetition frequency. The optimal thickness of carbon coating is 5–12 nm, cluster sizes are 50–120 nm.

The researchers have experimentally tested and patented their method for cluster carbonic coating formation. Medical-technical trials were carried out at the Research Institute of Transplantology and Artificial Organs of the RF Public Health Ministry. They have proved that polymeric surfaces with cluster carbon applied to them adsorb albumin well, but do not adsorb thrombocytes, and they show high hemocompatibility in terms of all parameters.

Another development by the same group of researchers is improvement of bioactive properties of the titanic dental implant surface. When titan is used in tooth implants, it is necessary to take into account titan interaction with bone tissue, which depends on microrelief and physicochemical properties of the implant surface.

To create microrelief on the titanic surface, specialists use material etching in inorganic acid mixture, and to impart hydrophilic nature to the surface, they suggested to apply the atomically-layerwise precipitation method. The titanium dioxide (TiO_2) film was applied onto the titanic surface by this method. The Russian specialists have determined process-dependent parameters that allow to obtain titanium dioxide film of preset thickness (8, 24 and 48 nm) on a complicated surface.

To assess biocompatibility of modified titanic samples, the researchers studied the ability of bone tissue cells – osteoblasts – for division and differentiation at the implant border. The researchers have found confirmation that the surface processing method suggested by them improves implant’s affinity to bone.

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