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INVESTIGATION OF A BIODEGRADABLE POLYMER AND A GRAPHENE-BASED MATERIAL COMPOSITE FOR IN VIVO APPLICATIONS

E. G. Abyzova, E. M. Dogadina, E. N. Bolbasov, S. I. Tverdokhlebov, R. D. Rodriguez
Scientific supervisor – PhD, Professor of Research School of High-Energy Physics, E. S. Sheremet
Linguist – PhD, PhD, Professor of Research School of High-Energy Physics, E. S. Sheremet

Federal State Autonomous Educational Institution for Higher Education
National Research Tomsk Polytechnic University
Russia, Tomsk, Lenin Avenue, 30, abyzovaeg@gmail.com

Every year the number of cases of the need to install implants for various indications, monitoring, neurostimulation, or support of tissues and organs increases. The installation of implants occurs when standard classical methods of treatment, such as magnetic resonance imaging (MRI), X-rays and others, fail. In this regard, there is a problem of assessing the condition of implants and tissues around them to prevent inflammation and monitor the condition around the implant. To do this, the patient must visit the clinic for magnetic resonance imaging, X-ray or computed tomography. These methods are often insufficiently effective and are able to detect issues only at a later date. The use of remote monitoring would improve and facilitate the work of doctors, as well as allow patients to feel safe due to the absence of any interference with their daily activities of patients or their personal lives [1]. Moreover, a device made of biodegradable materials would have a beneficial effect on the environment, since it would not require extraction from the human body and disposal. However, the current crucial issue in developing such devices is the suitable materials fulfilling both functional and safety requirements.

In recent years, carbon nanomaterials such as graphene (G), graphene oxide (GO), reduced graphene oxide (rGO) and carbon nanotubes (CNT) are the leading materials that are included in many biomedical materials research and development. These materials have found their application in drug delivery systems, tissue scaffolds, cancer therapies and cellular sensors [2]. One of the cheapest, easiest to prepare and promising carbon nanomaterials is graphene oxide (GO). Graphene oxide allows one to create flexible structures, while it is dispersed in aqueous media, which is important in biomedical applications. Graphene oxide provides an increased density of functional groups, which facilitates the immobilization of enzymes and high control over surface properties. The reduction process makes it possible to return graphene oxide to the graphene form by chemical, thermal or photonic action. This reduction process transforms the dielectric into an electrically conductive graphene-like material known as reduced graphene oxide (rGO).

The reduced graphene oxide with a biodegradable polymer is proposed to be used to develop an electronic component for wireless monitoring of the implant condition. The creation of the electronic component will be carried out using laser reduction of graphene oxide of the required shape.

Polylactic acid (PLA) was chosen as a substrate because of its good integration with reduced graphene oxide. The GO solution is applied to polymer scaffolds (PLA), and then reduced by a laser with a wavelength of 405 nm [3]. The samples were tested for mechanical and chemical stability. The rGO on PLA composite proved to be stable after mechanical exposure and after being in water and alkaline and acidic environments. Samples of PLA and PLA with rGO on the surface were tested for biocompatibility with mouse fibroblast cells 3T3 L1 for 72 hours. We found that there is cell growth on the surface of all samples, the cells are viable, no toxic components are released from the films, and there was no bacterial growth. There was no difference in cell growth during different sample processing. All samples remained sterile.

The biodegradable electronic components being developed will allow monitoring the condition of smart biodegradable implants in the human body.

References

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HYDROCARBON COMPOSITION ANALYSIS OF ZEOFORMING PRODUCTS OBTAINED FROM VARIOUS STABLE GAS CONDENSATES

A. A. Altynov, I. A. Bogdanov, A. V. Matveev

Supervisor – assistant professor of Division for Chemical Engineering M. V. Kirgina

National research Tomsk polytechnic university

30 Lenina Ave, Tomsk, Tomsk region, Russia 634050, altynov_andrey@tpu.ru

According to [1] there's an annual increase of natural gas production in Russian Federation. In proportion to natural gas obtaining increase the production by-product of this process called stable gas condensate (SGC) also rises.

SGC is obtained during the stabilization (also known as rectification) of unstable gas condensate, which in its turn is extracted (low-temperature condensation) during natural gas production. As a result, there's a liquid, clear product containing hydrocarbons with the amount of carbon higher than 5, and a commercial gas which mostly consists of methane fraction and inconspicuous amount of ethane fraction. As a rule, SGC is blended with commercial oil in order to increase the value of oil release into the main pipeline. However, the potential appliance of this feedstock is way wider.

In this work three SGC samples obtained from various oil fields in western Siberia of Russia were investigated in order to obtain blended components for automobile gasoline production.

Zeoforming is known to be one of the most promising ways of light hydrocarbon feedstock processing into blended components of automobile gasoline. The catalyst applied in this process is zeolite of ZSM-5 type.

The experiment was carried out at the laboratory catalytic unit with the use of zeolite catalyst provided by "Novosibirsk chemical concentrates plant". The experiment conditions are temperature of 375 °C, pressure of 0.25 MPa and feedstock space velocity 2 h^{-1}.

During the work the hydrocarbon group compositions of SGC feedstock and products of their processing at the catalytic unit were determined.

The hydrocarbon group composition of SGC samples and obtained zeoforming products (ZP) are shown at the tables 1 and 2.

According to table 2 data there's a vivid considerable increase of olefins and aromatic hydrocarbons content after the processing and also there's a vivid significant decrease of naphthenes content.

Table 1. Group hydrocarbon composition of SGC samples

Hydrocarbon group, % vol.	SGC 1	SGC 2	SGC 3
N-paraffins	41.16	35.15	34.46
Isoparaffins	38.28	43.00	43.63
Naphthenes	19.58	19.06	20.37
Olefins	0.46	1.24	0.98
Aromatic hydrocarbons	0.49	1.51	0.57