WEAR RESISTANCE OF FULLERENE C_{60} COATING IN BODY SIMULATED FLUID

Lashneva V.V., Dubok V.A., Tkachenko Yu.G.; Matveeva L.A. [(1)]
Frantcevich Institute for Problems of Materials Science of NASU,
Krjijanovsky Str.3, Kiev, 03142, Ukraine,
[(1)] Institute of Semiconductors Physics of NASU, Nauki Pr. 115, Kiev, 03150, Ukraine,
[*] Fax: 38 (044) 424-21-31, E-mail: dubok@ipms.kiev.ua

Introduction

Development of materials for medicine is one of the foreground tasks of modern materials science. This was particularly revealed during last decades, when different kinds of implants become popular in surgery. One of the most important is hip implants surgery, i.e. replacement of an injured hip joint by artificial implant. It is one of the most effective surgical operations, which one practically completely restores ability to work for injured peoples and returns the physically disabled people to normal life. About 1 million hip implantations are executed annually all over the world, and their quantity permanently grows.

However despite of availability of different kinds of hip endoprosthesis, not one of them can withstand long term service life in human body and must be fully or partly replaced by new ones. Mainly the hip endoprosthesis service life is limited by wear resistance of its friction pair, which one in the majority of designs is constituted of titanium alloy head and cup made of polyethylene Chirulen. The "Gentle link" of such pair is polyethylene cup, whose wearing is about 0,1 mm per a year. Due to such wearing the service life of hip ehdoprosrhesis is limited by 5 -10 years, depending on physical activity of the patient.

The object of this study is to increase the wear resistance of polyethylene in the friction pair with titanium alloy thus increasing service life of hip endoprosthesis. To attain the aim the fullerene C_{60} coating was deposited on polyethylene Chirulen and its wear resistance was studied in body simulated fluid.

Results and discussion

The coating was deposited on polyethylene Chirulen substrate in vacuum by thermal vaporization of high purity C_{60} powder from effusion tantalum cell at temperature of the evaporator 470 °C. Crystal structure and chemical composition of coating were studied by X-ray diffraction, atomic force microscopy, Fourier transformed IR -spectroscopy and Raman spectroscopy. Thickness of coating was determined by МИИ-4 interferometer. The thickness was 1,0-1,5 microns. The wear resistance was determined by pin-on-disk scheme. The pin was made of polyethylene Chirulen with and without C60 coating; the disk was made of titanium alloy BT 6. The conditions of the tests: load - 5 N/mm2, speed of friction - 0,1 m/s, temperature - 37 °C, environment - body simulated fluid (Ringer solution).

Duration of tests - 20 hours. The volume of polyethylene, taken off due to friction was controlled after every 5 - hour cycle of friction. The results of measurement are presented in the table.

The table. Wearing of polyethylene Chirulen with and without C60 coating in friction pair with titanium alloy BT 6.

Hours	Wearing of polyethylene Chirulen, cm^{-3}	
	Chirulen without C_{60} coating	Chirulen with C_{60} coating
5	0.0160	0.0023
10	0.0260	0.0033
15	0.0320	0.0040
20	0.0390	0.0043

Conclusions

Thus, fullerene C_{60} coating considerably increases the wear resistance and reduces the wearing of polyethylene Chirulen in friction pair with titanium alloy BT - 6. The coating can be recommended for usage in friction pair of hip endoprosthesis.

.