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MICROBIOLOGICAL COROSSION OF METALLIC PRODUCTS AS A RESULT OF BIOFILM

ABSTRACT

One of indispensable conditions for microbiological corrosion to appear is the formation of biofilm on the surface of the metal. That is the biological surficial covering, which contains biologically active microorganisms along with their metabolical compounds. The biofilm is a frequent form of microorganisms existence in water environment. It prevents from diffusion of the metabolic products created by separate cells of microcolonies. It causes that the side products of metabolic changes may gather close to the metal surface. If the metal surface is not resistable to their influence some corrosion processes may occur. The article shows the results of the research of the metallic specimens surface in the environment of three different bacteria types.

Key words: *biofilm, microbiological corrosion, metals, bacteria*

INTRODUCTION

Formation of biofilm results from adhesis and the growth of microorganisms on the implant – tissue border. In the process of biofilm creation three stages may be distinguished (Fig.1) [1]:

- the formation of biofilm and creation of the bacterial colonies;
- transitional stage - formation of multi – layer colonies;
- the growth and development of mature biofilm form;

In the Fig.2 differences of the first stage are presented, that is the formation of biofilm (the microbiological covering). Essential role in this stage is played by quick adhesion of bacteria (the number of bacteria subjected to adhesia on the surface unit) to the metallic background. Adhesion of bacteria depends on the chemical compounds and the roughness of the background. The time of bacteria microcolony formation on the metal surface is relatively short – about one day [1,2,3].

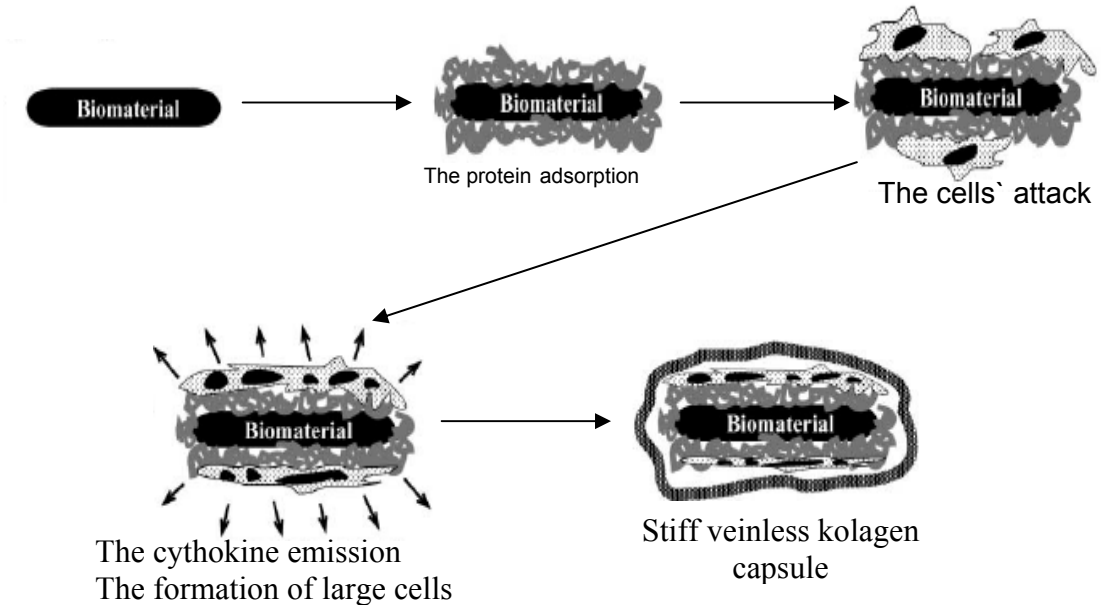

Fig. 1. The reaction of the body to the implant [1]

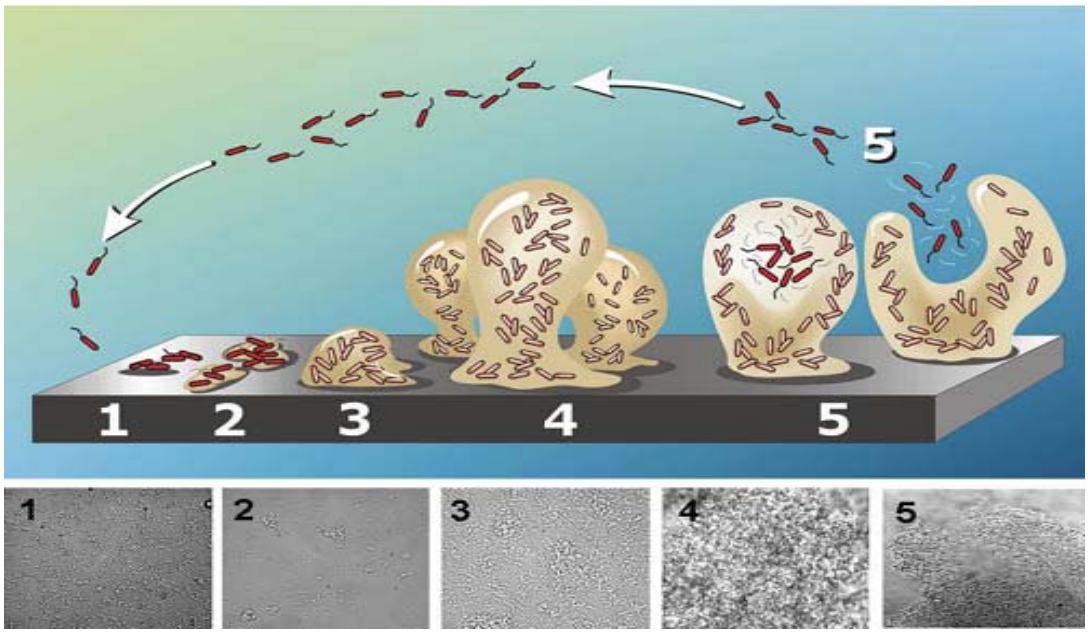

Fig. 2. The stages of biofilm forming on metallic background [1]: 1) the bacteria cell; 2) the bacteria adhesis to the background; 3) the development of bacteria; 4) forming of microcolonies; 5) forming of microbiological film (biofilm)

Biofilm protects bacterial cells from defensive mechanisms of the host organism, hampers phagocytosis as well as reduces antibiotic and antibody penetration. Bacteria forming biofilms have a slower metabolism and are subjected to phenotype changes, which produce their resistance and virulence. Biological film may be fragmentised and deglutinated due to injuries, the effect of which are its fragments, rich in bacteria aggregates and being able to spread through the blood and cause infections [2-5].

In practice all surfaces may be subjected to colonizing process caused by live microorganisms. The presence of microorganisms is particularly favourable for the development of microorganisms. Owing to it they can easily adjust to different extreme surrounding conditions. The presence of biofilm changes the environment on the metal – tissue border increasing the corrosion process [5-7].
The aim of the research was to observe the surface of the samples after removing them from the bacteria liquid and estimating the degree of their degradation.

MATERIALS AND METHODS

The round samples with the diameter of 5 mm made of titanium alloy Ti6Al4V, chemical composition: 4,08%V; 6,39%Al; 0,17%Fe; 0,015%C; 0,185%O; 0,005%N; 0,0035%H; Ti as the rest and microstructure as shown in Fig.3 were examined.

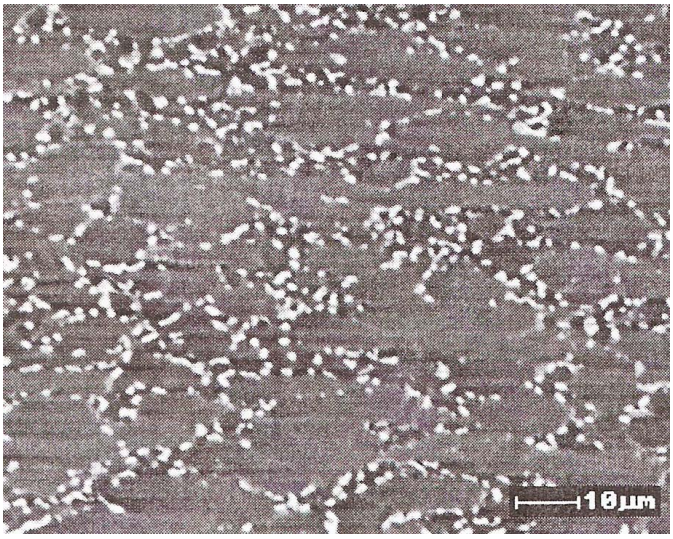

Fig. 3. The microstructure of the Ti6Al4V alloy containing phase combination (α + β)

In the laboratory of Koscierzyna hospital three kinds of bacteria, most commonly occurring in human body: *Staphylococcus aureus, Staphylococcus epidermidis, Enterobacter cloacae* were grown. The samples were dipped in bacteria liquid for the period of 6 months. The next stage of the research was to observe the surface on the Environmental Scanning Electron Microscopy - Philips XL30.

THE RESEARCH RESULTS AND DISCUSSION

The samples taken out of the bacteria liquid are presented in Fig.4.

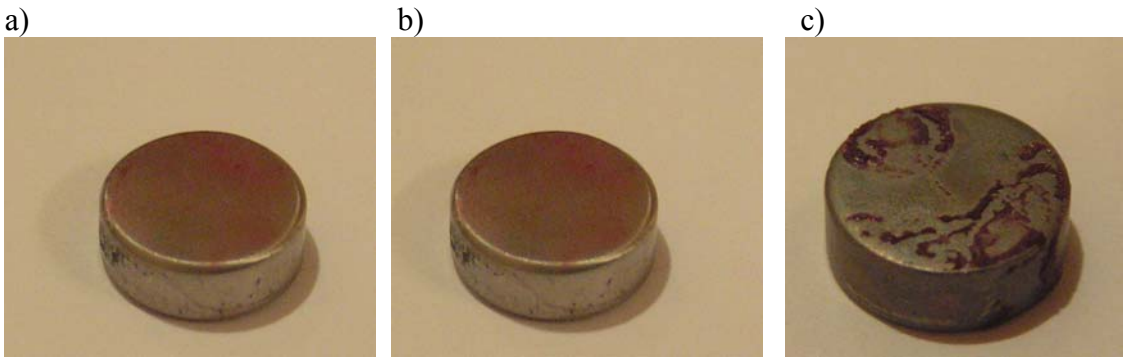

Fig. 4. The samples of Ti6Al4V alloy after removing them from bacteria liquid:
a) Staphylococcus aureus, b) Staphylococcus epidermidis, c) Enterobacter cloacae

Fig.5 shows the surface of the sample soaked in *Staphylococcus aureus.*

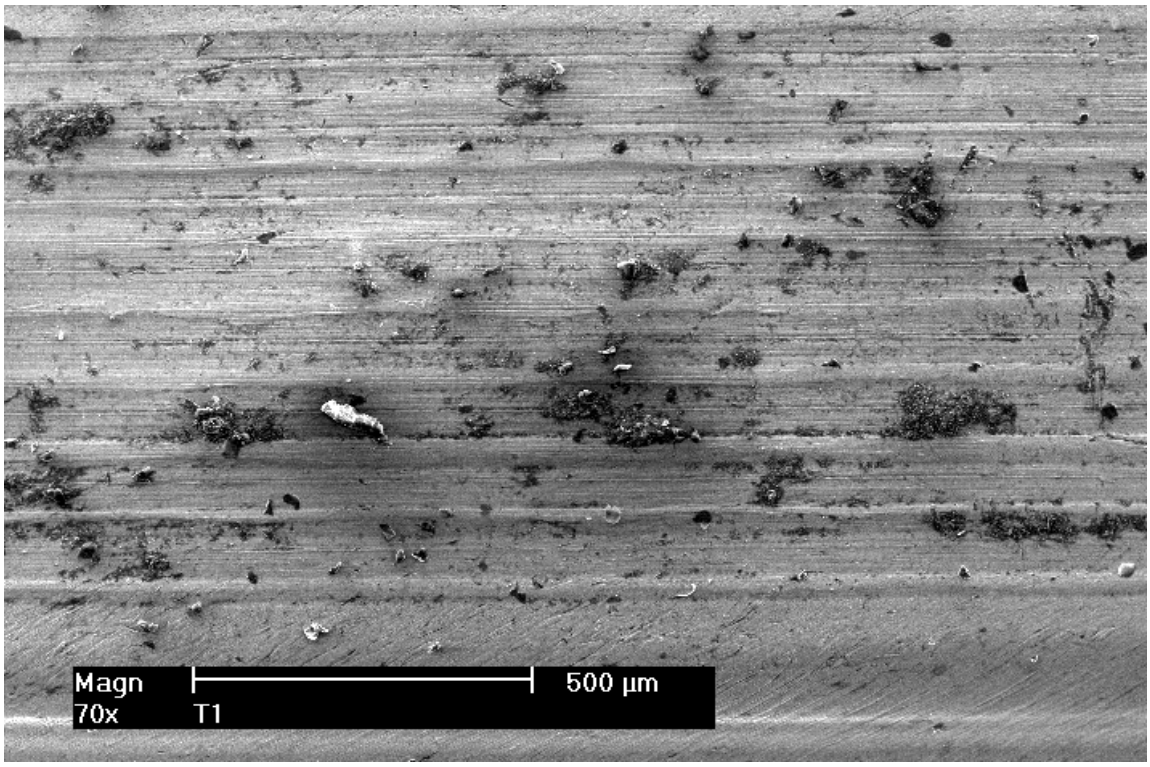

Fig. 5. The sample soaked in *Staphylococcus aureus; magn. 70x*

Fig.6 present the surface of the sample soaked in *Staphylococcus epidermidis.*

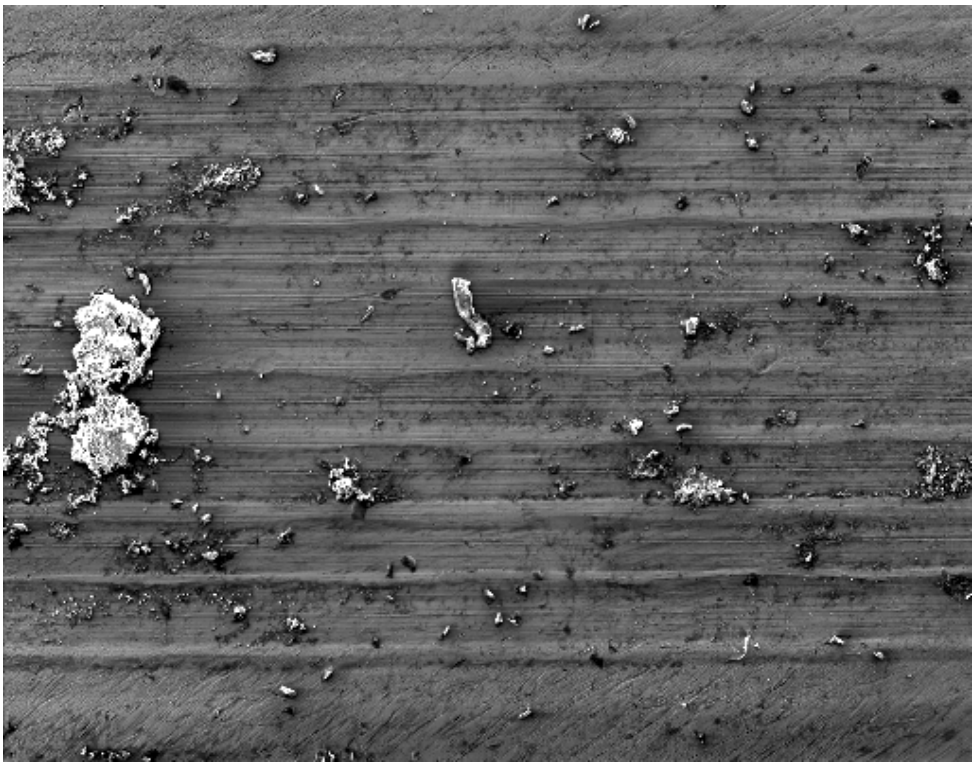

Fig. 6. The sample soaked in *Staphylococcus epidermidis, magn*.100x

The surfaces of the samples soaked in *Staphylococcus aureus* and *Staphylococcus epidermidis* have numerous tine holes and the remains of dead bacteria.
The sample soaked in *Enterobacter cloacae* (Fig.7) looks different. The surface contains many, deep corrosion holes as well as solid salt (white dendrite).

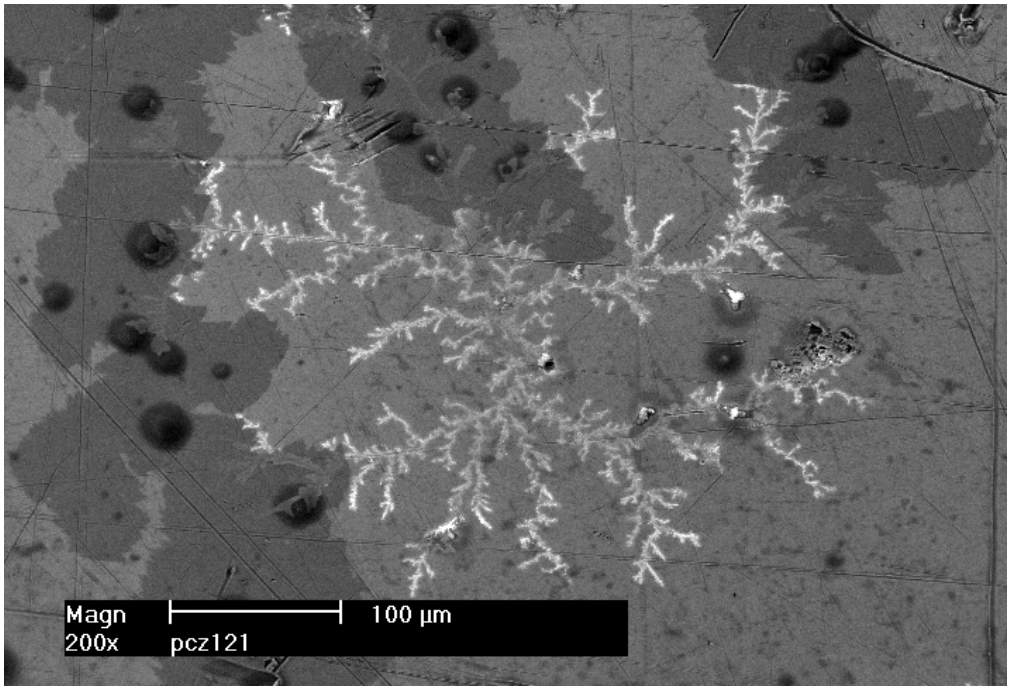

Fig. 7. The sample soaked in *Enterobacter cloacae,* magn. 200x

CONCLUSIONS

On the surface of the examined samples some degradation products were observed. As shown the most aggressive environment were *Enterobacter cloacae,* which caused the biggest destruction on the surface of examined samples in 6 months` period.
The paper presents introductory results of the research, to carry out in future.

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