Tailoring microstructure of metallic materials towards antibacterial properties

Modern world faces many challenges in health protection which have become extremely important in the pandemic times. These challenges also face new materials since they can help in limiting the transfer of infectious diseases. Therefore, the production of antibacterial materials is essential for us and future generations.

The attachment of bacteria to industrial surfaces leads to infection, contamination, and/or material destruction. The importance of counteracting infections in the health service buildings is testified by the fact that according to the European Centre for Disease Prevention and Control (ECDC) about three million of infections connected with health service leads to about 50,000 demises yearly in Europe [1]. It should be marked that about 80% of infectious disease are transferred by touch contact. The equipment used commonly in hospitals (furniture, medical utensils) is made from aluminium and stainless steel, which makes an impression of being clean, yet may be the source of the pathogenic and lethal bacteria and viruses.

In the literature antibacterial properties are mainly assigned to the chemical composition of metals and their alloys rather than to their microstructural features. Among various materials copper is the one mostly well-known for its antibacterial properties. Scarce are information considering the impact of density of dislocations, grain and precipitates size on antibacterial properties of various materials, therefore, the project is highly original. It has been proved that increased density of dislocations introduced to copper by cryo-rolling enhanced its antibacterial properties [2]. Moreover, nanostructurization of copper also led to enhanced antibacterial properties [3]. For this reason, it is planned in the submitted project to produce nanostructured copper of the exceptionally high density of dislocations by severe plastic deformation techniques (SPD). Apart from copper, other materials microstructure features impact will be investigated in the project. The selected materials are aluminum copper alloy 2024 and an austenitic stainless steel. Here, the choice is based on the fact that these are materials present in our everyday life, therefore, enhancing their antibacterial properties seems to be crucial. The variety of microstructures differing in mentioned above microstructural features will be produced by the combination of SPD techniques with annealing. Microstructures will be characterized by advanced electron microscopy techniques, positron annihilation spectroscopy and X-ray photoelectron spectroscopy. Their antibacterial properties will be verified against Escherichia coli and Staphylococcus aureus. E. coli has been selected as some strains of this bacteria can cause serious food poisoning in their hosts and are occasionally responsible for food contamination incidents that prompt product recalls. S. aureus can cause a range of illnesses, from minor skin infections to life-threatening diseases such as pneumonia and sepsis.

Since the project has an interdisciplinary character, a new interdisciplinary team will be created to carry out the research tasks.

In a larger perspective, the project results will have a significant impact on suppression of the proliferation of bacteria by providing the knowledge for the production in the nearest future new antibacterial materials for the everyday use.

Literature:

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