Forum Inżynierii Materiałowej

Materials Engineering Forum

- The Materials Engineering and Metallurgy Committee of the Polish Academy of Sciences
- Polish Materials Science Society

Engineered Regenerative Oxide as Nano-enzyme

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Venue: Presentation: A keynote lecture speech as part of the Materials Science Forum seminar being an initiative of the Polish materials science and engineering community.

Antioxidant nanomaterials with its catalytic regenerative abilities towards scavenging oxidative stress has gained much attention as nanozymes for numerous biomedical applications. Especially some oxide based nanozymes works through the catalytic modulation of their multivalent surface redox states. As an example, specially designed CNP molecule act as nanozymes induces the cellular survival and proliferation through scavenging oxidative radicals and regulates the intracellular oxygen environment overall. Some examples will include wound related disorders. Protective effect of these nanozymes have also been observed when used against diabetic retinopathy, macular degeneration, retinoblastoma, and inherited retinal degeneration. Recently, we have integrated these nanoparticles into a sensor platform and successfully detected select biomolecules for disease detection. In summary, these inorganic Nano enzymes not only acts against the oxidative radicals, but also can detect them, making them a good candidate for a variety of biomedical applications.

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Surface modification of the NiTi shape memory alloys for medical applications

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Despite the fact that more than half a century has passed, since the shape memory effects in NiTi alloys was discovered, these materials still remain in the center of attention. It is due to their potential application possibilities as medical implants or components of medical instruments. The reason for this is a good biotolerance, corrosion resistance, and the largest (in the family of NiTi-based alloys) - shape memory effect. These features are sufficient in the case of medical instruments - remaining in a relatively short time of contact with living organisms. However, the use of these alloys for implants with extended residence time may not be sufficient. The problem is a corrosion, which in the case of NiTi, leads to the release of nickel ions, which are considered as a toxic and/or allergenic. Hence, research is conducted on the modification of the NiTi surface, aimed at producing multifunctional layers or coatings depending on the intended use. These modifications are mainly done for preventing the release of nickel, as well as increasing corrosion resistance, osseointegration and bactericide, while the shape memory effects are maintained.

The basic materials used in the surface modification of NiTi alloys are primarily ceramic and polymer biomaterials as well as their composites. The most commonly used are calcium phosphate; titanium oxide or nitride or titanium oxynitride, carbon, diamond-like, aluminum oxide, zirconium oxide, silicates, polylactide or chitosan with silver additives. In order to obtain multifunctionality of layers/coatings, the composites can be created combining their individual properties. In addition to the material used for the layers or coatings, the decisive factor is their production method, which affects the structure of the NiTi alloy as well as the reversible martensitic transformation. Not all techniques and the technological conditions have a beneficial effect on the course of the transformation itself, without which the shape memory phenomena do not exist.

The developed methods of surface modification of NiTi alloys enabled the design and production of prototyped medical implants, which were used in practice in cooperation with Polish medical and veterinary units.