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OPTIMIZATION OF THE CHEMICAL COMPOSITION OF MAGNESIUM ALLOY FOR BIODEGRADABLE IMPLANTS USING EXPERIMENT PLANNING

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Nowadays, biodegradable materials are usedfor the manufacture of implants in osteosynthesis. Among them, the most promising are magnesium alloys of the Mg – Zr – Nd system. Studies show that the chemical elements of alloys are biologically inert, non-toxic, do not cause carcinogenic reactions and do not lead to metallosis. In addition, the great advantage of these alloys is their mechanical properties:$\sigma_в \geq 230$ MPa, E = 43…45 GPa, $\delta \geq 2\%$, which are very close to the properties of bones ($\sigma_в$ = 120…150 MPa, E = 17…20 GPa, δ = 1,4…3,1%) that prevents "stress-shielding".

However, the mechanical properties of the alloys of the Mg – Zr – Nd system decrease with prolonged biocorrosion influence.Exposure of samples to an artificial blood substitute (gelofusine) showed that after 3 months of use (average fracture consolidation time), the characteristics of the implant are reduced by more than 50%. Therefore, the development of a new alloy of the Mg–Zr–Nd system with an increased level of mechanical properties is an important task.

Itwasstudied the effect of alloying elements in the next intervals 0,4…1,5% Zr, 2,2…3,4% Nd, 0,1…0,7% Znon ultimate tensile strength ($\sigma_в$) and relative elongation (δ) using mathematical planning of the experiment according to the plan 23.

As a result of the studies, regression equations that describe the effect of the alloying elements under study on the ultimate strength (1) and the elongation (2) were obtained:

$$\sigma_в = 249{,}5 - 6{,}75x1 + 15{,}75x2 - 9{,}5x1x2 \quad (1)$$

$$\delta = 3{,}85 + 0{,}75x1 - 0{,}225x2 - 0{,}625x1x2 \quad (2)$$

As a result of the analysis of the regression equations it was determined that an increase in the neodymium content increased the ultimate strength, but its maximum concentration lowered the relative elongation. The effect of zirconium had the opposite effect. The maximum concentration of zirconium significantly increased ductility while reducing strength. The combined effect of neodymium and zirconium was negative. The effect of zinc on the properties of the alloy was insignificant.

In this regard, to obtain the maximum complex of mechanical properties of the alloy, graphic optimization of its chemical composition was carried out.

As a result, the following values of the content of alloying elements were obtained: Zr = 1,25…1,30%, Nd = 2,9…3,1%, Zn = 0,6…0,7%.

Testing of the samples from the developed alloy in gelofusine showed that it has the required level of physical-mechanical properties after 3 months of biocorrosion action. Implants made from this alloy showed their non-toxicity in the animal experiment and are recommended for further research.

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