THERMODYNAMIC CHARACTERISTICS OF THE INTERACTION OF FLUORAPATITE WITH LACTIC ACID

Provorkina A.A., *Golovanova O.A.*
Omsk State University
644077, Omsk, Mira ave., 55A

Polylactide is one of the most widely used bioresorbable polymers in orthopedics and dentistry, serving as a matrix for implants and drug delivery systems. During its biodegradation, lactic acid is locally released, leading to a decrease in pH in the near-surface layer and initiating the dissolution of the mineral component of bone tissue [1]. Fluorapatite ($Ca_{10}(PO_4)_6F_2$, FAP) is a key inorganic constituent of tooth enamel and a promising material for implant coatings due to its high chemical stability. However, the thermodynamic aspects of its interaction with lactic acid under physiological conditions remain insufficiently understood [2].

Based on experimental data on the partial dissolution of fluorapatite in lactic acid solutions as a function of pH, and on the complete inhibition of dissolution at pH = 3.8, a thermodynamic model for the interaction between these compounds was developed. The model is based on the stoichiometric equation:

$$Ca_{10}(PO_4)_6F_2 + 6HL \rightarrow 6CaHPO_4 + CaF_2 + 3Ca^{2+} + 6L^-,$$

where HL denotes lactic acid and L^- denotes the lactate ion.

The developed thermodynamic model was experimentally validated and enables prediction of FAP behavior in acidic and neutral environments arising during polylactide biodegradation and carbohydrate metabolism. It was established that the key factors limiting FAP dissolution are the formation of a passivating CaF_2 layer and the protonation of fluoride ions with the formation of HF. Further research in the field of kinetics, consideration of multicomponent media, and experimental validation of the model will enable the transition to the design of biomaterials with tailored properties.

1. Zaaba N. F., Jaafar M. A review on degradation mechanisms of polylactic acid: Hydrolytic, photodegradative, microbial, and enzymatic degradation // Polymer Engineering & Science. 2020. Vol. 60. No. 9. P. 2061-2075 https://doi.org/10.1002/pen.25511

2. Tõnsuaadu K. et al. A new perspective on fluorapatite dissolution in hydrochloric acid: Thermodynamic calculations and experimental study // Inorganics. 2021. Vol. 9. No. 8. P. 65. https://doi.org/10.3390/inorganics9080065

The research was carried out within the state assignment of ministry of science and higher education of the Russian Federation, theme № 075-03-2025-469.