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Matrix resistance stress reduction-optimization of immobilized cell growth

Ivana D Pajic-Lijakovic, Milan Milivojevic and **Steva Levic**
University of Belgrade, Serbia

Some of the main rheological properties that Ca-alginate hydrogel matrix should satisfy for biomedical and biotechnological applications are the matrix viscoelasticity and the ability of stress relaxation. Although alginate satisfies both of them, experimental data points that cell growth is significantly reduced by micro-environmental effects. Micro-environmental restriction effects are connected to matrix resistance stress accumulation. Matrix stress is generated within the boundary layers around the cell aggregates under compression caused by cell rearrangement and growth. Simultaneously induced relaxation phenomena of both subsystems: (1) immobilized cells and (2) hydrogel matrix occur at three time scales through successive relaxation cycles. Complex dynamics of matrix compression intensifies mechanical and electrostatic cell-matrix interactions. Minimizing of the resistance stress is the strategy for improving the matrix performances. Electrostatic repulsive interactions between negatively charged cell membranes and surrounding alginate chain parts as well as inter- and intra-chain interactions under compression significantly reduced cell growth dynamics even in the initial phase. Minimizing of the resistance stress is prerequisite for whole process optimization. We considered and compared physical and chemical modified Ca-alginate hydrogel. Physical modification is connected to entrapped gas bubbles within Ca-alginate hydrogel. The bubbles mechanically amortize the compression effects within the surrounding cell aggregates. Chemical modifications are connected to minimizing repulsive interactions between negatively charged alginate chains above the isoelectric point by blending Ca-alginate with poly-cationic polymers such as chitosan and gelatin. Cell action could be simulated in the experiments without cells during repeated stress relaxation cycles. Maximal resistance stress could be reduced four times for Ca-alginate-chitosan composite and 9 times for Ca-alginate-gelatin composite relative to Ca-alginate gel after 10 stress relaxation cycles under constant strain per cycle equal to 5%.

iva@tmf.bg.ac.rs

Optimization of heat treatment to obtain desired properties of miserite glass-ceramics for dental applications

Jae Chul Bang and **Young Ju Song**
Soonchunhyang University, South Korea

Glass-ceramics with good mechanical properties are suitable for application in dental implants. In this study, we synthesized glass-ceramics based on miserite system. The optimization of heat treatment was studied to obtain desired crystalline phases and the resulting mechanical properties, such as hardness, fracture toughness, and bending strength. The amount and shape of the miserite crystals were examined by XRD, SEM, and DTA. Various colors in Vita shades were also achieved by the addition of various metal oxides such as Er_2O_3, Fe_2O_3, and Mn_2O_3.

bangj@sch.ac.kr