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Dnevni red:

1. Izlaganja stipendista za MCM2017:

Vida Čadež, IRB: The role of chitin in the biomineralization of mollusks and its integration in a PVP-CMC hydrogel scaffolds as a bone tissue regeneration biomaterial

Vilko Mandić, FKIT: Low thermal treatment optimisation of sol-gel derived composite-coating for multi-purpose functionality and protection of all-metals

Mario Matošević, INA: Microstructural characteristics of staurolite from mica schist of the Drava depression basement (Croatia)

Martina Radić, IRB: NDPK A and NDPK B – subcellular dynamics and interactions

2. Razno

Tajnica:
Jelena Macan

Predsjednica:
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The role of chitin in the biomineralization of mollusks and its integration in a PVP-CMC hydrogel scaffolds as a bone tissue regeneration biomaterial

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Keywords: biomaterials, bone tissue engineering, hydrogels, biomineralization, chitin

Functionalized hydrogels have a great potential as biomaterials for bone tissue repair. They can be used as matrices for bone tissue ingrowth, as therapeutics (by increasing disk hydrations) or/and as drug delivery systems. The challenge is to develop hydrogel scaffolds that are highly porous, but strong enough to withstand diverse mechanical strains, while mimicking the natural extracellular matrix (ECM) structure. Integration of ECM as a part of a biomaterial provides simple and efficient way to obtain scaffolds with enhanced framework structure. In this sense, marine organisms attract special attention as ECM sources (1). Their extracellular organic matrix is rich with diverse proteins and chitinous fibers. Potential of chitin is already known in the biomimetics (1,2), but most research is conducted on the chitin isolated from arthropods, i.e. on α -chitin. In comparison, β -chitin is more suitable to serve as a biomaterial since it has better water retention possibilities, but it is also more difficult to extract from highly mineralized mollusk shells (3). Therefore, the incorporation feasibility of chitin, a bioactive, antibacterial and biodegradable material (1,2), was examined in order to test its ability to enhance properties of the perspective mineralized PVP-CMC hydrogel scaffold (4,5). Chitin based PVP-CMC hydrogels were prepared and characterized both as non-mineralized and mineralized form of hydrogel scaffolds. Both α -chitin (commercially bought) and β -chitin



(isolated from the *Sepia officinalis* cuttlebone) were individually tested. Structure – function relationships of organic matrix and hydrogel scaffold structures were examined from morphological and structural perspective with the use of Fourier transmission spectroscopy (FTIR), atomic force microscopy (AFM), field emission scanning electron microscopy (FESEM) and rheometry. It was observed that at 1% strain all hydrogel scaffolds have linear trend, with highly pronounced elastic properties in comparison to viscous ones. Incorporation of β -chitin increased storage modulus of all mineralized samples, making it interesting biomaterial for further research on its utilization as a scaffold for bone tissue repair.

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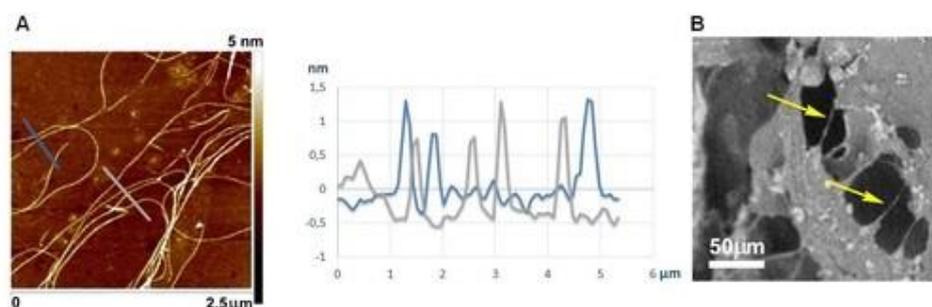


Figure 1. AFM and FESEM images of biomaterials: (a) AFM image of β -chitin isolated from the *Sepia officinalis* cuttlebone with cross section of β -chitin fibers, marked as blue and grey lines, (b) FESEM of biomineralized hydrogel scaffold, fibers marked with yellow arrows.



Low thermal treatment optimisation of sol-gel derived composite-coating for multi-purpose functionality and protection of all-metals

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Keywords: Ceramic coatings, Composite, Anticorrosive, Tribological, Sol-gel

Development of protective coatings for the metal surfaces has been continuous demand in wide industrial area and therefore was continuously scientifically researched. Inorganic as well as hybrid organic-inorganic coatings were found to be very favourable solutions. Recently achieved multifunctional layers shown it is possible to exhibit simultaneously both anticorrosion and tribological efficiency. However, discrepancies arise upon consideration of: (a) the up-scale to high area, (b) the price of deposition techniques, (c) the overall stability and (d) the requirements for thermal treatment, all of which prevents real technological applicability. This investigation aims to surpass these discrepancies and yield multifunctional (hard, anticorrosive, tribo-effective) multi-layer coatings (2 or more layers) on behalf of advanced sol-gel-based (cheap, simple) procedure with lower-temperature treatment (applicable, easy scale-up). First of all we withhold from one-pot synthesis and thereof maximise distinctive properties in each of the layers. Sol-gel method was utilised to tailor different but compatible layers. This investigation aims to evaluate the feasibility of a crystalline coating, which was rarely done. As a (metal-contacted) protection-layer, i.e. corrosion barrier (both from environment and chemicals), dense, crystalline (anatase) and thin (50-100nm) was considered. This layer was shown to have low porosity and SS surface, closed pores and good mechanical properties. Next layer was the container-type layer; it was shown to be thicker (300-500nm), consisting of amorphous TiO₂, porous (open mezzo-pores with uniform pore distribution and size 10-50nm) capable of accepting infiltration with another liquid anti-corrosive agent (benzotriazole). This layer show great anti-corrosive behaviour with reasonable mechanical properties. The final layer consists of core-shell particles which somewhat penetrate the pores of the 2nd layer thus closing them (and close the infiltrated anti-



corrosive liquid) and forming additional top layer. The tribo-active core-material was enclosed in outer hybrid shell for stability finally offering reasonable mechanical properties. Materials were extensively characterised using thermal, structural, microstructural and functional methods. Overall, the 3-layer-coating (<math><1\mu\text{m}</math>) processed below

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Microstructural characteristics of staurolite from mica schist of the Drava depression basement (Croatia)

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Keywords: staurolite, mica schist, dynamic metamorphism, Tisia, Drava Depression

Staurolite, with the chemical formula $(\text{Fe,Mg,Zn})_2\text{Al}_9\text{Si}_4\text{O}_{22}(\text{OH})_2$, is a nesosilicate mineral formed during regional metamorphism in the amphibolite facies (medium grade metamorphism), usually as a porphyroblast. Atypical staurolite has been found in the garnet-staurolite-muscovite-biotite schist of the SW part of the Pannonian Basin System's crystalline basement, in the exploration wells of the Grubišno Polje field, located in the Drava Depression, Croatia. The analyzed rock can be correlated with biotite-muscovite gneisses of the Ravna Gora progressive-metamorphic series (Raffaelli, 1965), a part of the Papuk complex (Jamičić, 1983, 1988) or Hercynian progressive-metamorphic complex of the Slavonian mountains (Pamić & Lanphere, 1991). This is in accordance with Pamić (1999), who claims that the rocks of the surrounding area of Grubišno Polje are connected to the crystalline complex of the Slavonian mountains. Based on modern regional-geological concepts, the Slavonian mountains, along with the area of Grubišno Polje, are a part of the Tisia microplate (e.g. Schmid et al., 2008 and references therein). The rock is characterized by augen structure with mylonitic foliation. The peak metamorphic assemblage includes quartz, biotite, muscovite, staurolite, garnet, K-feldspar and plagioclase. Accessory minerals are apatite and zircon, while tourmaline, carbonate, hematite and chlorite represent retrograde mineral phases. Foliation is defined by the arrangement of quartz and phyllosilicates into distinct elongated and lenticular domains (Q and P domains). Garnet and rare feldspars occur as porphyroclasts, while staurolite appears as an aggregate of finer clasts with sericite-muscovite in intergranular space. The staurolite in the garnet-staurolite-muscovite-biotite schist has been confirmed optically, by using polarizing microscope Olympus BX51, as well as chemically and mineralogically, by the scanning electron microscope (SEM) JEOL JSM-6510 LV with Energy-



dispersive X-ray spectrometry (EDS). The staurolite grains are mainly prismatic, elongated along the *c* axis, with rarely developed twins. Individual grains and fragments (50-400 μm) are formed as a result of cleavage along the *b* axis, along with irregular fracturing. They typically display pleochroism, from colorless to pale yellow. The porphyroblastic schist was developed during regional metamorphism in the amphibolite facies from pelitic protolith enriched with iron and potassium. Later episode of dynamic metamorphism resulted in recrystallization and the occurrence of retrograde assemblage. Anastomosing of quartz and phyllosilicate domains around staurolite aggregates indicates that the staurolite initially represented porphyroblast as well. The shear stress led to the segmentation and a fracturing of staurolite porphyroblasts, rotation and recrystallization of newly-formed grains and crystallization of sericite-muscovite in fractures between staurolite grains.

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NDPK A and NDPK B – subcellular dynamics and interactions

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Keywords: NDPK A, NDPK B, live cell imaging, FRET/FLIM technique

The Nme gene/protein family was named after the first member identified, Nm23-H1/Nme1, which is responsible for metastasis suppression in many tumor types. The Nme1/NDPKA and Nme2/NDPKB are two units of a well-known enzyme nucleoside-diphosphate kinase (NDPK), which transfers the terminal phosphate from (d)NTPs to (d)NDPs and is, therefore, responsible for the maintenance of the cellular nucleotide pool. Besides this housekeeping role, the Nme/NDPK A and B proteins have been assigned several additional biochemical functions such as the His-protein kinase and the scaffold function. There has also been evidence that they may function as transcriptional factors and as exonucleases. The two subunits can assemble into enzymatically active hexamers in all possible combinations (A₆, A₅B, ..., B₆). Our hypothesis is that the isoenzyme assembly, with potentially distinct roles of the two subunits, differs between specific cellular physiological processes and locations. To be able to determine the potential diverse functions of the A and B subunits, as well as their spatially specific assembly, we subcloned their cDNAs into pEGFP and pmCherry fluorescent reporter vectors, and transfected human tumor cells in culture. By using live cell imaging techniques, we monitored their cellular dynamics with and without induction of DNA damage. Further, we investigated localization of the interaction between subunits by FRET/FLIM technique. Our preliminary results suggest that the assembly of heterohexamers is generally favorable compared to homohexamers. Additional experiments are needed to determine possible spatial specificity of these interactions.