

Course title: **Inorganic nonmetallic materials (T-116)**

Teacher:

Prof. Stanislav Kurajica, Ph.D., University of Zagreb Faculty of Chemical Engineering and Technology

Assist. Prof. Anamarija Rogina, Ph.D., University of Zagreb Faculty of Chemical Engineering and Technology

Teaching hours: 20

Syllabus: Structure and physical and chemical properties of solid matter: crystal state, crystal lattice energy, surface energy, structure of real crystals, non-stoichiometry and crystal defects. Methods of structure characterization: X-ray diffraction, spectroscopic techniques. Microstructure: polycrystalline monophasic and multiphasic systems. Methods of microstructure characterization: electron microscopy and atomic force microscopy. Thermodynamics of solid-state processes: phase diagrams, solid solutions. Diffusion in the solid state. Processes of nucleation and growth. Kinetics of processes in the solid-state: general principles, solid-state rate limiting processes, processes limited by diffusion, reaction on the phase interface, nucleation and growth. The influence of reaction parameters on solid-state process rate. Sintering and recrystallization. Methods of investigation of high-temperature processes. Monoliths, powders, fibers, membranes, thin films and layers. Inorganic composites, inorganic-organic composites, nanocomposites. Thermal, electrical, optical, mechanical and chemical properties of inorganic materials and composites.

Teaching methods: **Lectures, discussions.**

Examination methods: **Oral exam.**

Monitoring of the course quality and successfulness: **Student Survey.**

List of recommended readings:

1. A. Putnis, *Introduction to mineral sciences*, Cambridge university press, Cambridge CB2 8RU, 2008.
2. S. Kurajica, *Rendgenska difrakcija na prahu*, HDKI/FKIT, Zagreb, 2020.
3. C. G. Bergeron, S. H. Risbud, *Phase Equilibria in Ceramics*, The American Ceramic Society, Columbus, 1984.
4. R. W. Balluffi, S. M. Allen, W. C. Carter, *Kinetics of Materials*, John Willey & Sons, Hoboken, 2005.

Curriculum vitae:

Stanislav Kurajica was born in 1965 in Dubrovnik. He graduated in 1991, received MSc degree in 1994, and PhD degree in 1998 at the Faculty of Chemical Engineering and Technology (FCET) of the University of Zagreb with the dissertation "Phase crystallization in systems obtained by the sol-gel process". Since 1991, he has been employed at the FCET. In 2013, he was elected to the position of tenured professor in the technical sciences, in the fields of chemical engineering and materials. He was dean and vice-dean of the FCET, member of the Senate and the Council of the Technical Faculties of the University of Zagreb, head of the Department of Inorganic Chemical Technology and Nonmetals of the FCET, and coordinator of the Chemistry and Materials Engineering study. S. Kurajica teaches at the doctoral, graduate and undergraduate studies of the FCET and at the undergraduate study Conservation and Restoration at the University of Dubrovnik. He was the mentor of six doctoral dissertations and more than 50 final and graduate theses. He is the co-author of the textbook "Introduction to Nanotechnology" and the author of the textbook "X-ray powder diffraction". The scientific activity of S. Kurajica is focused on the field of materials science and engineering, especially nanomaterials, technical ceramics and catalysts, reactions in the solid state, especially their kinetics, advanced synthesis methods, X-ray diffraction analysis, etc. He was the leader of one international and three domestic scientific projects and one technological project, collaborator on four international and eight domestic projects. He has published more than 130 scientific papers, of which more than 90 are in journals cited in tertiary publications. He participated in the work of more than 100 international and domestic scientific meetings and held eight invited and a large number of plenary and sectional lectures. He is received several medals at international innovation fairs and co-authored a patent application. S. Kurajica is a member of the Croatian Academy of Technical Sciences, the founder and first president of the Croatian Society for Ceramic Materials, a member of the American Nano Society, the Croatian Society of Chemical Engineers and the Croatian Society for Materials and Tribology. He was awarded the State Prize for Science in the field of technical sciences (2020), the "Fran Bošnjaković" prize of the University of Zagreb (2014) and the "Franjo Hanaman" prize of the Faculty of Chemical Engineering and Technology of the University of Zagreb (2016).

Anamarija Rogina, born in 1987 in Zagreb, graduated magna cum laude in 2010 from the University of Zagreb, Faculty of Chemical Engineering and Technology, majoring in Chemistry and Materials Engineering. During her studies, she received three Dean's awards for the most successful student. In 2010, she started working at the same faculty as an assistant in the Department of physical chemistry and enrolled in a doctoral study entitled Engineering Chemistry. In 2015, she defended her doctoral dissertation entitled "In situ synthesis of hydroxyapatite in a matrix of biodegradable polymers" under the mentorship of Prof. Marica Ivanković. She did part of her doctoral research during a three-month scientific stay in 2014 at the Center for Biomaterials and Tissue Engineering, Polytechnic University of Valencia, Spain. She continued her collaboration with the same Center with a one-month scientific stay in 2015, and in 2016 participating in the course Integrated laboratory of polymers and biopolymers. In 2018, she was elected to the position of assistant professor at the Faculty of Chemical Engineering and Technology in the Department of inorganic chemical technology and nonmetals. She is the winner of the National Award for Science for young researchers in 2020 and the L'Oreal-UNESCO Award "For Women in Science" in 2015. She is a member of the editorial board of Materials Today Bio (Early Career Researcher Board, 2022 – 2024, Elsevier), the editorial board of Polymers MDPI magazine, and the Croatian Society for Materials and Tribology (HDMT). Her scientific area is the development of biodegradable composite biomaterials as potential bone substitutes for bone tissue engineering and drug delivery applications.

List of references: *(by the teacher and relevant to the course)*

Prof. Stanislav Kurajica, Ph.D.

1. S. Kurajica, V. Mandić, K. Mužina, I. Panžić, D. Kralj, M. Duplančić, I. K. Ivković, Thermal stability and properties of Pd/CeAlO₃ catalyst prepared by combustion synthesis, *Journal of Thermal Analysis and Calorimetry*, 148 (2023) 10481-10490.
2. V. Mandić, S. Kurajica, I. Panžić, A. Bafti, J. Šipušić, K. Mužina, F. Brleković, L. Gigli, M. Gaboardi, Utilization of conventional PXRD apparatus for characterization of thin-films using reconsidered equations for XRD
3. S. Kurajica, I. K. Ivković, G. Dražić, V. Shvalya, M. Duplančić, G. Matijašić, U. Cvelbar, K. Mužina Phase composition, morphology, properties and improved catalytic activity of hydrothermally-derived manganese-doped ceria nanoparticles, *Nanotechnology*, 33 (2022) 135709
4. S. Kurajica, I. K. Munda, F. Brleković, K. Mužina, G. Dražić, J. Šipušić, M. Mihaljević, Manganese-doped ceria nanoparticles grain growth kinetics, *Journal of Solid State Chemistry*, 291 (2020) 121600
5. S. Kurajica, E. Tkalčec, V. Mandić, J. Schmauch, Mullite crystallization kinetics of lanthanum doped sol-gel derived precursors, *J. Eur. Ceram. Soc.*, 31 (2011) 377-383

Assist. Prof. Anamarija Rogina, Ph.D.

1. L. Bauer, A. Rogina, M. Ivanković, H. Ivanković, Medical-grade poly(lactic acid)/hydroxyapatite composite films: Thermal and *in vitro* degradation properties, *Polymers* 15 (2023) 1512.
2. A. Ressler, N. Kamboj, M. Ledinski, A. Rogina, I. Urlič, I. Hussainova, H. Ivanković, M. Ivanković, Macroporous silicon-wollastonite scaffold with Sr/Se/Zn/Mg-substituted hydroxyapatite/chitosan hydrogel, *Open Ceram.* 12 (2022) 100306.
3. L. Bauer, M. Antunović, A. Rogina, M. Ivanković, H. Ivanković, Bone-mimetic porous hydroxyapatite/whitlockite scaffolds: preparation, characterization and interactions with human mesenchymal stem cells, *J. Mater. Sci.* 56 (2021) 3947-3969.
4. A. Rogina, I. Košić, M. Antunović, M. Ivanković, H. Ivanković, The bioactivity of titanium-cuttlefish bone-derived hydroxyapatite composites sintered at low temperature, *Powder Metall.* 63 (2020) 300-310.
5. N. Ukrainczyk, A. Rogina, Styrene-butadiene latex modified calcium aluminate cement mortar. *Cem. Concr. Compos.* 41 (2013) 16-23.