Course title	**Materials in Extreme Conditions**
Code	13.3 Chemistry 02-MEXC-11
Value	2 ECTS points
Availability	Winter semester
Prerequisites	None
Teacher	Prof. Andrzej Katrusiak
Teaching method	15-hour lecture
Course description	Materials can drastically change their properties at varied thermodynamical conditions. Methods of materials analysis in varied temperature and high pressure, hydrothermal conditions, strong electric field and in exited states. Experiments of this kinds are performed for investigating properties of materials, phase diagrams, mechanisms of chemical reactions, transformations of molecules, melting of substances etc, but also for practical applications in engineering (jet engines), geology and petrology (minerals and rocks kilometers below the surface, rocks formation), biology (life origin, life at oceans depth) and astronomy (interior of planets and stars). Extreme conditions are also applied for synthesizing new materials of exceptional properties. Diffractometric analysis at extreme conditions, used for determining the microstructure of materials, will be described. Learning outcomes: Students will learn about extreme conditions and thermodynamical aspects of pure sciences of physics, chemistry and biology, as well as their practical and technological consequences; the basic thermodynamic description of extreme conditions, methods of their generating, and analytical methods for determining the structure and properties of materials in extreme environments.
Assessment method	Students will come to class well prepared on the material lectured before and will participate in the class discussion. Students will be asked to facilitate discussion, to raise problems, react to questions, and critique. Requirements for this course are participation in the lecture and tutorials. The final assessment is either (students choose): a paper (ca. 15 pages, 12 cpi, 1.5 spaced) on one of the topics listed or a topic of special interest that is related to class themes; or a test exam.
Syllabus:	
Week 1	Composition of Universe: exceptional normal conditions.
Week 2	Phase diagrams, phase transitions.
Week 3	Thermodynamics and classifications of phase transitions.
Week 4	Lattice vibrations – soft modes.
Week 5	Thermal expansion.
Week 6	Compressibility.
Week 7	Strain – stress analysis, elasticity.
Week 8	Superhard materials – diamond and hard materials of the future.
Week 9	Positive vs. negative Poisson ratio materials. Cork and rubber.
Week 10	Materials analysis at varied temperature and pressure.
Week 11	High-pressure generation – large-scale presses, piston and cylinder devices, diamond-anvil cells.

Week 12	Calibration of pressure and temperature.
Week 13	Diffraction methods at extreme conditions.
Week 14	Hierarchy of interactions at extreme conditions.
Week 15	Prediction of material structure and properties at varied conditions.
Literature	C. Giacovazzo, H. L. Monaco, D. Viterbo, F. Scordari, G. Gilli, G. Zanotti, M. Catti, *Fundamentals of Crystallography*, Oxford University Press, 1992. *Los Alamos Science-Neutron Scattering* –Los Alamos. http://www.lanl.gov/science/ *European Synchrotron Radiation Facility Highlights*, Grenoble. http://www.esrf.eu/UsersAndScience/Publications/Highlights *ISIS, Annual Reports*,http://www.isis.rl.ac.uk/isis2007/pdf/isis2007annualreport.pdf *Materials Today*, Elsevier http://www.materialstoday.com/