

NOMATEN Hybrid Seminar

Location: PNT Room Maria

Time: 1:30 PM

gotomeeting room (for online): <https://meet.goto.com/NCBJmeetings/nomaten-seminar>

Seminar date: May 21st, 2024

Title: Spectroscopic approach to PDC materials designed for corrosion resistance, energy storage, catalysis, etc.

Speaker's name: Dr. Piotr Jelen

Speaker's affiliation: AGH University of Science and Technology, Krakow, Poland

Abstract: Polymer derived ceramics, PDCs, are a group of silicon-based ceramic materials that are gaining increasing interest. The most common ones are carbide, oxycarbide, oxynitride, or silicon nitride. They are characterized by high thermomechanical stability, oxidation and chemical resistance, as well as bioactive and catalytic properties. These materials are obtained based on the pyrolysis of preceramic precursors, most often organosilicon polymers. Thanks to this approach, it is possible to design materials for specific applications. Among these, silicon oxycarbide (SiOC) glasses are the most interesting. The so-called black glasses, due to their color, are polymer derived ceramics (PDC) of amorphous silica structure where part of oxygen was replaced by carbon. This leads to the creation of Si-C/Si-O (C-Si-O) bonds which along with free carbon phase influence physical and chemical properties of the material. Additional modifications at the level of preceramic precursors with appropriate cations make it possible to control the physicochemical properties of the final SiOC glasses, e.g. the addition of boron, copper, iron, nickel or aluminum, which significantly influence the possible applications of these materials. PDC materials can be obtained in solid form as well as layers on various types of substrates. The latter option is especially interesting because it allows obtaining protective or protective-conductive coatings that increase the resistance or physicochemical properties of the substrate materials. As an example improvement in oxidation resistance was observed for SiOC-coated TiAl as well as SiOC-coated Crofer 22APU-based SOFC interconnects. The addition of aluminum even further enhances the oxidation resistance. Thanks to the possibility of adapting chemical properties to specific applications, their range of applications (SiOC materials) is extremely wide and includes the already mentioned protective and bioactive layers, or the possibility of working as catalyst carriers.

The key elements in the structural research of PDC materials are spectroscopic methods, with particular emphasis on infrared spectroscopy (FT-IR) and Raman imaging. These are non-destructive methods showing both the process of formation the SiOC system, as well as their subsequent protection against corrosion. Thanks to the use of surfaces and cross-section chemical imaging methods, it is possible to chemically monitor the course and progress of corrosion in ceramic layers, as well as in the metallic materials themselves.

Bio: Has been an employee of the Structural Research Laboratory located at the Department of Chemistry of Silicates and Large Molecular Compounds (KCKZW) at the Faculty of Materials Science and Ceramics at the AGH University of Science and Technology since 2011.

S. Staszic in Krakow. Specializes in vibrational spectroscopy, primarily Raman and FT-IR spectroscopy. On a daily basis works with LabRAM HR UV-Vis-NIR and WITec Alpha 300M+ spectrometers along with Bruker Vertex 70v. Has qualifications in the field of materials engineering and analytical chemistry. Author of 135 scientific articles in journals from the so-called Philadelphia list with Hirsch index (h-index) is 23 with 1,405 citations. Previous cooperation with NCBJ is documented in 17 publications, including:

1) Polymer Derived Ceramics based on SiAlOC glasses as novel protective coatings for ferritic steel; Bik M., Galetz M., Dąbrowa J., Mroczka K., Zając P., Gil A., Jeleń P., Gawęda M., Owińska M., Stygar M., Zajusz M., Wyrwa J., Sitarz M. ; (2022) Applied Surface Science, 576, art. yeah. 151826, DOI: 10.1016/j.apsusc.2021.151826.

2) Spectroscopic studies on phosphate-modified silicon oxycarbide-based amorphous materials; Gawęda M., Jeleń P., Bik M., Szumera M., Olejniczak Z., Sitarz M.; (2023) Spectrochimica Acta - Part A: Molecular and Biomolecular Spectroscopy, 291, art. yeah. 122341, DOI: 10.1016/j.saa.2023.122341.