DOCTORAL THESES TOPICS FOR THE ACADEMIC YEAR OF 2022/2023

Study program: METALLURGICAL TECHNOLOGY

1. **Influence of strain rate on phase transformations of steels cooled from forming temperature**
   Continuous cooling transformation (CCT) diagrams play a key role in controlling the structural properties of the hot-formed products. Based on their knowledge, the optimal cooling rate after the finishing deformation can be selected for specific steel and thus achieve the required combination of mechanical properties. The kinetics of individual phase transformations is significantly influenced by the parameters of this deformation, which include the strain rate in combination with the magnitude of the cumulated deformation. In recent years, several dozen (D)CCT diagrams influenced by the initial structure or previous deformation have been developed and compared at our workplace, while unique know-how has been acquired. The experiments are based on structural analyzes and the use of the Gleeble 3800-GTC simulator with its dilatometric modules. The advantage of this device is the possibility to apply compressive plastic deformation of different magnitude before cooling at different rates and to change the strain rate in a very wide range. The influence of the strain rate in the case of DCCT diagrams is so far little studied and at the same time very interesting from a theoretical point of view and beneficial for practice (especially rolling mills and forges). The aim of the work will be to generalize the experimentally acquired knowledge with the possibility of their mathematical description, allowing us to predict more accurately the microstructure of bulk-formed steel products.
   Supervisor: Prof. Ing. I. Schindler, CSc., mail: ivo.schindler@vsb.cz

2. **Construction of DCCT transformation diagrams and their application in control of the hot formed steel products' properties**
   Continuous-cooling transformation diagrams of steels influenced by previous deformation (DCCT) are developed in cooperation of scanning non-contact optical dilatometer system (component of the Simulator HDS-20, which is unique in the Czech Republic), structure analyses and hardening measurement. Deformation radically changes the phase transformations kinetics in the course of cooling. DCCT diagrams influenced by the initial microstructure (grain size) are in great demand particularly for the possibility of effective optimization of microstructure and mechanical properties of the hot formed products via their cooling rate.
   Supervisor: Doc. Ing. P. Kawulok, Ph.D., mail: petr.kawulok@vsb.cz

3. **Analysis of the influence of intensive plastic deformation on structure and properties of selected bio-applicable titanium alloys**
   Titanium alloys are at present preferred in medicine especially due to their favourable properties. They have a wide range of application, from dentistry to orthopaedics. Nevertheless, each type of application demands slightly different properties of the given product, which goes hand in hand with variations in structure. The dissertation work will be focused on characterization of selected titanium based alloys subjected to the influence of intensive plastic deformation. Plastic deformation will be imparted into the processed materials via conventional, as well as unconventional forming technologies. The emphasis of the work will be on the analysis of mechanical properties and structure changes related to the particular applied deformation technology. Besides, verification of the influence of deformation ratio and the method of imposing the strain into the material on deformation parameters is planned to be performed.
   Supervisor: Doc. Ing. R. Kocich, Ph.D., mail: radim.kocich@vsb.cz

4. **The study of possibillities for composites production by technologies based on plastic deformation**
   Thesis should be focused on theoretical as well as experimental evaluation of composite materials

preparation. Each production technology will be evaluated in view of structure as well as properties changes of composites. Among others computer simulations will be used in order to predict material behavior. Obtained values will be compared with the results arisen from numerical predictions.

Supervisor: Doc. Ing. R. Kocich, Ph.D., mail: radim.kocich@vsb.cz

5. **Analysis of current and modified SPD processes in view of material structure and properties modification**

The aim of these thesis would be in the study of effectiveness of chosen SPD processes in order to its influence for structure refining i.e. final properties modification. Besides, interest will be paid on the application possibilities of these processes in real conditions. Original as well as newly developed forming SPD processes will be analyzed in this work.

Supervisor: Doc. Ing. R. Kocich, Ph.D., mail: radim.kocich@vsb.cz

6. **Design and development of data assembling methodology for rheological law valid for very high strain rates**

The aim of these thesis would be in the design and development of methodology leading to achievement of data necessary for chosen mathematical models assembling that describe deformation behavior of chosen materials in broader range of temperatures. For these purposes will be part of work carried out on equipment enabling realization of high speed deformation tests. These aims would be reached also by numerical simulation based on FEM software utilization. Besides, interest will be paid also on the application of newly developed modules aiming to description of phenomenon accompanying these forming processes from view of structure development.

Supervisor: Doc. Ing. R. Kocich, Ph.D., mail: radim.kocich@vsb.cz

7. **The possibilities of forming methods application in ODS materials with higher thermal resistance manufacturing**

The aim of these thesis would be in the study of effectiveness of chosen forming processes in view of their suitability for compact bulk materials. Besides, interest will be paid on the grain refinement effectivity or more precisely on final properties. Among others, conventional as well as unconventional forming methods will be studied. Main attention would be paid on monitoring of mechanical properties in particular under higher temperatures. The focus will be devoted also to the possibility to spread these manufacturing methods into commercial scale.

Supervisor: Doc. Ing. R. Kocich, Ph.D., mail: radim.kocich@vsb.cz

Study program: CHEMICAL METALLURGY

8. **Characterization and study of electrochemical properties of selected types of solid industrial wastes after acid leaching**

This work will be focused on the study of electrochemical properties of selected solid wastes, such as metallurgical sludge and dust, after acid leaching, aiming at their possible further processing. Detailed characterization of the structure of studied materials will be carried out. The influence of phase transformations on their electrochemical properties will be studied using model oxide systems. Modified carbon paste electrodes will be applied to study electrochemical properties. Elemental analysis of investigated solid wastes will be performed by XRFS method, information on the internal structure of material and electrochemical products will be provided by X-ray diffraction, SEM analysis, FTIR and Raman spectroscopy. As for the electrochemical methods, chronocoulommetry and cyclic voltammetry will be employed.

Supervisor: Doc. Ing. Š. Langová, CSc., mail: sarka.langova@vsb.cz

9. **Theoretical and experimental study of fine-grained metallurgical wastes recycling**

In the context of sustainable development, the use of waste as a secondary raw material is still actual. The amount of collected fine-grain dust increased as a consequence reduction of emission from metallurgical and sinter plants. These dust usually contain more than 20 wt. % of iron and a number of other elements and compounds that can be used in industry. Size of dust particles is the

second problem of using material as raw. It is necessary know the method of separation different element and compounds but it is interest study processes how to prepare pellet/briquette and make manipulation with dust easier. Search suitable material for pellet/briquette preparation and study chemical reaction during their processing in metallurgical plants is the topic or dissertation thesis.

Supervisor: Prof. Ing. J. Seidlerová, CSc., mail: jana.seidlerova@vsb.cz

10. Study of organic formation in recycling processes of metallurgical waste

Metallurgical wastes are an important source of iron. However, their recycling is associated with specific problems, including the generation of gaseous pollutants. The work is focused on the study of gaseous pollutants formation depending on the type of both the recycling process and the processed waste under laboratory conditions. Knowledge of the mechanisms and causes of gaseous pollutants formation could contribute to preventing their occurrence.

Supervisor: Prof. Ing. J. Seidlerová, CSc., mail: jana.seidlerova@vsb.cz

11. Study of electrochemical properties of original and variously treated metallurgical sludges using carbon paste electrodes

The work will be focused on the study of electrochemical properties of original and chemically or thermally treated metallurgical sludges. A modified carbon paste electrode will be used for this purpose. This electrode enables, by means of a modifier, to study in detail the electrochemical behavior of the selected material. Pure iron oxides will be used as model systems. The results will be verified on solid Fe-electrodes.

Elemental analysis of investigated solid wastes will be performed by XRFS method, information on the internal structure of material and electrochemical products will be provided by X-ray diffraction, SEM analysis, FTIR and Raman spectroscopy. Phase changes caused by temperature regime will be studied by thermal analysis. As for the electrochemical methods, chronocoulometry, potentiometry and cyclic voltammetry will be employed.

Supervisor: Doc. RNDr. B. Kostura, Ph.D., mail: bruno.kostura@vsb.cz

12. Binder systems for diamond grinding tools

The dissertation will focus on the design, preparation and complex characterization of new binder systems based on non-ferrous metals for the diamond grinding tools sintered along the boundaries of diamond grains. Diffusion processes and phase transformations in the systems as Cu-Sn-Ti, Cu-Sn-Co, etc., taking place during the sintering process will be studied in detail. The findings will lead to the development of innovative diamond grinding tools for machining products such as cemented carbides and glass, which will have improved performance, especially lower resistance in machining, improved self-sharpening properties and increased dimensional stability. The structural characteristics, chemical and phase composition of the prepared composite materials will be investigated using scanning electron microscopy, energy-dispersive X-ray spectroscopy, thermal analysis, XRPD, etc.

Supervisor: Doc. Ing. K. Skotnicova, Ph.D., mail: katerina.skotnicova@vsb.cz

13. Preparation of inverse Heusler alloys Mn2FeZ by powder metallurgy techniques

Heusler alloys based on Mn (X2YZ) have great application potential in the field of shape memory, giant topological Hall effect, spin-transfer torque, etc. The dissertation will focus on the preparation and complex characterization of new inverse Heusler alloys by powder metallurgy methods. These alloys will be obtained by mechanical alloying in a high-energy ball mill, followed by powder forming and sintering of compacts under various conditions in order to achieve a bulk material with low porosity. Alloys in powder and sintered form will be subjected to structural, chemical and phase analysis using scanning electron microscopy, energy-dispersive X-ray spectroscopy, thermal analysis methods, XRPD, etc. Magnetic

Supervisor: Doc. Ing. K. Skotnicova, Ph.D., mail: katerina.skotnicova@vsb.cz

14. Synthesis and physicochemical characterization of iron oxides nanocomposites with carbon coatings: FexOy/C used as electrode materials in batteries and supercapacitors

The main aim of the doctoral thesis is to develop cost-effective methods of preparation of nanocrystalline iron oxides and their nanocomposites with carbon coatings: FexOy/C of the appropriate structural and electrochemical properties, which find an application as the electrode materials in batteries and supercapacitors. The materials will be synthesized i.e. using modified sol-gel methods, co-precipitation, hydrothermal or combustion methods. Some part of this research work will be focused to create nanocomposites with carbon coatings, i.e. with MWCNT, rGO or g-C3N4. All the synthesized electrode materials will be extensively characterized using several complementary techniques. The crystal structure of the electrode materials will be analyzed by X-ray powder diffraction combined with Raman spectroscopy techniques, the particle size and morphology will be studied by SEM, TEM, HRTEM. Additionally, BET measurements will be used to control the specific surface area and porosity of the synthesized materials. Electrochemical measurements will be performed on the electrode's prepared from the synthesized materials.

Supervisor: Doc. Ing. V. Matějka, Ph.D., mail: vlastimil.matejka@vsb.cz

15. Study of chemical heterogeneity of materials using methods of thermal analysis

The dissertation will focus on the study of microsegregation processes at the crystallization of materials (especially metal) using methods of thermal analysis. The possibilities of predicting basic segregation characteristics, such as the partition coefficient based on DTA or DSC analysis, will be studied. The focus of the work will be mainly on our own experimental measurements on Setaram SETSYS 18TM or Netzsch STA 449 F3 Jupiter devices. The aim of the work will be the development of a methodology for the description of microsegregation processes during crystallization and subsequent prediction of chemical heterogeneity for selected systems. The student is expected to have a good knowledge of English, especially due to work with foreign language sources of information.

Supervisor: Prof. Ing. J. Dobrovská, CSc., mail: jana.dobrovska@vsb.cz

16. Study of materials for heat storage and transport technologies

Thesis is focused on the study and development of innovative inorganic materials in solid and liquid phase (liquids and melts) for thermal energy storage, transport and conversion (TESm - Thermal Energy Storage materials and HTF – Heat Transfer Fluids). Aim of the study is obtaining of modified and new stable progressive materials usable in technological applications (e.g. in the field of CSP - Concentrated Solar Power technologies and in other technological fields) with the pottential of more efficient energy storage, transport and conversion. Modification of known and development of new materials with their study will be realised for low (bellow 550 °C) and high (above 550 °C) temperature applications. Experimental study of materials will be realised mainly with use of thermal analysis (TA) and calorimetric methods: DTA, 3D DSC, TG, TG/DTA, TG/DSC a Dilatometry. Theoretical study will be realised also. The subject matter is thermophysical, thermodynamical and kinetic behaviour – properties (behaviour) study of synthesised materials – relation between chemical and phase composition and resulting properties.

Supervisor: Prof. Ing. B. Smetana, Ph.D., mail: bedrich.smetaa@vsb.cz

Study program*:* NANOTECHNOLOGY

17. CO2 transformation to valuable chemicals by photocatalytic processes over highly active materials

The main goal of the work is to describe the fundamental facet of the effects on the activity of prepared materials in the CO2 transformation and to clarify the relationship between the activity, selectivity and stability of materials and their physico-chemical properties.

Supervisor: Prof. Ing. K. Kočí, Ph.D., mail: kamila.koci@vsb.cz

18. Study of properties of sorbents based on carbon foam

As part of the dissertation, chemical modifications of carbon foam will be performed using various nanoparticles to improve sorption or catalytic properties leading to effective removal of inorganic

and organic pollutants from water and air. Nanoporous carbon foams will be prepared from natural substances and subsequently modified and characterized in terms of physicochemical, structural and sorption properties. The dissertation will be developed in close collaboration with Northumbria University, Newcastle upon Tyne, UK.

Supervisor: Prof. Ing. D. Plachá, Ph.D., e-mail: daniela.placha@vsb.cz

19. <u>Preparation of polymer membranes for wastewater treatment</u>

The dissertation will focus on the preparation of robust and efficient thin-film polymer and polymer nanocomposite membranes suitable for the separation of substances from the aqueous environment in industrial applications. The student will focus on the preparation of polymers and polymer nanocomposites in the form of a thin film, including the selection of suitable polymers and nanofillers, as well as on the study of their physicochemical, structural, and mechanical properties. Selected materials will then be used to separate substances from water. The dissertation will be prepared in cooperation with an industrial partner in the Czech Republic.

Supervisor: Prof. Ing. D. Plachá, Ph.D., e-mail: daniela.placha@vsb.cz

20. <u>Preparation of polymer nanocomposites with antimicrobial effects</u>

As part of the dissertation, polymeric biocompatible nanocomposites with antimicrobial effects with a wide range of applications will be prepared, eg for the preparation of support scaffolds for cell growth with the possibility of using 3D printing or for other biomedical applications. The use of various nanofillers, optimization of material composition and subsequently physicochemical, structural, mechanical, antimicrobial, and cytotoxic properties of prepared materials will be studied. Based on the identified properties, suitable applications will be designed and tested. The dissertation will be prepared in cooperation with ICTP / CSIC in Madrid.

Supervisor: Prof. Ing. D. Plachá, Ph.D., e-mail: daniela.placha@vsb.cz

21. <u>Preparation of scaffolds based on natural polymers</u>

As part of the dissertation, supporting macroporous scaffolds based on natural polymers with antimicrobial effects suitable for growing and growing cells will be prepared. The work will optimize the preparation and composition of the material and then test the physico-chemical, structural, mechanical, antimicrobial, and cytotoxic properties of the prepared materials, including their degradability. The dissertation will be prepared in cooperation with ICTP / CSIC in Madrid and Czech industrial partner.

Supervisor: Prof. Ing. D. Plachá, Ph.D., e-mail: daniela.placha@vsb.cz

22. <u>Preparation and modification of carbon nitride-based nanocomposites: photocatalytic and antibacterial aktivity</u>

Recently, the number of research projects dealing with graphitic carbon nitride (g-C_3N_4) has increased. This is an organic lamellar semiconductor photocatalyst that is capable of generating electrons and holes using sunlight. The resulting charge carriers then react on the surface of this photocatalyst with oxygen dissolved in water to form redox species (hydrogen peroxide, superoxygen and hydroxyl radical) that can be used to destroy pollutants or to eliminate bacteria that may be resistant to antibiotics. The research will look at modifying g-C_3N_4 with inorganic compounds to enhance not only the photocatalytic activity but also the antimicrobial properties.

Supervisor: Doc. RNDr. R. Dvorsky, Ph.D., e-mail: richard.dvorsky@vsb.cz

23. <u>Preparation of sorption nanostructures with photocatalytic regeneration</u>

The water and air treatment sorbents must be replaced after saturation and the exposed material must be disposed of or costly restored. Permanent photocatalytic regeneration of pollutants to non-toxic components directly on the sorption surface could be a much more economical option, especially if the regeneration is carried out by solar radiation. In our laboratory, we have successfully prepared a sorption material capable of photocatalytic regeneration by sunlight and have focused on enhancing the sorption capacity of such materials using a patented controlled sublimation process.

Supervisor: Doc. RNDr. R. Dvorsky, Ph.D., e-mail: richard.dvorsky@vsb.cz

24. Nucleation of photosensitive nanoparticles and their modification using sradiation sources

The nucleation process of the new phase is a very important initial stage of solid phase crystallization in both precipitation reactions and melt cooling. While homogeneous nucleation of critical nuclei is less likely in terms of statistical thermodynamics, in practice heterogeneous nucleation at phase interfaces and secondary nucleation dominate. In contrast to primary nucleation, homogeneous or heterogeneous nucleation, secondary nucleation is initiated by other means such as by already presented nanoparticles, mechanical activation by the stirrer and a number of other influences. One of them is the excitation and ionization of atoms due to the absorption of different types of radiation by the substance. It is in this area that research is planned on secondary nucleation initiated by electromagnetic radiation of UV, X-ray and γ, and corpuscular radiation of β^-.

Supervisor: Doc. RNDr. R. Dvorsky, Ph.D., e-mail: richard.dvorsky@vsb.cz

25. Desintegration and exfoliation of nanoparticles by cavitation high-energy water jet CWJM

When a high-energy liquid beam enters the liquid dispersion of nanoparticles,it generates intense shear stresses and simultaneously cavitation occures in its vicinity. The cavitation implosion of microbubbles generates hydraulic shocks on the particle surface with impact pressures up to tens of GPa, which significantly exceed the strength parameters of the materials. This mechanism causes the dispersed microparticles to disintegrate into nanoparticles. Exfoliation of layered lamellar materials such as graphite is also a significant issue in current nanotechnology. Lamellar materials dispersed in a liquid can also be effectively exfoliated by extreme shear stress in the vicinity of a high-energy liquid beam.

Supervisor: Doc. RNDr. R. Dvorsky, Ph.D., e-mail: richard.dvorsky@vsb.cz

26. Preparation of heterogeneous catalysts based on transition metal oxides and lanthanides enriched with active species for catalytic oxidation of volatile organic compounds

The doctoral work will bring new knowledge about the effect of preparation and chemical composition of heterogeneous supported catalyst on its physico-chemical properties (micro/structure, acidity, reducibility etc.) and catalytic activity in oxidation of volatile organic compounds (VOCs) often used as solvents in pharmaceutical industry. In the frame of the work the catalyst preparation and chemical composition will be optimized in order to achieve catalyst highest performance from the view of catalytic activity as well as selectivity and durability. The attention will be also dedicated to the description of oxidation mechanism of selected VOCs on the developed heterogeneous catalyst. Within the catalytic experiments the oxidation of dichloromethane, formaldehyde or toluene will be investigated. Student will partially do the experimental work in cooperation with foreign university via the short-term student stays.

Supervisor: Prof. Ing. L. Obalová, Ph.D., e-mail: lucie.obalova@vsb.cz

27. Nanoporous carbon for energy storage

The thesis is focused on the study and research of meso and nanoporous carbonaceous material with graphitic structure. The preparation of the material is accomplished by carbonization of the macromolecular precursor material and high temperature treatment in an inert atmosphere. Graphitic material will be part of the cathode nanocomposite with Li-S or Li-Si components. Carbonized material is used to improve the electrochemical properties of the sulfur or silicon system, the disadvantages of which are: low electrical conductivity; dissolution of lithium polysulphides which causes the deposition of insoluble lithium sulfide on the anode and the overall loss of conductivity; and pulveriyation of electrode materials due to bulk material changes. Part of the thesis will be experimental development associated with chemical and structural evaluation of nanocomposites , the study of theoretical properties of the material on the basis of molecular modeling.

Supervisor: Doc. Ing. G. Simha Martynková, Ph.D., e-mail: grazyna.simha@vsb.cz

28. Biocompatible hydroxyapatite ceramics and its composites with a biogenic component

The doctoral thesis will focus on the synthesis and preparation of hydroxyapatite ceramics for dental and orthopedic prosthetic use, as well as characterization in terms of structure and chemistry, and evaluation of application parameters. The prepared ceramic via chemical route will be tested for biocompatibility. The aim is to create material with improved mechano-chemical parameters, increased biocompatibility and the possibility of integration with living tissue. The prepared ceramics will be modified with various types of organic substances, especially to increase the antimicrobial and regenerative ability of the final product in the body.

Supervisor: Doc. Ing. G. Simha Martynková, Ph.D., e-mail: grazyna.simha@vsb.cz

29. Advanced diffraction optical structures in security holography

The main target of the thesis is to design new diffracting structures for applications in security holography. The structure will exhibit special colour effects, 3-dimensional animation effects, polarization selectivity, and light capture. The sample structure will be prepared using laser lithography and physical vapor deposition.

Supervisor: Doc Dr. Mgr. K. Postava, e-mail: kamil.postava@vsb.cz

30. Spintronic terahertz coherent sources

The thesis will focus on design, preparation and characterization of novel spintronic-based sources of monochromatic Terahertz radiation. The polarized emission of light using spin-polarized carriers will be studied in both theoretical and experimental point of view.

Supervisor: Doc Dr. Mgr. K. Postava, e-mail: kamil.postava@vsb.cz

31. Properties of ultrafast spin-orbit current in magnetic multilayers

Dynamics of spintronic and spin-transport phenomena will be studied using pump-probe technique based on ultrashort pulsed laser beam. The pumped electric pulse will be obtained using Auston switch. Probe beam delayed by optical delay line will inspect magnetic state using magneto-optical effects. Testing structure will be prepared using advance lithography.

Supervisor: Doc Dr. Mgr. K. Postava, e-mail: kamil.postava@vsb.cz

32. Advanced methods of Mueller matrix ellipsometry

The main target of the thesis is develop advanced ellipsometric technique and apply them to characterize special samples with high impact in semiconductor industry, biomedicine, material science, and nanotechnology. The methods will include measurement in wide spectral range from ultraviolet to terahertz frequencies, determination complete polarization response including anisotropy, optical activity, magneto-optical effects, etc. Also special configuration for variable azimuthal angle and angle of incidence and scaterring techniques will be applied.

Supervisor: Doc Dr. Mgr. K. Postava, e-mail: kamil.postava@vsb.cz

33. Stability study of functional composites

Clay minerals are potential adsorbents of inorganic or organic pollutants due to their structural arrangement. In addition, their adsorption can be altered by surface treatment or intercalation. Thus, the specific adsorbents – composite - can be designed for selective adsorption. Such a composite must not only have a good adsorption capacity, but it must be stable in the environment. The aim of this work is to propose a method that could test the stability of functional composite containing particles/nanoparticles of metal oxides.

Supervisor: Prof. Ing. J. Seidlerová, CSc., e-mail: jana.seidlerova@vsb.cz

34. Biosynthesis of metal nanoparticles by plant biomass and study of nanoparticles formation

The biological way (bioreduction) is an alternative method for nanoparticles preparation. The main goal of this work will be the preparation of metal or metal oxides nanoparticles by biosynthesis (bioreduction) with plants extracts, identification of phytochemicals and other biomolecules which are participating in the bioreduction process and the clarification of the particular biosynthesis mechanisms.

Supervisor: Prof. Ing. J. Seidlerová, CSc., e-mail: jana.seidlerova@vsb.cz

35. Molecular simulation of adsorption on nanocomposite adsorbents and adsorbents prepared from natural materials

The subject of the dissertation is to compare different strategies for simulating the adsorption of molecules on materials with complex and/or difficult to define structure (natural phyllosilicates intercalated and surface modified with organic substances, core@shell structures, activated carbon, etc.). Adsorption simulations on large and complex models of adsorbent structures (very time consuming) will be compared with adsorption simulations on simplified models in order to achieve comparable results and find the optimal degree of simplification. The aim of the dissertation is to find simple and fast simulation strategies providing sufficiently accurate results for given types of adsorbents.

Supervisor*: Doc. Ing. J. Tokarský, Ph.D., e-mail: jonas.tokarsky@vsb.cz*

Study program*:* THERMAL ENGINEERING AND FUELS IN INDUSTRY

36. Research and determination of boundary conditions during cooling of semi-finished products produced by continuous casting and hot forming

Research of dependences of thermal boundary conditions during cooling of continuously cast billets or rolled products on parameters of cooled object and surrounding environment and development of measuring methods for their determination.

Supervisor: Prof. Dr. Ing. R. Pyszko, mail: rene.pyszko@vsb.cz

Study program: CHEMICAL AND ENVIRONMENTAL ENGINEERING

37. Catalytic destruction of nitrogen containing pollutants

Nitrogen oxides (N2O, NO, NO2) and NH3 are significant pollutants. Many current technologies for reducing these substances in waste gases are economically demanding or require the presence of a reducing agent (ammonia, urea, hydrocarbons) that can lead to emissions of other pollutants (ammonia slip). It is therefore desirable to develop and test new methods for reducing emissions of these components.

The main task will be an experimental study of catalytic degradation of nitrogen oxides without the use of a reducing agent and/or oxidation of NH3 on catalysts containing selected transition metals and a description of the physical-chemical properties of catalysts by available analytical techniques (chemical analysis, X-ray diffraction, physical nitrogen sorption, temperature-programmed desorption and reduction, etc.). The aim of the thesis will be to assess the effectiveness and stability of the materials studied, to clarify the mechanism of ongoing reactions and the relationships between the properties of catalysts and their activity and selectivity, and to optimize the method of catalyst preparation.

Supervisor: Prof. Ing. L. Obalová, Ph.D., mail: lucie.obalova@vsb.cz

38. Monolithic catalysts based on transition metal oxides and lanthanides enriched with active species prepared in supercritical and pressurized hot fluids for catalytic oxidation of volatile organic compounds

The doctoral work will bring new knowledge about preparation of monolithic catalysts with active species in supercritical and pressurized hot fluids, the effect of preparation and chemical composition of heterogeneous supported catalyst on its physico-chemical properties (micro/structure, acidity, reducibility etc.) and catalytic performance in oxidation of volatile organic compounds (VOCs) often used as solvents in pharmaceutical industry. In the frame of the work the catalyst preparation and chemical composition will be optimized in order to achieve catalyst highest performance from the view of catalytic activity, selectivity as well as durability. The attention will be also dedicated to the description of oxidation mechanism of selected VOCs on the developed heterogeneous catalyst. Within the catalytic experiments the oxidation of dichloromethane, perchlorethylene or toluene will be investigated. Student will partially do the experimental work in cooperation with foreign university via the short-term student stays.

Supervisor: Prof. Ing. L. Obalová, Ph.D., mail: lucie.obalova@vsb.cz

39. Photocatalytically active materials in building industry

The theme of doctoral thesis is focused on the utilization of photocatalytically active materials (photocatalysts) in building industry. Photocatalysts are used in the field of photocatalytic cleaning of water and air and thus contribute to elimination of contaminants in living environment. Application of the photocatalyts in building industry for air purification is promising with respect to the fact that the surfaces of building are in direct contact with surrounding atmosphere. Building materials based on latent hydraulic materials, for example metallurgical slags, represents still not widely used alternative to common building materials based on Portland cement. Application of photocatalytically active materials in the mixtures of latent hydraulic materials, or deposited on their surfaces, could further increase the utility value of the resulting products. The aim of the work is to propose and prepare suitable photocatalysts and verify their applicability and functionality in the mixtures of alkali activated latent hydraulic materials. Part of the work will be also focused on the description of the effect of photocatalyst on hydration processes. As the output of the work the formulation of the mixture including selected: i) latent hydraulic material, ii) alkali activator and iii) selected photocatalyst will be proposed with emphasize to acquire the optimal ratio between photocatalytic performance and mechanical properties. The indication of possible specific application of developed material will be proposed as well.

Supervisor: Doc. Ing. V. Matějka, Ph.D., mail: vlastimil.matejka@vsb.cz

40. Preparation of polymer membranes for gas and vapour separation

The dissertation will focus on the preparation of robust and efficient thin-film polymer nanocomposite membranes suitable for the separation of gases and vapors in industrial applications. The prepared membranes will be tested for the regeneration and purification of hydrogen, CO2 and other gases, for the separation and regeneration of volatile organic compounds and other hydrocarbons. The dissertation will focus on the preparation of polymer nanocomposites in the form of a thin film, including the selection of suitable polymers and nanofillers, the study of its physicochemical, structural and mechanical properties and then also test the transport of selected gases.

Supervisor: Prof. Ing. D. Plachá, Ph.D., mail: daniela.placha@vsb.cz

Study program: MATERIAL SCIENCE AND ENGINEERING

41. Treatment technology of low-calcium coal fly ash for building materials production

Fly ash is a coal combustion by-product with low pozzolanic reactivity which limits its resource utilization and engineering properties in building materials. The study will investigate a wet-milling treatment to activate the coal fly ash and promote its sustainable utilization in production of high quality concrete. The quality of concrete represented by structure and pressure strength will be compared with the concrete produced by the standard technology.

Supervisor: Prof.Ing.B.Strnadel,DrSc., mail: bohumir.strnadel@vsb.cz

42. Physical-metallurgical fundamentals of high coercivity Nd-Fe-B magnets with decreased content of rare earth metals

The thesis will be aimed at the development of physico-metallurgical fundamentals of new type of magnetic materials based on Nd-Fe-B system with decreased content of REM intended for high-coercivity permanent magnets with the high temperature-time stability.

Main research activities:

a) The effect of principal manufacturing parameters of magnetic materials based on R2Fe14B intermetallic compound (R = Nd, Pr, Dy, Tb), i.e. conditions of powder material preparation, alloying method, alloying composition, sintering and heat treatment conditions) on their structural and magnetic characteristics.

b) The study of phase transformations and diffusion processes, which occur during the formation of intergranular Nd-rich phase and principal-phase-grains in the course of mechanical activation and sintering.

Supervisor: Doc.Ing.K.Skotnicová,Ph.D., e-mail: katerina.skotnicova@vsb.cz

43. Improvement of physical-mechanical and utility properties of diamond layers based on non-ferrous metals

Shape accuracy and surface quality are key for many applications. Diamond grinding and cutting wheels with a metal matrix show good shape retention due to the high strength and rigidity of the metal bond. Therefore, they are applied mainly in precise and ultra-precise grinding or cutting processes. The aim will be to increase the physical-mechanical and utility properties using post-compaction methods. Improved types of diamond grinding and cutting tools will increase grinding / cutting speed, reduce resistance when machining workpieces, and extend the life of CNC machines. At the same time, they will enable higher deployment of production robotization, as they will significantly increase the tool change interval. The structural characteristics, chemical and phase composition of the prepared composite materials will be investigated using scanning electron microscopy, energy-dispersive X-ray spectroscopy, thermal analysis, XRPD, etc. Hardness and bending strength will be investigated in terms of mechanical properties.

Supervisor: Doc.Ing.K.Skotnicová,Ph.D., e-mail: katerina.skotnicova@vsb.cz

44. The effect of hydrogen on fatigue and brittle fracture properties of steels used for pressure cylinders production

The dissertation thesis is focused on the effect of pure high-pressured hydrogen to fatigue and brittle fracture properties of materials used for production of pressured cylinders used for hydrogen transportation. The topic is highly actual from the point of view based on a use of new energy resource (hydrogen, CNG, etc.). The effect of hydrogen embrittlement will be evaluating on the basis of unconventional test methods e.g. fracture toughness measurement and fatigue crack growth rate with subsequent fractographic analysis of fracture surface. The aim of dissertation thesis will be comparison studied material behaviour on air and in the pure hydrogen environment and optimalization of heat treatment with intention of as high as possible elimination of the effect of hydrogen on studied material with crack under static and fatigue loading.

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Study program: MANAGEMENT OF INDUSTRIAL SYSTEMS

45. Using Non-traditional Control Systems in Industry

Nowadays we can see rapid increasing usage of simple one chip controllers. These are not directly determined for control purposes in metallurgy. The goal of this thesis will be an overview of these systems, supply they adequate safety and system software.

Supervisor: Doc. Ing. I. Špička, Ph.D., mail: ivo.spicka@vsb.cz

46. Distributed Systems using Lightweight Communication Protocols

Within the Industry 4.0 conception, to design a system that would enable the collection of operational and technological data from production. It would utilize lightening communication protocols (Mqtt), microcomputer systems (eg Raspberry Pi, wireless communication modules) and utilize appropriate visualization tools in web browsers. The aim is to design a distributed data acquisition system using suitable sensors.

Supervisor: Doc. Ing. I. Špička, Ph.D., mail: ivo.spicka@vsb.cz

47. Data Processing with Artificial Intelligence Methods

Analytical methods do not always lead to optimal results. The use of modern techniques based on artificial intelligence principles, especially in metallurgy, can improve data processing. The

goal would be the proposal and verification of methods and methodology for smart data processing.

Supervisor: Doc. Ing. I. Špička, Ph.D., mail: ivo.spicka@vsb.cz

48. The Role of Employee Adaptation Process based on Availiability of Qualified Employees on the Labour Market

The aim of the dissertation thesis is to define the theoretical basis of the adaptation of employees to a new job in an industrial company based on a review of current Czech and world literature. The practical part will focus on defining and demonstrating the importance and benefits of the adaptation process in the conditions of an industrial enterprise. The outcome will be to propose a procedure for evaluating the effectiveness of the adaptation process based on the inclusion and definition of all related costs of adaptation and recommendations of measurable criteria of employee adaptation benefits for the company. Recommended methods: literature search (recherche), analysis, synthesis, multicriteria comparison.

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49. Sustainable Project Management in Industrial Companies

The aim of the thesis is to create a methodology for the implementation of sustainable principles in the project management of industrial enterprises. Current sustainability trends and possibilities of their implementation in the given area of business management will be examined. The benefits, risks, limitations and other aspects of this implementation will be analyzed. The suitability of the methodology will be verified using a case study.

Supervisor: Doc. Ing. P. Wicher, Ph.D., mail: pavel.wicher@vsb.cz

50. Sustainability and Resilience Assessment System for the Industrial Companies

The aim of the thesis is to create an evaluation system combining the concepts of sustainability and resilience, which will be based on key performance indicators (KPI), multicriteria decision-making methods (MCDM) and the Balanced Scorecard (BSC) method. Not only the scientific principles of the proposed system will be addressed, but also all aspects of its practical implementation. The suitability of the system will be verified using a case study.

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51. Effective Sustainability Reporting of Industrial Enterprises

The aim of the thesis is to create a methodology that will define the effective process and output of sustainable reporting. This methodology will be based on a systematic classification and evaluation of current principles, options and trends in sustainability reporting. The main groups of documents will include reporting standards, reports of selected leading industrial companies and scientific publications. The suitability of the methodology will be verified using a case study.

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