XXIII. ročník odborného semináře doktorandů

ANORGANICKÉ NEKOVOVÉ MATERIÁLY

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Ústav skla a keramiky

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Úvod

Programem semináře jsou odborné přednášky doktorandů akademických pracovišť působících v oblasti chemie a technologie anorganických nekovových materiálů.

Organizátor semináře

Ústav skla a keramiky, VŠCHT Praha

Webová stránky

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Poděkování

Ústav skla a keramiky děkuje všem zaměstnancům VŠCHT Praha a doktorandům, kteří se na přípravě semináře podíleli.

PROGRAM SEMINÁŘE ANM 2017

1. Blok - host

Sekce I (9:30 – 10:15)

Dr. Sencer Sari 9:30-10:15
Uranium compounds in Art (str. 6)

PAUZA (10:15 – 10:30)

2. Blok - soutěžní sekce

Sekce II (10:30 – 11:50)
předsedající: doc. RNDr. František Škvára, DrSc.

Ing. Jakub Roleček 10:30-10:50
Mechanical properties of hybrid ceramic composites prepared by ice-templating (str. 9)

Ing. Tomáš Spusta 10:50-11:10
Study of transition from open to closed porosity stage during sintering of advanced ceramic materials (str. 10)

Ing. Tereza Uhlířová 11:10-11:30
Microstructure characterization of heterogeneous materials by microscopic image analysis and tomography (str. 11)

Ing. Mária Kavanová 11:30-11:50
Study of the glaze – ceramic body system of contemporary and historical ceramics (str. 13)

PAUZA (11:50 – 12:05)

Sekce III (12:05 – 13:05)
předsedající: prof. Dr. Dipl.-Min. Willi Pabst

Mgr. Eliška Duchková 12:05-12:25
Sorption of Pb^{2+} on waste brick dust (str. 14)

Ing. Vít Kašpárek 12:25-12:45
Colloidal nanoparticle processing and water splitting catalyst preparation (str. 15)

Ing. Kristýna Rysová 12:45-13:05
Electro-Optic Modulators Made of Glasses with Ag Nanoparticles (str. 17)

PAUZA NA OBĚD (13:05 – 14:10)

VYHLÁŠENÍ VÝSLEDKŮ SOUTĚŽNÍ SEKCE (14:10)

3. Blok

Sekce IV (14:15 – 15:15)
předsedající: prof. RNDr. Ondřej Gedeon, Ph.D.

Ing. Hua Tan 14:15-14:35
Impact of iron doping on induction heating during spark plasma sintering (str. 19)

Ing. Soňa Vytykáčová 14:35-14:55
Preparation and optical properties of silicate glasses containing silver nanoparticles (str. 20)

Ing. Mgr. Barbora Holubová 14:55-15:15
Recent advances and final steps in the field of protective hybrid silica coatings on historical glass (str. 22)

PAUZA (15:15 – 15:30)

Sekce V (15:30 – 16:30)
předsedající: prof. Ing. Aleš Helebrant, CSc.

Ing. Dana Mikolášová 15:30-15:50
Použití ve vodě rozpustných polymerů pro přípravu tenkých vrstev (Er3+/Yb3+):LiNbO3 pomocí sol-gel metody (str. 24)

Ing. Petr Hejda 15:50-16:10
Struktura a vlastnosti zinečnato-železitých metafosforečnanových skel (str. 26)

Ing. Nikola Bašinová 16:10-16:30
Teluričitá skla systému TeO_2 - $PbCl_2$ - MxOy (M = Bi, Mo, Sb, W, Zn) (str. 27)

Uranium Compounds in Art

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Various rare elements which were extremely expensive and difficult to extract from nature are nowadays easier to access due to advanced technology. This in turn has led to the widely use of such elements in the ceramic and glass industries with studies on their oxides and salts. Ceramic and glass artists who especially follow these new technologies and aim to apply them to art, have attained new experience using the various effects of the oxides and salts of such rare elements. There are various different effects, bodies and application methods available by trial of effects of these elements under different heating conditions. Following these progresses researchers have found the opportunity to improve their studies in the area of glass and ceramic arts by observing the different effects of these rare alkalines which cannot be obtained through known elements and the varying of effects under different heating conditions for applications in art. All these improvements have accelerated the research in the area of ceramic and glass art.

In this research presentation, the behavior within glazed ceramic/porcelain bodies of attained various rare soil elements and some oxides of which compounds are rarely found in the ceramic technology have been researched and conclusions drawn. Various studies have been carried out with attained oxides or compounds of elements such as Uranium , Thorium, Fransium, Selenium, Lanthanum, Cerium, Erbium and as a result of these trials the usage of these elements in ceramic and glass arts has been assessed. All positive and negative conclusions have been documented in this research study by low and high heating conditions.

The Czech Ceramic Society: National Student Speech Contest

8th February 2017, UCT Prague, Section of ANM 2017

The winner of the student speech contest will represent Czech Republic for the ECerS student speech contest on the 9th -13th July 2017 in Budapest, Hungary. The winner obtains free registration to ECerS XV and up to 500 € to cover travel costs and accommodation.

The presentation duration will be 15 minutes, followed by questions from the jury and the audience.

The commission will be composed of three members:

- Dr. Ing. Michal Přibyl
- Doc. Ing. Jaroslav Kutzendörfer, CSc.
- Doc. Ing. David Salamon, Ph.D.

The list of nominated competitors

- Ing. Jakub Roleček
- Ing. Tomáš Spusta
- Ing. Tereza Uhlířová
- Ing. Mária Kavanová
- Mgr. Eliška Duchková
- Ing. Vít Kašpárek
- Ing. Kristýna Rysová

ABSTRAKTY

Soutěžní sekce (I, II)

Mechanical properties of hybrid ceramic composites prepared by ice-templating

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Ice-templating, also known as freeze-casting, is a relatively simple, inexpensive, and very versatile technique to fabricate bulk porous scaffolds with controlled microstructure. Promising application is preparation of hybrid ceramic materials. Effort in designing and manufacturing hybrid ceramic composites is to emulate nature's toughening mechanisms by infiltration of polymers into ceramic structures. Such biomimetic materials have significantly better mechanical properties (tensile strength, fracture toughness) than the individual compounds that they are made of. However, for future applications is necessary to scale up ice-templating process. The main challenge linked with large scaffolds prepared by ice-templating method is achieving of controlled ice crystals growth throughout the whole sample volume. This phenomenon is caused by loss of sufficient temperature gradient in the ceramic suspension as the solidification front moves away from the cooling plate. Thus it is necessary to precisely control the ice-templating process. Ceramic suspension containing alumina (Al_2O_3) in water was used in this work. An influence of suspensions solid loading and additives on formation of lamellar roughness and interlamellar bridges was investigated during ice-templating of large ceramics scaffolds. Effects of these microstructural ceramic parts of hybrid composites on mechanical properties was studied and discussed.

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Study of transition from open to closed porosity stage during sintering of advanced ceramic materials

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Capsule-free hot isostatic pressing (HIP) represents a cost-effective variant to classical HIP allowing production of ceramics with top properties. For successful application of capsule-free HIP it is necessary to close all pores to prevent infiltration of the high-pressure gas into ceramics. This occurs when the sample completely transits from 2nd to 3rd stage of sintering, i.e. all open pores get closed at a density called critical density.

A robust experimental study of this transition for several materials (alumina, magnesia-alumina spinel, tetragonal and cubic zirconia) has been carried out and compared with three theoretical models. From theoretical models it follows that critical density is a material parameter depending only on dihedral angle and being independent of particle size, green density and pore size distribution. It varies from 88.1% to 93.7% of theoretical density for studied materials and used models. Measured critical densities agree well with models by Beere and Carter & Glaeser for cubic systems (spinel and cubic zirconia). However, they do not match very well experimental data for alumina (hexagonal system) being in agreement with other open sources data. The sophisticated model by Svoboda et al. significantly underestimates the critical density for all systems. The reason of disagreement is analyzed in detail and several hypotheses explaining differences between the model and reality are proposed. It is recommended to use Beere's and Carter's & Glaeser's models for prediction of critical density, while the model by Svoboda et al. characterizes rather the stage of pore closing initiation.

Microstructure characterization of heterogeneous materials by microscopic image analysis and tomography

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The microstructure of heterogeneous materials in general and ceramics in particular is the result of raw materials and processing and, together with the phase properties, determines the effective properties. Phase volume fractions, including the volume fraction of pores (porosity), are the basic microstructural descriptors on which estimates of effective properties of multiphase materials are based, but quantitative information on the microstructure beyond volume fractions, including topological (3D) connectivity information, can be helpful for making effective property predictions more precise. On the other hand, for single-phase polycrystalline materials stereology-based grain size measures are the key descriptors. Microscopic image analysis is a useful and powerful tool for the characterization of microstructures of heterogeneous materials. It enables the determination of global microstructural descriptors via stereological relations as well as the size distributions of objects (grains or pores) via the area equivalent diameters of object sections and appropriate transformations that provide at least approximate corrections to the random section problem. This contribution deals with the practical aspects of performing a complex microstructural characterization via image analysis on real material microstructures (yttrium aluminum garnet ceramics as a dense single-phase material, alumina-zirconia composites as a dense two-phase material and alumina and mullite-based ceramic foams as examples of porous ceramics). The use of stereology-based image analysis for determining the metric descriptors volume fraction (porosity), interface density, mean curvature integral density and the related size measures (mean chord length and the newly introduced "generalized Jeffries size") via point or object counts on planar sections is explained, including the calculation of statistical errors. Moreover, when parallel section planes with a well-defined distance are available

(preferably as virtual planar sections from X-ray computed tomography to avoid sample preparation artifacts), it is possible to determine the 3D Euler-Poincaré characteristic, which is otherwise not obtainable from a single plane. It is shown how this topological descriptor can be obtained by comparing the number of objects on a reference plane with that on intersections or unions with parallel planes. The measurement of size distributions consists in marking object sections (preferably automatically on binarized images), extracting the corresponding area equivalent diameters, grading these diameters into size classes and using appropriate transformation matrices (e.g. Saltykov, Cruz-Orive or Woodhead) for correcting the random section problem in order to obtain 3D size distributions. Based on these size distributions modes, quantiles (including medians) and statistical mean values can be determined and compared with the size measures obtained from stereological relations. Finally, it is shown how spatial voxel images (i.e. 3D models obtained from X-ray micro-CT / computed tomography) can be used to characterize the microstructure (pore size and wall thickness distributions) using the Hildebrand-Rüegsegger local thickness measure. For porous ceramics the microstructural descriptors obtained via stereological relations as well as the size distributions determined from planar sections and local thickness from tomography will be compared with the complementary information obtained from other characterization methods such as mercury porosimetry.

Study of the glaze – ceramic body system of contemporary and historical ceramics

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Glazes are stable glassy substances consisting predominantly of silica modified by alkali and other elements to achieve the desired properties. They may be applied to various types of ceramic substrates. Therefore they could be divided not only by the appearance, but also by the function which they perform. The basic criterion of their usage as a surface finishing of ceramic materials is their relatively high resistance to aggressive environmental conditions. Preparation of a fusible glaze with a suitable value of coefficient of linear thermal expansion is the crucial condition for the stability of a glaze-ceramic system.

To propose a suitable surface finishing for a specific ceramic body, it is necessary to know basic characteristics of a substrate. Properties of a glaze, a ceramic substrate, an interlayer and of a final glaze – ceramic body system must be evaluated to ensure glaze – ceramic body compatibility and to obtain a final product of a required quality. The main factor that influences stress relations between a glaze and a ceramic body is the difference in coefficients of linear thermal expansion. Tension stress in a glaze layer develops as a consequence of differences in coefficients of thermal expansion of a glaze and a ceramic body during cooling process after firing or during long-term usage of a ceramic product. The formation of defects within a glaze layer is influenced by the extent and type of a stress.

The main aim of this work was to study various contemporary and historical glaze – ceramic body systems and to evaluate concordance of coefficients of linear thermal expansion. Furthermore effects of degradation processes of lead and lead-free glaze – ceramic body systems were characterised. The causes and origins of defects of glazed surface layers were identified using optical (OM) and scanning electron microscopy (SEM).

Sorption of Pb^{2+} on waste brick dust

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Toxic cations (Cd, Zn, Pb), toxic oxyanions (As, Sb, Cr) and radioactive ions (U, Cs) belong to the most toxic inorganic contaminants with the risk to human health. Many studies have been focused on the investigation of new remediation techniques using the adsorption to fixation of toxic ions to suitable materials [1]. The attention is now focused on waste ceramic materials, especially the waste brick dust, which is waste (grinding) dust from the production of ceramic blocks. Waste brick dust with adsorbed toxic ions is supposed to be incorporated to building materials, e.g. concrete, as its final disposal. The recent study [2] indicates that the waste brick dust could be an effective sorbent of toxic ions, but the additional research is necessary.

The aim of this research was to investigate the effeciency of two types of the waste brick dust. Series of test experiments were performed by studying the surface, structural and sorption properties.

The brick dust was characterized using XRD and XRF analysis and BET surface area and pHPZC mesurements. Pozzolanic activity, which refers to the binding ability in concrete material, was assessed. Adsorption experiments were focused on the study of Pb^{2+} sorption, which is considered as relevant contaminant in surface and underground water and soils. In addition, the leaching experiments were performe
d. Pb^{2+} concentration was determined by AAS analysis.

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Colloidal nanoparticle processing and water splitting catalyst preparation

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In this work, we explored the impact of different colloidal parameters that may influence the activity of a nanostructured and composite metal oxide photocatalyst. The first part of this study is about surface charge adjustment of titanium oxide (anatase) and zinc oxide (wurtzite) nanoparticles in aqueous dispersions. Opposite charging of these two oxide particles types originating from metal organic chemical vapor synthesis (MO-CVS) was used to introduce heterojunctions between particles of the two and dissimilar oxides [1,2]. We prepared heteroagglomerates from TiO_2 and ZnO suspensions with different mixing ratios and employed the addition of Zinc citrate for surface charge adjustment. The presence of heterojunctions is expected to enhance the photocatalyst's activity in the water splitting reaction [1,3]. To explore this potential effect on samples, the colloidal properties of which were monitored at different stages of photocatalyst production, we also addressed the question whether the photocatalyst's surface is subject to changes during the photodeposition of platinum clusters as co-catalyst [4]. Associated optical property changes were measured by UV/Vis and photoluminescence spectroscopy and related to relevant developments in surface charge and particle-size distribution as determined from dynamic light scattering measurements. Finally, we measured the differential photocatalytic activity of Pt decorated heteroagglomerate nanoparticles inside a batch quartz reactor. We observed a strong negative effect of zinc oxide on the hydrogen production yield of the heteroagglomerates and will discuss its origin in the light of ZnO photocorrosion and active site blocking steps [5].

This work was supported by JECS Trust foundation.

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Electro-Optic Modulators Made of Glasses with Ag Nanoparticles

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FElectro-optic modulators are photonic devices that process optical signals using an electric field. To construct fast electro-optic modulators, the most important component is an optical material with a sufficiently high electro-optic coefficient. As a suitable and cost effective material for the construction of such modulators, we developed glasses with Ag nanoparticles in a system $PbO\text{-}Bi_2O_3\text{-}Ga_2O_3$. The glasses were melted at 1000°C for 30 min and the electro-optic active Ag^0 nanoparticles were made in the prepared glasses by the reduction of Ag^+ ions during the heat treatment of the glasses. The electro-optic properties were measured in an optical system comprising a laser source, a polariser, the glass sample, a quarter wave plate, an analyser, a diaphragm and a detector. The laser source was operated in continuous regime. On the glass sample, a high voltage from 5 to 27 kV was applied that influenced the transmittance. From the rotation of the analyser, the electro-optical coefficient was calculated. The electro-optic coefficient is high enough for the construction of electro-optic modulators that are able to operate in the transverse mode.

ABSTRAKTY

Sekce III, IV

Impact of iron doping on induction heating during spark plasma sintering

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Spark Plasma Sintering (SPS) is one of the novel sintering processes accompanied with unique kind of heating – pulsing electrical current. A persisting source of controversy regarding the benefits of the pulsed electric current sintering process is the oft-repeated claim that the electric pulsing creates a plasma that activates surfaces of powder particles, through removal of surface layers. However, so far convincing evidence of this conditions is absent. In spite of conflicting results electrical pulsing may have impact on sintering process.

We are going to proof that pulsing in SPS is also able to induce internal heating due to its strong electromagnetic field when dopants are conductive metals (e.g., iron). In this study, γ-Al_2O_3 powders doped with various amount of iron were sintered via Spark Plasma Sintering process. Two heating modes – auto and manual mode were applied to observe the role of electrical induction on heating. Temperatures, electric current and pulse pattern were experimented with grade iron γ-Al_2O_3 powders. Phase transformation of γ to α -Al_2O_3 serves as direct indicator of internal temperature, independently on measured outside temperature.

Induction heating was proofed during the Spark Plasma Sintering of electrically nonconductive materials with the dopant. Density and microstructure were investigated to explain the mechanism of induction heating. In addition, role of electric pulsing and strong electromagnetic field on internal heating (induction heating) were compared and discussed. Internal heating by iron doping within electrically nonconductive samples is able to decrease sintering temperature and save energy, furthermore it is one explanation for unique features of this novel material fabrication technology.

Preparation and optical properties of silicate glasses containing silver nanoparticles

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It has been shown that glasses containing silver metal nanoparticles are perspective photonics materials for fabrication of all-optics components. Resulting optical properties of the nanocomposite glasses depend mainly on the composition and structure of the glass, as well as on the method of the preparation and their subsequent treatment.

This contribution is focused on the preparation of silver metal nanoparticles by ion exchange method in different types of silicate glasses and on the characterization of their optical properties. Chemical composition of used glasses and subsequent heat treatment are the key attributes for preparation of nanocomposite optical substates. Therefore the influence of the glass composition and subsuquent treatment on the nucleation and growth of silver metal nanoparticles have been studied.

Nanocomposite thin films were prepared by ion exchange method in the six different silicate glasses, two commercial available and four special optical glasses for photonics without any inpurities. Used substrates differed mainly in the content of network formers and monovalent modifiers. The ion exchange from molten salts of silver were done under the identical condition for all studied glasses. Subsequently, all glasses were annealed at 600 °C for 1 hour in air. Based on this experiment, two types of used glasses were chosen and their temperature of glass transition (Tg) was determined. These samples were annealed after ion exchange in the range of temperatures from 200 to 700 °C. Presence of silver metal nanoparticles were detected by absorption spectroscopy in UV-VIS range. The concentration profiles of silver were analysed by electron microprobe analysis. Oxidation state of silver and the structural changes of glasses were studied by

photoluminescence spectroscopy in VIS range. Size of created silver metal nanoparticles were calculated from Mie´s theory.

Results shown, that ion exchange is suitable method for preparation of nanocomposite glasses containing silver metal nanoparticles. In glasses with contain of elements, which are able to reduce silver ions, nucleation and growth of silver metal nanoparticles occurs during subsequent annealing. The treshold temperature for nucleation of metal nanoparticles is closely above the Tg of glass substrate, regardeless to the composition of used glass. Growth of created nanoparticles can be achieve by increasing annealing temperature. This kind of nanocomposite glasses have nonlinear optical properties and can be used for fabrication of all-optics switches.

Recent advances and final steps in the field of protective hybrid silica coatings on historical glass

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In everyday life, especially architectural glass elements remain often unnoticed even though, it is an integral part of many civil and religious buildings. Such an exterior architectural glass suffer not only from lack of interest, but also particularly in the case of historical glass, it is heavily endangered by weathering phenomena. Since the protective glazing does not fulfil the optimal aesthetic and protective requirements, there is an increased interest for protective coating applications benefiting from all the assets of hybrid organosilane materials. These materials are characterized by dual behaviour which comes from their structure consisting of an inorganic part (heteropolysiloxane backbone) capable of strong, covalent siloxane bonding to glass surfaces, and an organic part (containing different organic functionalities) providing progress in overall performance of a final coating.

In this study, we pursued our previous project designing hybrid silica coatings prepared via the sol-gel process and consisting in mixing a silica-based inorganic matrix (tetraethyl orthosilicate) with different quantities of functionalized Si-alkoxides. With addition of different substances modifying final flow properties, the material was possible to apply with brush onto the glass samples at low temperatures without any heat treatment. Two glasses in the K_2O-CaO-SiO_2 system, following similar composition to historical glasses used for production of mosaic glass cubes, were used with two different CaO/K_2O ratios. The influence of the glass composition of low chemical resistance is further observed. The samples were analysed before and after model aging tests simulating various weathering parameters.

In general, we approved that the newly designed transparent low temperature coatings are easily applicable in thin films with common restoration-conservator tools, show good

overall homogeneity, improved adhesion to the glass substrate and no colour or chemical composition shifts. Hence, it appears to satisfy the main requirements for the protection of glass exposed to weathering phenomena.

Acknowledgments:
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Použití ve vodě rozpustných polymerů pro přípravu tenkých vrstev (Er3+/Yb3+):LiNbO3 pomocí sol-gel metody

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Niobičnan lithný dopovaný prvky vzácných zemin je jedním z nejvíce studovaných optických materiálů pro jeho unikátní vlastnosti např. elektro-optické, nelineární optické nebo piezoelektrické. Jedním z nejpoužívanějších dopantů pro použití v IČ oblasti je Er^{3+} s fotoluminiscencí kolem 1530 nm. Avšak erbité ionty mají problém s nízkou pravděpodobností záchytu fotonu a s následnou excitací. Z toho důvodu se Yb^{3+} ionty používají jako senzitizéry, které díky kooperativnímu tříhladinovému přechodu zvýší emisi Er^{3+} iontů v blízké infračervené oblasti.

Pro použití tohoto materiálu jako planárního zesilovače optického signálu je nutné připravit tenké vrstvy s homogenní mikrostrukturou, hladkým povrchem a dostatečnou tloušťkou pro vedení optického signálu. Tenké vrstvy s těmito vlastnostmi se dají připravit různými depozičními metodami např. iontovou implantací, epitaxí z kapalné fáze (LPE), epitaxí molekulárním svazkem (MBE), pulzní laserovou depozicí (PLD), chemickou depozicí z plynné fáze (CVD), depozicí z fyzikálních par (PVD), ale také výrazně levnějšími technikami sol-gel.

Práce se zabývá přípravou opticky aktivních tenkých vrstev LiNbO3 dopovaného Er^{3+} a Yb^{3+} ionty pomocí sol-gel metody. Samotná příprava roztoků probíhala v bezvodém prostředí za použití alkoxidů kovů. Po předchozí úspěšné přípravě vlnovodných struktur s použitím polyvinylpyrrolidonu (PVP) jsme srovnávali použití dalších ve vodě rozpustných polymerů: polyethylenglykol (PEG), polyakrylová kyselina (PAA) a polyvinylalkohol (PVA). Zkoumali jsme vliv jednotlivých polymerů na stabilitu roztoků vůči hydrolýze a kondenzaci a dále na kvalitu připravených tenkých vrstev. Dále jsme se zaměřili na přípravu roztoků s vyšší koncentrací přítomných kovů s ohledem na zvýšení

tloušťky vrstev. Roztoky obsahující polymery byly analyzovány pomocí DTA/TG analýzy. Fázové složení vrstev bylo stanoveno pomocí rentgenové fázové analýzy a jejich povrchová morfologie pomocí AFM. Optické vlastnosti byly zkoumány pomocí m-line a fotoluminiscenční spektroskopie. Tloušťka vrstev byla měřena pomocí UV-vis reflektance.

Struktura a vlastnosti zinečnato–železitých metafosforečnanových skel

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Cílem práce byla příprava zinečnato–železitých metafosforečnanových skel, tedy skel o složení xFe_2O_3–$(50-2x)ZnO$–$(50+x)P_2O_5$ ($0 \leq x \leq 25$) a studium vztahů mezi jejich strukturou a některými fyzikálními vlastnostmi. Skla byla připravena technikou chlazení homogenizované taveniny z teplot 1300 °C na předehřátou grafitovou podložku. Připravená skla byla homogenní a byla u nich stanovena hustota, mikrotvrdost, teplota skelného přechodu, teplota měknutí a koeficient teplotní roztažnosti. Struktura skel byla studována pomocí Ramanovy spektroskopie, elektronové paramagnetické rezonance (EPR) a oxidační stav železa byl určen pomocí magnetické susceptibility.

Ramanova spektra potvrdila metafosforečnanovou strukturu v celé kompoziční řadě. Z měření magnetické susceptibility vyplynulo, že železo je přítomno v oxidačním stavu +III, EPR spektra prokázala, že okolí Fe(+III) u je oktaedrické s tetragonální distorzí. Kompoziční závislosti teploty skelného přechodu, koeficientu teplotní roztažnosti a mikrotvrdosti indikují postupné zpevnění a zesítění základní skelné matrice s rostoucí koncentrací železa, což souvisí s náhradou čtyřikrák koordinovaného zinku(+II) šestkrát koordinovaným železem(+III). To vede k vyššímu 3D zesíťování struktury, tedy k jejímu zpevnění.

Teluričitá skla systému

$TeO_2 – PbCl_2 – MxOy$ (M = Bi, Mo, Sb, W, Zn)

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Teluričitá skla je možné řadit do skupiny skel oxidů těžkých kovů, vyznačují se svými fyzikálně-chemickými vlastnostmi, jako jsou široký interval optické propustnosti sahající od viditelné po střední infračervenou oblast, vysoké hodnoty indexu lomu, vysoké účinnosti zářivých přechodů iontů vzácných zemin, dobrá chemická i tepelná odolnost. Díky svým vlastnostem představují materiál s potenciálními aplikacemi ve fotonice a optoelektronice. Reálné využití ovšem negativně ovlivňuje přítomnost příměsí absorbujících procházející záření. Nejhůře odstranitelné jsou z nich hydroxylové skupiny, které již při velmi malých koncentracích způsobují v oblasti okolo 3 μm silnou absorpci.

V této práci byla studována olovnato-teluričitá skla s přídavkem oxidů přechodných kovů. Oxid teluričitý je podmíněný sklotvorný oxid, který skla tvoří pouze za přítomnosti jiných chemických látek. Ve studovaném skelném systému je stabilizace skelné sítě zajištěna chloridem olovnatým. Další přidávané oxidy - Bi_2O_3, MoO_3, Sb_2O_3, WO_3 a ZnO – mají vliv na polohu absorpčních hran a na optickou propustnost, ovlivňují i elektrické a další fyzikálně-chemické vlastnosti.

U připravených vzorků byla kontrolována homogenita za pomoci optické a elektronové mikroskopie, chemické složení bylo semikvantitativně určováno pomocí skenovacího elektronového mikroskopu spojeného s analyzátorem rentgenového záření (EDX). Diferenciální skenovací kalorimetrií (DSC) byly měřeny termické vlastnosti jednotlivých skel. Hydrostatickou metodou byla stanovena hustota jednotlivých vzorků. Optické vlastnosti byly sledovány pomocí transmisních spektroskopií UV-VIS a FTIR. Proměřena byla také teplotní závislost optických spekter a byly vyhodnoceny energie zakázaných pásů.