ABSTRACTS BOOK

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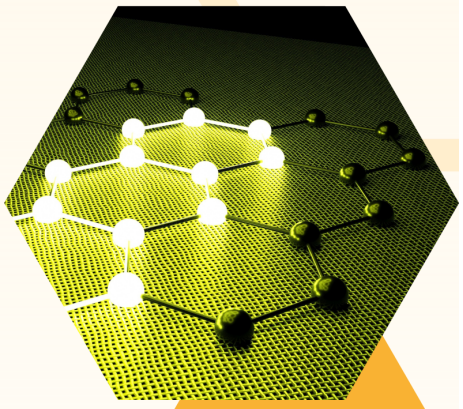

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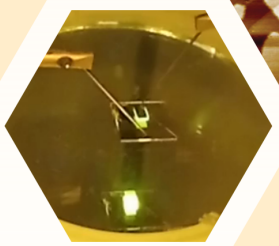

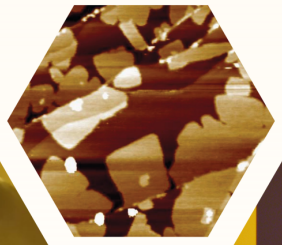

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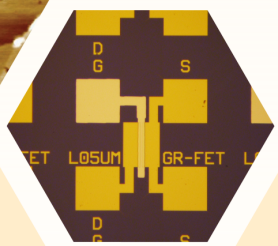

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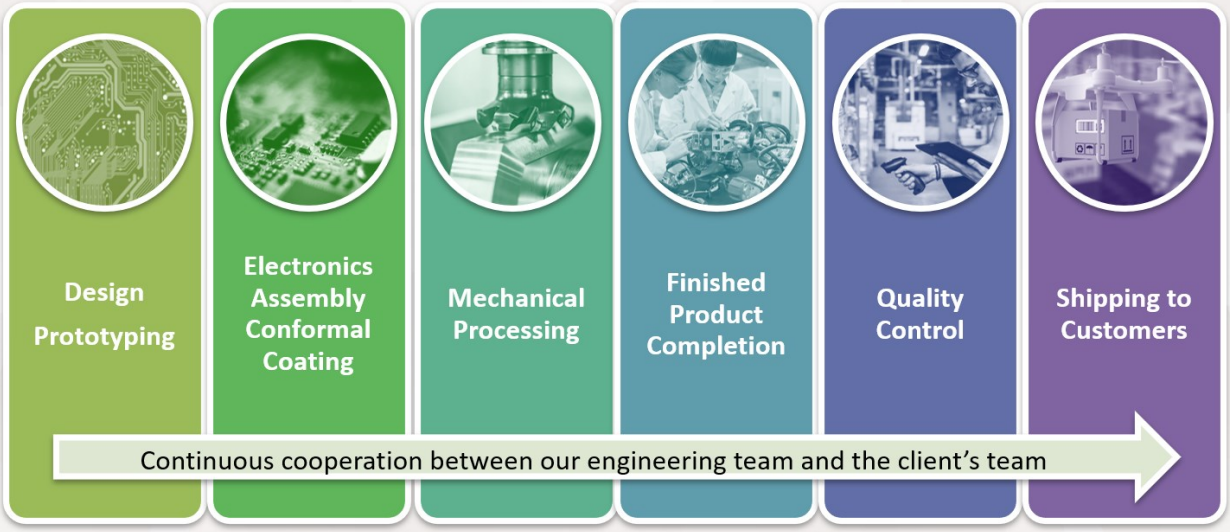

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FOCUSED ION BEAM BASED TECHNOLOGIES FOR GEMSTONES

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Focused ion beam microscopy is known mostly by its applications in microelectronics industry, but its nano scale precision can be also valuable for gemstones processing. We present three solutions: NanoPatterning for changing visual impressions by changing colors of a desired area (or whole facets), NanoIndividualization for engraving images on a gemstone table and NanoMarking for fabricating invisible to the human eye marks for ensuring their authenticity. Each of those structures have depth of up to 200 nanometers, so gemstone weight and value is not lowered.

Focused ion beam (FIB) microscope is a device used for imaging and processing material with precision up to tens of nanometers. It is used mostly in manufacturing of semiconductors and transmission electron microscopy sample preparation (lamellas), but its possibilities make it useful in many different industries. On this poster we present FIB technology applied to fabricating micro and nano scale solutions on gemstones.

Value of the most desired gemstones (e.g., rubies and diamonds) comes from their qualities like clarity, carat weight and cut. Those parameters are visually assessed before the gemstone is introduced to the market, so it is important to mark it beforehand. Common methods like laser marking produce symbols visible to the naked eye, so their counterfeits are easy to fabricate. On the other hand, FIB can fabricate patterns with details smaller that wavelength of the light.

In conclusion we developed three technologies for gemstones' modification and security. NanoPatterning focuses on increasing diamond brilliance by fabricating a diffractive grating on its table. NanoIndividualization focuses on engraving unique images on gemstone tables, so that they can be seen by the naked eye. NanoMarking combines simple patterns with data stored in a database. By containing 25-bit word (which gives us more than 2 billion possible sequences) in 5x5 μm area, which coordinates are stored in the database, we fabricate mark close to impossible to find.

References:
[1] Most Expensive Diamond Colors With Prices, accessed 27 September, 2022, https://www.gemsociety.org/article/most-expensive-diamond-colors-with-prices/
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THE INFLUENCE OF SEVERE PLASTIC DEFORMATION ON THE MICROSTRUCTURE AND MECHANICAL PROPERTIES OF CU-MG ALLOYS

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This work investigates the effects of chemical composition, initial microstructure, and severe plastic deformation on the microstructure and mechanical properties of Cu-Mg based alloys. The energy-dispersive X-ray spectroscopy (EDS) method was used to determine the chemical composition of the initial material. For each alloy, the melting point as well as the critical temperatures were experimentally measured using differential scanning calorimetry (DSC) analysis, and the DSC analysis results were used to select the heat treatment temperatures. Then, different samples of each alloy were subjected to severe plastic deformation (SPD) using the MaxStrain module of the Gleeble thermomechanical simulator [1]. Simulations performed with FORGE® software were used to determine the distribution and amount of the plastic strain along the deformation zone in the samples [2]. Light microscopy and electron backscatter diffraction (EBSD) were used to perform the microstructural analysis, and hardness test was employed to assess the mechanical properties of the samples.

The DSC results revealed that the addition of Mg results in the formation of Cu_2Mg intermetallic particles, which is beneficial for the mechanical properties of the alloys. Meanwhile, the hardness test results showed that the addition of Mg increases the hardness of the alloys before and after the MaxStrain processing, however, the application of MaxStrain results in increased hardness in the deformation zone. Moreover, the EBSD investigation revealed that the application of MaxStrain results in significant grain refinement in the deformation zone of the samples. The shear bands as well as deformation twins were visible within the microstructure of MaxStrain processed samples. In addition, the Cu_2Mg intermetallic phases were not deformed during the MaxStrain SPD process. Furthermore, it was discovered that the MaxStrain process variables, such as the number of passes, had an impact on the microstructure and mechanical properties of the SPD processed alloys.

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CONDENSATION CHEMISTRY - A FACILE APPROACH TOWARDS OPTOELECTRONIC MATERIALS

Muhammad Faisal Amin[1], Paweł Gnida[1], Sonia Kotowicz[2], Jan Grzegorz Małecki[2], Mariola Siwy[1], Paweł Nitschke[1], Ewa Schab-Balcerzak[1,2]

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Low production cost, solution processability and ease in their purification commend the use of azomethines in various optoelectronic devices. Because of the presence of -C=N- moiety in them imines bear excellent thermal, optical, and electronic properties. Choosing appropriately substituted aldehydes and amines for condensation leads to the product with the desired properties. Keeping in view of their progress in various optoelectronic devices, triphenylamine based imines are now being exploited for their use in photovoltaic cells [1-3]. In the present work, three novel solution-processable triphenylamine based azomethines were synthesized and characterized [4]. The effect of the presence of the amino-thiophene-3,4-dicarboxylic acid diethyl ester groups and various number of hexyloxyphenyl units on thermal, electrochemical and optical properties of imines was investigated. Additionally, the imines were explored as donor materials in bulk heterojunction solar cells.

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3. Petrus, M., et al., Small-molecule azomethines: Organic photovoltaics via Schiff base condensation chemistry. Journal of Materials Chemistry A, 2014. 2(25): p. 9474-9477.
4. Amin, M.F. Gnida, P. Kotowicz, S. Małecki, J.G. Siwy, M. Nitschke, P. E. Schab-Balcerzak Spectroscopic and physicochemical investigations of azomethines with triphenylamine core towards optoelectronics (under review).

FUNCTIONALIZED CARBON NANOTUBES AS ADDITIVES FOR INDUSTRIAL LUBRICANTS

Marcin Przybyła [1] Ilona Scudło [1], Jolanta Iłowska [1,] Julia Woch
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The aim of presented research is application of carbon nanostructures, such as chemically modified carbon nanotubes (MWCNTs) and graphene, as nanoadditives for industrial lubricants. Our goal is the improvement of their tribological characteristics, in particular reducing friction and wear. Funcionalization of carbon nanotubes was performed using amine and amide compounds.

Investigation on tribological properties were carried out with the four ball apparatus with the method of PN-C-04362:2017-03. It was observed, that the addition of functionalized nano-additives to lubricants even at low concentrations considerably increased of weld point in comparision to original base lubricants composed of lithium thickeners. The measurements of weld point showed, that the functionalized nanoparticles affected the tribological properties of lubricants.

This work is perform in the frame project POIR04.01.04-00-0017/20-00 entitled: Improvement of exploitation properties of industrial lubricants by used of nanoadditives, cofinanced by UE from means of European Found of Regional Develop in the frame of operation program Intelligent Develop 2014-2020.

HYBRID SENSOR PLATFORMS FOR INTEGRATED PHOTONIC SYSTEMS BASED ON CERAMIC AND POLYMER MATERIALS (HYPHa)

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The main goal of the study within the project is creating an universal and cheap material platform based on newly tested hybrid materials. The basis of these materials will be silica compounds with the addition of some oxide as TiO_2 or Al_2O_3, which can be used as structural matrices, polymer coatings or develop as active or protective layers. Optical activation of those platforms can be obtain by doped them by organic dyes (e.g. perylene-based dyes, which are active emitting substances) and by integrating with active two-dimensional materials (such as dichalcogenides (S, Se, Te) transition metals (TMDC). Such materials so far have been tested independently of each other or were used in other platforms, revealing unique structural properties, optical and electrical. To date, a comprehensive combination of the presented materials has not yet been made and proposed for the development of new materials for advanced applications and a market-attractive technological level. Thus the results obtained with the project can be another step toward design and production of optically active hybrids platforms for photonic.

Acknowledgments

The research was co-financed by the Foundation for Polish Science from the European Regional Development Fund within the project POIR.04.04.00-00-14D6/18 “Hybrid sensor platforms for integrated photonic systems based on ceramic and polymer materials (HYPHa)"

SERSITIVE: FROM IDEA THROUGH START-UP TO SERS-BASED BIOMEDICAL APPLICATIONS

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[2] *Mossakowski Medical Research Centre PAS, Warsaw, Poland;*
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Surface-Enhanced Raman Spectroscopy (SERS) allows obtaining the unique fingerprint of a molecule or even of a cell type. Additionally, Raman-based reporters may detect very low concentrations of substances such as biomarkers or antigens. That is why SERS is gaining popularity in life science and biomedical research. SERS-based biosensors and microfluidic systems may be fast (a few seconds measurements) and accurate platforms for detecting cancer, metabolic diseases, and virus identification. As biological research is often associated with a high number of samples, there is a need for relatively low-cost SERS substrates, which are easy to handle and are compatible with multi-well plates.

A few years ago, the demand for the SERS technique began to grow on the market, and there were no companies providing substrates for SERS research due to the difficulty in obtaining a repeatable amplified signal. So we took the challenge to create unique SERS-active platforms. After three years of hard work, we created a competitive product in terms of price, quality, and performance – SERSitive[1]. In response to market demands, we have recently developed sensitive and repeatable silver and silver-gold SERS substrates dedicated to potential use in biosensors and microfluidic systems for diagnostic, forensics, and life science research.
While conducting research, scientists have to visualize, evaluate, normalize and process the results of their research, which is why SERSitive's newest product is a free application for quick and easy data processing and visualization - SERSitiVIS. The application includes the counting tools for Enhancement Factor (EF), Principal Component Analysis (PCA), and Relative Standard Deviation (RSD). In addition, the application can be used to visualize spectra using tools such as normalization or background removal. The processed data can be exported in both text (CSV) and image (PNG, JPG) formats.

References:
[1] https://sersitive.eu
[2] https://share.streamlit.io/czubert/sersitivis/vis.py (alternatively there is a link on the mentioned website)

EVALUATION OF PEGYLATED GOLD NANOPARTICLES AS siRNAs CARRIERS

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Introduction Gold nanoparticles (AuNPs) are widely investigated as potential drug and nucleic acid carriers [1]. Many different modifications of these molecules have been performed to improve their properties. In the present work two pegylated gold nanoparticles (AuNP14a and AuNP14b) as potential carriers of anti-ApoE siRNA [2] .

Aim of the study The main goal of this research was to assess if AuNPs are able to complex the anti-ApoE4 siRNA and to evaluate the cytotoxic and haemotoxic profiles of siRNA alone and complexed with AuNPs.

Methodology In order to assess the concentration in which AuNPs form complexes with siRNA the zeta potential, zeta size, agarose gel electrophoresis and circular dichroism techniques have been applied. The biological safety of tested compounds was determined by MTT assay on HBEC-5i cell line and haemolysis assay on freshly isolated red blood cells.

Results The results showed that complexes of tested AuNPs with siRNA forms in different nanoparticles concentration: 30 μg/ml for AuNP14a and 55 μg/ml for AuNP14b, the average size of complexes ranged from ~250 nm to ~150 nm respectively. The data obtained by circular dichroism and gel electrophoresis methods indicated as well, that studied nanoparticles can form the complexes with siApoE4. In cytotoxicity and haemotoxicity assays more cationic AuNP14a induced stronger toxic effect than AuNP14b. In the lowest tested AuNPs concentration (50 μg/ml), MTT assay showed 59.9 ± 5.1% (AuNP14a) and 90.6 ± 3.5% (AuNP14b) of HBEC-5i cells viability. Similar dependence was proved for haemolytic assay where haemolysis induced by AuNP14a was higher (4.9±1.9%) than by AuNP14b (3.8±1.1%).

Conclusions AuNP14b forms complexes with siApoE4 in higher concentrations than AuNP14a, and it was shown that AuNP14b is less toxic for the tested cells. Results show that studied nanoparticles can be promising candidates for further investigation as delivery systems.

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THERANOSTIC NANOCARRIERS FOR DRUG DELIVERY IN CENTRAL NERVOUS SYSTEM DISORDERS – GRIEG-1 PROJECT

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Prevention and treatment of neurodegenerative diseases and stroke-related brain damage are major and unresolved problems of contemporary medicine. Despite the progress in understanding molecular mechanisms of neuronal injury and preventing them, few neuroprotective substances are used in the clinic and their efficiency in treating stroke and neurodegenerations is not satisfactory. One of the major limitations to current neurodegenerative disease treatment is an inefficient delivery of neuroprotective drugs to the affected part of the brain and difficulties in the diagnosis if the drug is well addressed, i.e., if it reaches the targeted organ. Theranostics is a new branch of medicine based on the joining of therapeutic and diagnostic functions into one entity. The application of nanotechnology in theranostics will allow the engineering of drug carriers simultaneously delivering therapeutic components and possessing a diagnostic function. The main objective of the GRIEG-1 project is to develop a new strategy to deliver neuroprotectants by applying theranostic nanocarriers for neuroprotective drugs, which can cross the blood-brain barrier without imposing side effects on its normal function and can be detected in a given part of a brain by Nuclear Resonance Imaging (MRI). Three Polish scientific institutions, **Jerzy Haber Institute of Catalysis and Surface Chemistry of the Polish Academy of Sciences, Jerzy Maj Institute of Pharmacology PAS, Henryk Niewodniczański Institute of Nuclear Physics PAS and two Norwegian SINTEF Industry** and **Oslo University Hospital** participate in the project consortium. The project is financed in the frame of the Norway and EEA Grants 2014–2021 under the Basic Research Programme operated by the National Science Centre.

In the project, we apply various methodologies of encapsulation of neuroprotective drugs together with fluorescent or MRI contrast agents. The size of nanocarriers not exceeding 150 nm should be non-toxic, invisible to the immune system, able to cross the blood-brain barrier and can be precisely localized in the organism. Fluorescently labelled nanocarriers will be used in the in vitro cell tests of neuroprotective activity of encapsulated drugs and ex vivo tests of their localization in the brain, whereas nanocarriers with MRI contrasts will be used in the in vivo tests on animal models. The ultimate aim of the project is the development of new drug carriers that can be used in future in therapies for neurodegenerative diseases like Parkinson's, Alzheimer or schizophrenia. We present some preliminary results concerning the encapsulation of selected neuroprotectants, investigation of the cell response and MRI detection efficiency.

LASER HYBRID FABRICATION: COMBINING DIFFERENT TECHNOLOGIES IN ONE MICRO-DEVICE

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The femtosecond (fs) laser is a well-established tool in material processing. Due to highly nonlinear light –matter interaction in a time frame shorter than heat dissipation from the laser affected zone, fs pulses enable extremely precise “cold processing”. A property like this creates the possibility to perform multiple processing techniques using a single tool, so additive and subtractive manufacturing can be realized. We demonstrate how medical device fabrication can benefit from hybrid fs processing, which includes the high resolution of two photon polymerization [1], the geometrical flexibility of selective glass etching [2], and the speed of femtosecond ablation [3]. The produced functional elements are a microfluidic macromolecule separator based on integrated nanofilters and a liver-on-chip where 3 different types of liver cells could interact trough the filter between the channels.

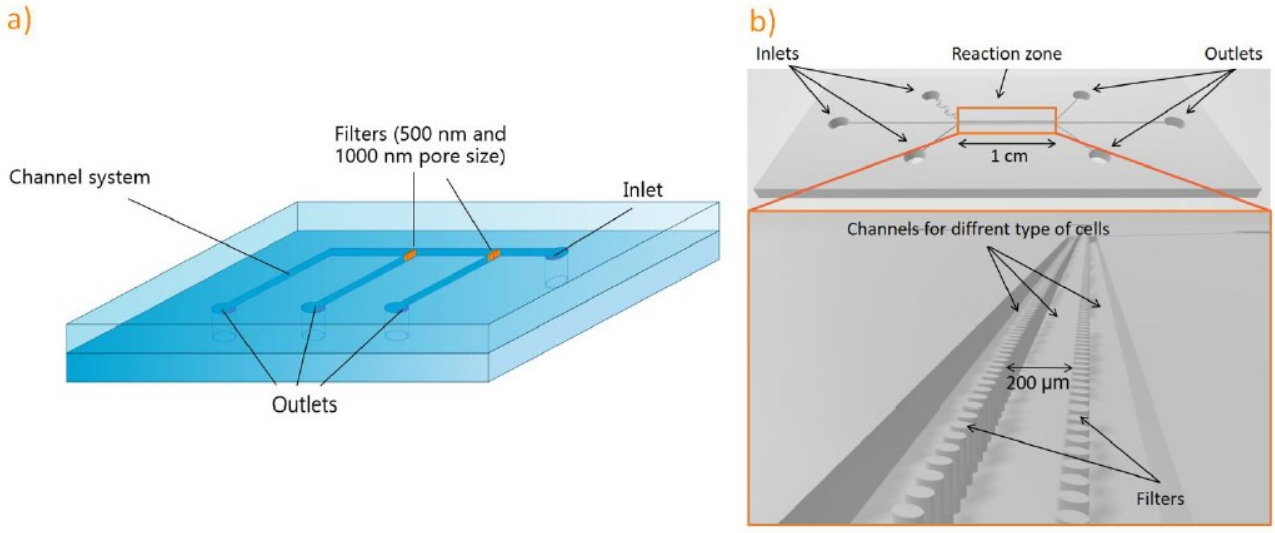

Figure 1. Models of the devices later manufactured using femtosecond hybrid fabrication: a) lab-on-chip type device microfluidic separator; b) liver-on-chip

The study was focused on optimizing the microchannel ablation and macromolecule separator pore size manipulation protocol for the microfluidic separator and proper pillar integration into the liver-on-chip device. We present the possibility to use a single micromachining station to perform multiple processes and manufacture a functional device for microfluidic applications like drug development or the creation of environment suitable for cell interaction.

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SELECTED APLLICATIONS OF NANOCATALYSTS IN CHEMICAL TECHNOLOGY AND ENVIRONMENTAL PROTECTION

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With economic development, responsibly interacting with environment is becoming very important, according to the principles of environmental sustainability. There have been a variety of concepts that have been proposed to solve this problem. Green chemistry principle connects energy and material efficiency with minimal risk and safety of chemical processes. Catalysis is at the centre of this concept because it enables chemical processes to be enhanced by using only a small amount of catalysts, i.e. substances that might increase the reaction rates. The concept of environmental catalysis is of key importance for contemporary economy.
Therefore, it is of great importance to search for new types of catalysts that would show high activity and selectivity at mild conditions.

The work focuses on new types of nanocatalysts in pollutant removal processes: selective catalytic reduction of nitrogen oxides SCR, processing of carbon dioxide in the methanation reaction and the decomposition of ammonia in industrial gases.

In the current situation, reducing carbon dioxide emissions to the atmosphere is becoming very important. As a part of this strategy, low temperature methanation of CO_2 based on novel nanocatalysts of nano-Ru supported on nanowired Ni can very attractive, because it provides a valuable product – methane [1,2].

Another serious environmental problem is connected with emission of nitrogen oxides in combustion of fossil fuels. It is the cause of both environmental degradation and human diseases. Additionally, progress in this area is forced by increasing environmental requirements. Our experience indicates on the possibility of using highly active nanocatalysts in this process, as well as modifying currently used SCR catalysts to improve their efficiency [3].

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FLUOROSURFACTANTS AS STABILISING AGENT IN BLOOD SUBSTITUTE PREPARATIONS

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The search for an effective blood substitute would solve the problem of chronic shortage of blood donors, avoid the risk of disease transmission and lower immunity, and effectively address religious concerns related to human blood transfusions. One of the main directions of these research are perfluorocarbon nanoemulsions which have the ability to dissolve and transport respiratory gases: oxygen and carbon dioxide (synthetic oxygen carrier systems). Perfluorocarbons (PFCs) are derivatives of aliphatic, cyclic or polycyclic hydrocarbons in which all of the hydrogen atoms have been replaced by fluorine atoms. These compounds are both hydrophobic and lipophobic, so they can enter the bloodstream only in an emulsified form [1]. Production of stable PFC nanoemulsion requires high concentrations of surfactants due to the large interfacial area, however surfactants in high concentrations show significant cytotoxicity [2], which is unacceptable when considering nanoemulsions blood substitute applications. For this reason, the development of new biocompatible and effective surfactants seems crucial for future exploration of PFC nanoemulsions potential. The one of the promising group are fluorosurfactants. New group of ionic surfactants have been synthesized with perfluorohexyl- or perfluorooctyl-groups as hydrophobic tail. The CMC and the parametres of the O/W emulsion (the particle size distribution and the zeta-potential) were determined. The influence of the surfactants on in vitro proliferation of human endothelial cell lines HMEC-1,

FUNCTIONAL NANOCOMPOSITES STUDIED BY SPECTROSCOPIC METHODS

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Nowadays, spinel ferrites magnetic nanoparticles (SF-MNPs) incorporated into 1D or/and 2D carbon-based matrix are intensively studied due to their outstanding promising application properties as e.g. drug delivery systems for *magnetic hyperthermia materials* (MHs) or *microwave-absorbing materials* (MAMs). Our experience with SF and their composites began around 2.5 years ago and continue to develop and enrich as documented by our publications [1-5] and supported by the granted SOLARIS/PHELIX proposals. During this time, we have tested several functionalized multiwall carbon nanotubes (f-MWCNTs) and graphene oxide (GO)-based nanocomposites focusing on, e.g. (i) enhancement of their magnetic properties provided by SF-MNPs, (ii) the synergic effect between NPs and matrix and in some cases on (iii) the analysis of MHs and MAMs properties.

The analysis of exemplary SF-MNPs/f-MWCNTs nanocomposites is presented. The studies were carried out by complementary techniques, emphasizing the role of spectroscopic methods like e.g. X-photoemission spectroscopy (XPS) and X-ray absorption (XAS), also with the use of synchrotron radiation as one of the tools useful in nanomaterials analysis. XPS confirmed the presence of various N-based groups from the functionalization of CNTs, as in our previous studies [5]. XAS spectra acquired by PHELIX beamline at SOLARIS for C K-edge besides p* and s* states showed the possible contribution from Fe-C. The distribution of Fe^{3+} cations among tetrahedral and octahedral sites is confirmed by, e.g. Fe L-edge and Fe2p spectra. The apparent modification of Fe states in nanohybrids may originate from the possible structural changes or additional Fe species generated in specimens. The change in the work function estimated for photon energy hn = 50eV is associated with the charge transfer from metallic SF-MNPs to f-MWCNTs.

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APPLICATION OF NANOMATERIALS IN ORGANIC SYNTHESIS

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The increasing anthropopression of man on the natural environment is the result of the increasing use of fossil fuels, including to fuel the economies of developing countries that are going through a stage of intense industrialization (China, India, Brazil). Human activity has caused several significant changes on earth through the emission of greenhouse gases: N_2O, CO_2, CH_4, hydrofluorocarbons and chlorofluorocarbons [1]. For example, a systematic increase in CO_2 in the atmosphere has been observed since the industrial revolution, from 280 ppm to 400 ppm in 2016 [1-3]. Conventional resources, mainly fossil fuels, are becoming limited due to the rapid increase in energy demand. At the same time, due to the strong economic justification, there is a constantly growing trend based on the production of chemicals with higher added value from biomass or waste materials. The widespread availability of e.g., CO_2 and biomass is currently the focus of scientists interest in terms of their use for the production of biofuels.

The lecture will cover the issues at the interface between organic synthesis and the preparation of new nanomaterials that are potential catalysts for the selective processing of polyalcohols to 1,3-dioxolanes and their applications in environmental protection. In addition, the results of research on the selective conversion of glycerin to propylene glycol with the use of polimetallic nanomaterials will be presented. The above-mentioned nanomaterials were evaluated on the basis of selected X-ray techniques (EDXRF, XPS, XRD) and electron microscopy, the qualitative quantitative composition of the synthesis products was determined using ^{1}H and ^{13}C NMR, COSY, HMQC spectroscopic techniques and, as an auxiliary, GC-FID chromatography. The research made it possible to deepen the knowledge by improving new technologies for controlling the processes of selective processing of surplus biomass with the participation of noble metal nanocatalysts (Re, Ru, Rh, Ir, Pd, Au). The main effect of the research is the increase in knowledge about the basic phenomena in the above-mentioned scientific fields as well as the possibility of practical use of research results in the field of petrochemistry and agrochemistry.

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IN SITU DETERMINATION OF PHYSICAL AND CHEMICAL PROPERTIES OF NANOMATERIALS

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Correlations between the properties of nanomaterials and the parameters of their preparation (temperature, reactant concentration, etc.) were most often determined only in an experimental way. Such a synthesis of nanomaterials was performed empirically, by trial and error, which consumes significant financial outlays. The lack of knowledge in the field of thermodynamics of nanomaterials makes it impossible to consciously synthesize these materials in a controlled manner. Therefore, the main goal of scientific investigations on nanomaterials synthesis should be to understand the thermodynamic and kinetic basics of processes involving nanomaterials and the gas phase (and/or promoters) to enable the design of technologies for obtaining nanocrystalline materials with the desired and designed properties.

An innovative measurement apparatus was designed and built to measure simultaneously, and under in situ conditions, the magnetic permeability, electrical conductivity, temperature as well as changes of mass and gas composition in the gas phase/solid system at a given temperature and under atmospheric pressure. Chemical processes may be conducted at 300-700°C under conditions of changing and precisely controlled (programmed) gas phase composition (e.g. during nitriding, carburising, oxidising and reduction reaction). The system is equipped with a tubular differential reactor and enables to conduct measurements both in kinetic and quasi-equilibrium states.

The knowledge gained thanks to the measurements carried out in such an apparatus contributes to the development, among others, in such fields of science, engineering and technology as:
- heterogeneous catalysis – study of new phenomena as well as reinterpretation of already known ones in reactions with the use of catalysts with a nanocrystalline structure,
- preparation of nanomaterials – precise determination of the conditions for the synthesis of nanomaterials, functional materials, and thin films with designed physical and chemical properties,
- materials engineering – understanding the mechanisms of phase changes,
- sensor fabrication – an equilibrium is also established between the active material of the sensor and the gas phase (research of new phenomena; reinterpretation of already known ones); a change in the magnetic properties of the sensor material along with the progress of its reaction with the gas phase may be used in the construction of innovative sensors,
- characterization of nanomaterials (e.g. determining the size distribution of nanoparticles).

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MO-BASED PPY – ACTIVE ORGANIC ELECTRONICS COMPONENTS WITH TAILORED NANOSTRUCTURE

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Polypyrrole (pPy) being carbon-based nitrogen containing polymeric material is known for its protective [1] and sorptive [2] properties. Being stimuli-responsive material it is willingly used as biosensing platform [3], drug delivery matrices, artificial muscles component. The properties of the pPy are strongly dictated by the morphology of material which can be tailored by the choice of the synthesis condition in terms of additives, oxidative agent or type of doping ions. Many studies were done to find the additives capable to induce structure organization within the polymer chains with organic dyes being most promising ones. Among them methylene orange (OM) was found to be the most interesting owing its structure guiding ability as it is named as soft sacrificial template. However, there is lack of detailed studies related to the influence of concentration of MO on the assemblies ability of pPy chains as well as time of the synthesis.

Here we show results of the studies for series of pPy synthesized by a dye – assisted chemical route in a presence of MO with various concentration. The material was obtained in an aqueous solution in respect to green technology approach. We showed that the ability of this dye to induce organization in pPy is strongly concentration dependent (in terms of MO) with changing content of the globular and nanotube structures in a final product. The organization influences also the effective length of π-conjugation along the polymer chains. It was calculated based on the ratio of intensity of FTIR peaks corresponding to antisymmetric and symmetric stretching vibrations in the pyrrole ring. The results revealed that at low template concentration the conjugation length was lowered while only after reaching the highest concentration the desired enhancement in conjugation length was induced. The observation was supported with XRD analysis that revealed peaks of the semi-crystal phase in the samples deposited in the presence of high-concentration of MO template. Our results demonstrate the profound impact of the concentration of the MO soft template on the morphology of the polypyrrole. It shows the possibility to induce nonorganization within molecular structure of the conducting polymer that influence markedly on macroscopic properties like conductivity. We anticipate that our study is a reference point for a vast majority of polypyrrole users (in fields like sensor production, sorption materials, battery components) that allows to point the mutual dependency of the synthesis condition and morphology of the material.

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II − CONJUGATED COMPOUNDS AS ELEMENTS OF HYBRID SOLAR CELLS

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Obtaining new, functional organic materials with unique properties and application potential as elements of optoelectronic systems has become the goal of many researchers around the world. Among the new generation devices, perovskite solar cells (PSCs) deserve special attention. As the only cells of the latest technology, they recorded a rapid increase in efficiency from 3.8% in 2009 to 25.2% in 2020, which may indicate that this type of cells will dominate the solar cell market. In addition, the advantages of PSCs include low-temperature technology and a relatively simple cell construction process compared to traditional silicon-based cells. An important element of this cells' type is hole transporting material (HTM). HTMs are crucial for both the movement of the holes to the counter-electrode and the regeneration of the light absorbers in the oxidized condition.

The presented work aimed to investigate the physicochemical (thermal, electrochemical, and spectroscopic) properties of new low-molecular compounds containing π-conjugated bonds and to determine the influence of selected structural elements on the essential properties that determine their applicability as organic semiconductors with the ability to transport positive charges (hole transporting materials, HTMs). The research subject was two groups of compounds: azomethines and oxetanes. The obtained compounds were tested as a hole transporting materials in PSCs. Atomic force microscopy studies of the perovskite layer covered with the tested compounds showed a decrease in root mean square (RMS) from 170 − 80 nm (without HTM) to 50, 55, and 85 nm for AZ-4, OX-3, and AZDT-3, respectively. The reduction of RMS provided better perovskite interfacial contact/HTM/Au. Moreover, HTMs were doped with Li-TFSI. Devices with HTM have showed increase of V_{oc} compared to the reference cell, which may indicate low voltage losses at the junction.

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FUNCTIONAL MATERIALS AS ELEMENTS OF HYBRID OPTOELECTRONIC DEVICES

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Obtaining and characterizing the physicochemical properties of compounds dedicated to organic electronics is still a current research topic for many groups of scientists. The study of thermal and electrochemical properties and a wide-ranging study of optical properties allow for determining their physicochemical properties, which are vital when designing the structure of devices [1]. Obtaining information about the chemical structure and physicochemical properties of organic compounds enables their classification for applications in optoelectronic devices, such as light emitting diodes (OLEDs), dye cells (DSSCs) or perovskite cells (PSCs). An important aspect is also initial application research (pilot studies), during which we can simulate the conditions in the surrounding environment in real-time.

The presented research results are intended to indicate the structural elements of given groups of compounds in terms of their application possibilities in OLEDs or solar cells. The compounds were subjected to comprehensive physicochemical measurements: thermal, optical and electrochemical. The obtained compounds were characterized by high thermal stability and showed 5% weight loss above 288 ºC. They were melting at a temperature from 137 to 300 ºC. DSC studies have shown that the compounds are a molecular glasses. Photoluminescence studies in solution, films and blends with PVK:PBD showed their ability to emit light in the range from blue to orange or non-ability to emission. On their basis, compounds with appropriate properties were used to verify their ability to electroluminescence in OLED devices, where they played the role of an active layer or its component or as hole transport materials (HTM) in organic-inorganic hybrid cells [2,3]. In the case of perovskite solar cells used materials have smoothed the perovskite layer, which improves the HTM – electrode interfacial contact.

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IMPROVING THE FUNCTIONAL PROPERTIES OF AN ALUMINUM ALLOY BY PRODUCING SURFACE NANO-LAYERS

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The paper presents a series of tests of aluminum alloy and nano-layers produced on this alloy in order to determine the improvement of functional properties as a result of anodizing. The tests were carried out on the EN AW-5251 aluminum alloy, an oxide layer produced on this alloy and a modified oxide layer by means of a thermo-chemical treatment. The properties of the samples were collated and compared. The formation of the oxide layer was carried out by means of direct current anodizing in a three-component electrolyte. A current density of 3 A/ dm^2 was used, the electrolyte temperature was 298 K, the process time was 60 minutes. Before the anodizing process, the samples were prepared by etching in KOH and neutralization in HNO_3. The thermochemical treatment of the Al_2O_3 layer was carried out in an aqueous solution of sodium dichromate at a temperature of 371 K for 60 minutes. In order to determine the effect of anodizing aluminum alloys on their functional properties, a number of tests were carried out, such as: microhardness tests, wetting angle measurements and surface free energy calculations, surface morphology tests using a scanning microscope (SEM),X-ray diffraction tests (XRD), surface chemical composition analysis using EDS, tribological tests in reciprocating motion and stereometric measurements. On the basis of the conducted research, it was found that Al_2O_3 nanolayers are characterized by a much better sliding cooperation compared to aluminum alloy, while their thermochemical treatment in sodium dichromate solution significantly increases the coefficient of friction μ and a significantly reduce mass wear compared to the nanolayer without modification. The significantly lower mass wear of the polymer slidingly cooperating with the layers modified with sodium dichromate can be explained by the presence of sodium chromium oxide on the surface of the layer, high surface wettability and high Svk parameter. All these parameters contribute to better sliding cooperation, creating a self-lubricating layer. The mass wear polimer cooperation with the oxide layer decreases with a decrease in the contact angle, and thus with an increase in wettability. It follows that surfaces with high surface wettability can be used in tribological nodes due to their low wear. In tribological tests of layers without thermo-chemical treatment, an increase in the friction coefficient with an increase in the contact angle was observed. In the layers subjected to thermo-chemical treatment, there is an inverse relationship, an increase in the contact angle reduces the coefficient of friction [1-3].

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AMYLOID FIBRILS - NEW BIOGENIC NANOMATERIALS

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Although usually protein fibrils are associated with pathological processes accompanying development of protein misfolding disorders such as Alzheimer's, or Parkinson's diseases, their less recognized face is ability to form biomaterials of exceptional properties. One of such is the spider silk, produced *via* the spinning process by spiders and silkworms. The unique nanoconfinement of the parallel and antiparallel b-sheet arrangement in silk nanofibrils resultsin significant extensibility and tensile strength yielding the material with toughness higher than steel or Kevlar.[1] Incredible features of natural amyloid fibrils inspired scientists to use themto generate new artificial multifunctional materials of tailored properties.[2]

Amyloid fibrils show substantive polymorphism resulting in the formation of different amyloid assemblies from the same protein.[3] Another intriguing feature is chirality of fibrils revealed at various levels of their multilayered architectures.[4] Understanding of polymorphism and chirality of amyloid fibrils is interesting *per se* and from the point of view of controlled synthesis of fibril superstructures.

Investigating amyloid fibrils we initially focused on evaluating how small changes in the protein sequence and formation conditions affect the different levels of fibril architectures, in particular the secondary structure/protofilament/mesoscopic organization. To address this problem, we analyzed in detail amyloid fibrils obtained from two homologous proteins, i.e. hen egg white and human lysozyme, under quiescent and agitation conditions. Using a multiparameter approach (including chiroptical spectroscopies and high-resolution microscopic methods) we demonstrated that small differences in amino acid sequence
and in the preparation conditions indeed translate into essentially different fibril structures at various levels of organization (the secondary structure, protofibril structure/handedness and the mesoscopic structure). Our results add to understanding of the complicated fibril structures and may be a first step toward synthesis of fibril nanomaterials of desired optoelectronic and photonic properties.

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FLAKE GRAPHENE-BASED MATERIALS IN BIOMEDICAL APPLICATIONS

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Flake graphene and its derivatives represent a promising material for imparting new, biomedically relevant properties, functions, and applications. Graphene oxide (GO) and reduced graphene oxide (rGO), among many immanent properties, confer bolstering of roughness, mechanical properties, surface wettability and surface potential of the resulting material. Moreover, graphene oxide and reduced graphene oxide promote the desired cellular response.
Biomedical applications of a G-Flake® graphene materials synthesized at Łukasiewicz Research Network - Institute of Microelectronics and Photonics covering manifold biomedical fields, including *inter alia*: tissue engineering, regenerative medicine, drug delivery systems, graphene-based layers of 3D scaffolds and sensors. The summoned graphene materials including: graphene oxide, reduced graphene oxide, graphene paste and graphene paper are going to be briefly introduced. The introduction of the materials is going to be followed by the examples successful implementation of flake graphene-based materials towards aforementioned applications.
It should be underlined, that each specific biomedical application of graphene materials should be preceded by detailed characterization of such materials, as there are many parameters to play with. Each of the parameter in turn will have an impact on the features of the final biomedical product. Hence, flake graphene fabrication protocol should be designed and done in a strictly defined way, to achieve desired function of the material and to trigger desired cellular behaviour.

FABRICATION, STRUCTURAL AND SPECTROSCOPIC STUDIES OF FINE NANO AND MICRO-CRYSTALLINE Yb^{3+}-DOPED $LuPO_4$

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Rare earth-doped orthophosphates establish a considerable family of compounds characterized by different physico-chemical properties. Their high thermal stability, high insolubility, relatively cheap synthesis, and the fact that they are good host lattices for RE^{3+} ions make them a new promising matrix for inorganic luminescent materials. Among the lanthanide ions, Yb^{3+} is an optically active ion for laser applications. In addition, the possibility to obtain effective luminescence in the NIR region makes it attractive also from the bio-imaging point of view. Basic research on the influence of the synthesis route on structural and spectroscopic properties of obtained materials is crucial for the proper modeling of new efficient optical materials for potential applications.

So, taking advantage of the Yb^{3+} ion as a structural probe, here we present a detailed analysis of both structural characterization and high-resolution spectroscopic properties of Yb^{3+}-doped $LuPO_4$ in the form of nano/micro-crystalline powders crystallizing in a zircon-type tetragonal system. A series of nano-crystalline samples (0.5 – 5 mol%) was obtained by ionic liquid-assisted hydrothermal synthesis. Here, the RE^{3+} nitrates and a task-specific ionic liquid (TSIL), *i.e.* choline dihydrogen phosphate (as the reactant), and an in-situ nanoparticle templating agent were employed.

This protocol allowed to fabrication of fine nano-size powders exhibiting desired well-crystallized single-phase phosphate nano-materials. For comparative research, a series of micro-materials obtained via a high-temperature solid-state reaction was used. The correlation between three synthesis routes and unexpected spectroscopic properties in nano and micro-crystalline Yb^{3+}-doped $LuPO_4$ was shown. Only one, symmetry site is occupied by Yb^{3+} ion in $LuPO_4$, however, unusual emission from both 5 and 6 levels of $^2F_{5/2}$ excited state, which are in thermal equilibrium, was detected. The results were correlated to $LuPO_4$ activated by Nd^{3+} reported by us previously [1-3].

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A STUDY OF THE ETCHING TYPE OF SILICA-TITANIA OPTICAL PLATFORM FOR INTEGRATED PHOTONICS

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This research investigates a highly attractive platform for an optical waveguide system based on silica-titania material. Such systems modeled in detail are capable of operating from visible to near-IR wavelength ranges. According to the current experience of this topic [1,2] silica-titania waveguide platform proves its advantage due to low cost, low loss, and easy-to-develop integrated optics systems.

The SiO_2:TiO_2 thin films were deposited via a sol-gel dip-coating method on a different glass substrate (BK7, soda-lime, buffer layered on glass). This method of deposition is a flexible and cost-effective one. Reactive ion etching, and wet chemical etching techniques are widely used for obtaining waveguide structures in photonic integrated circuits (PICs).

In this study, we have explored the possibility of using both techniques to structure silica-titania thin film. The etch rate of the samples is determined by utilizing plasma and wet-chemical etching techniques. If the fabrication of waveguides (WG) structures on these films is well-controlled by utilizing the wet-etching process, it can provide highly economical photonic devices. The first trials of optimizing this process were undertaken and are shown in this study.

The WG configurations investigated in this work are attractive for on-chip communication. The etch rate and morphology of the WG structures are analyzed for both types of etching methods. It is indicated that the dip-coating method combined with wet etching can lead to the formation of low-cost photonic devices. However, the biggest challenge up to date seems to be a control of the isotropic nature of wet etching and surface roughness. We hope that the results presented in this work will be valuable in the realization of low-cost photonic integrated circuits based on the silica-titania platform.

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ALL-IN-ONE PROFESSIONAL POLISH DEVICE FOR LABORATORIES AND WORKSHOPS

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Additive manufacturing technology, including FFF method, is essentials in numerous laboratories and workshops. It allow users and researchers to create elements and prototypes of various geometries depending on their needs. Multifunctional machines combine well-known 3d printers with different tools like laser or CNC devices to ensure easier, time- and space-saving prototyping, designing and manufacturing.

Zmorph FAB is a multifunctional machine for research, prototyping and multiple experimental applications. As a multi-purpose device it allows the user to switch between a 3d printer in FFF technology, CNC milling- and laser engraving- machine by choosing corresponding toolheads.

As a 3d printer, Zmorph FAB performs single or dual material printing with layer resolution between 0,05mm and 0,4mm. Available materials for this purpose are PLA, PETG, ABS and NYLON but also water-soluble support material – PVA or flex materials. CNC toolhead is equipped with a 300W spindle, that can perform 6000 RPM. It allows the user to work with multiple materials including ABS, Nylon, PTFE, PC, CCL FR4, Carbon, all kind of wood materials, or even to perform basic operations with softer metal materials like brass or aluminum alloy. The laser toolhead utilized a 2.8 W laser with 450 wavelengths. It allows to engrave in different materials including wood, EPP, cardboard, EVA Foam, CCL and FR4.

In the presentation, we will introduce Zmorph FAB with all dedicated toolheads, showing crucial parameters and information about the device. We present practical applications in different fields and show the advantages of multifunctional devices.

FLUORENE-BASED COPOLYMERS AS EFFICIENT AGENTS FOR SELECTIVE ISOLATION OF SINGLE-WALLED CARBON NANOTUBES

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Single-walled carbon nanotubes have reached high technology readiness levels in many of the most demanding fields like electronics, photonics, and medicine, among others. Such progress would not have been possible without the development of selective isolation methods, which so far have focused mainly on the separation between semiconducting and metallic nanotubes, as well as the enrichment of material with SWCNTs of similar diameters. However, several papers reveal that such a level of sorting is often unsatisfactory, as it fails to bring out the overall potential associated with electronic and photonic characteristics of nanotubes [1].

During the last few years, hundreds of papers have been published on the isolation of the most desirable semiconducting single-walled carbon nanotubes (s-SWCNTs) from unsorted materials [2]. In this context, methods based on conjugated polymers (CP), including fluorene, carbazole, and thiophene derivatives, appear to be the most promising because they offer low cost, efficiency, simplicity, scalability and possibility of direct use of so-obtained dispersions in many areas of R&D field [3]. However, until now scientists have not figured out the mechanism of selective extraction with conductive polymers. Consequently, it is extremely challenging to find a proper combination of carbon nanotube source/polymer/solvent to isolate a selected type of SWCNTs. For this reason, researchers have so far found only two such combinations that allow for the reliable, one-step isolation of monochiral (6,5) and (7,5) chiralities, as well as several others, but in a purity range of 50-75%, or demanding a multi-step purification process. In the scope of our research, we carried out the synthesis of fluorene-based conjugated polymers (CPs), followed by their utilization in the extraction process (CPE) and extensive optimization of the system composition, as well as process conditions. In addition to demonstrating the feasibility of efficient synthesis of homo and copolymers based on fluorene, such as PFO-BPy and PFO, we created perfect conditions allowing one-step isolation of smaller and more reactive (7,3)-type nanotube with monochiral purity, previously unattainable in organic solvents. This constitutes a groundbreaking achievement that could expand the application potential of SWCNTs.

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FLUORESCENT INK BASED ON SEMICONDUCTOR QUANTUM DOTS FOR HIGH RESOLUTION PRINTING

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Quantum dots (QDs) are small (<10 nm) crystals of semiconductor. QDs can effectively change one colour to another, electricity to light or light to electricity. These nanocrystals are already used in the printed electronics industry such as displays, but also in lighting industry, security printing, medical imaging and solar cells. The aim of the project is to obtain fluorescent ink containing dispersed, colloidal quantum dots. The ink is used to print optoelectronic elements in high resolution.

The production of QDs based inks consists of three main steps: quantum dots synthesis, surface engineering (functionalization) of quantum dots and ink formulation. These inks exhibit specific physicochemical properties such as quantum yield, FWHM, viscosity or surface tension. Their unique spectral features can benefit the display industry. QNA Technology develops inks based on QNA's quantum dots (red, green, blue). The repeatability and stability of QDs-based inks are a priority in commercial applications.

Due to the ink optimization process, it is possible to formulate the ink tailored to wide range of substrates (paper, glass, plastics, etc.), making it easy to print or deposit QDs on these – even flexible - substrates. These inks will be optimized for use in inkjet printers. Once the ink is formulated and optimized, it is possible to print microstructures of the desired size and shape in high resolution.

Acknowledgment to all member of QNA Technology team working on fluorescent ink development.

QNA Technology S.A. implemented a project co-financed by European Funds: "*Fluorescent ink based on semiconductor quantum dots for high resolution printing*", under the Intelligent Development Operational Program 2014-2020, Priority I "Support for R&D by enterprises", Sub-measure 1.1.1. project number: POIR.01.01.01-00-0210 / 19-01

SYNTHESIS OF QUANTUM DOTS FOR HIGH QUALITY BLUE LIGHT SOURCES

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High quality and durability blue emitters are strongly required by display and lightening industries. Currently in display field there is a competition between technology utilizing organic OLED and inorganic quantum dots (QDs). The second one can be used as a colour converter (e.g. in micoLED) or as an electroluminescent material.

Heavy-metal free is a key feature of material being developed by QNA Technology. We develop synthesis of zinc based quantum dots emitting in 450-470 nm. Narrow emission (FWHM < 40 nm) in such wavelength range allows to render a high colour gamut while still be safe for human eye as compare to shorter wavelength emitter. The crystal nature of QDs allows them to withstand the high light power condition. Moreover, due to the possible surface engineering they can be dispersed in a range of solvents, as well as ink, photoresist or other suitable solution.

Reproducibility of strictly defined optical and colloidal properties of QDs is a significant challenge when nanomaterials synthesis is scaled-up. Thus, in QNA we test various approaches, including flow rectors, in order to resolve a problem of batch to batch variation and to offer our clients highly reproducible product.

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Acknowledgment to all member of QNA Technology team working on Pure Blue dots development.

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INFLUENCE OF WET-CHEMICAL ETCHING AND INDUCTIVELY COUPLED PLASMA-REACTIVE ION ETCHING ON MORPHOLOGYOF GLASS PLATFORM FOR INTEGRATED PHOTONICS

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In recent years in integrated optics field of science scientists were mainly focused on optimizing affordable processes for the mass manufacture of optical thin films [1]. Most common methods used to obtain the waveguide structures in photonic integrated circuits (PICs) are wet chemical etching and reactive ion etching techniques [2]. However, the biggestchallenge is to control surface roughness of the obtained grooves because of isotropic nature of wet etching. If the fabrication of waveguide structures on glass substrates is well-controlledby utilizing the wet-etching process, it can provide highly economical production method of photonic devices.

In this work we have investigated the effects of performing inductively coupledplasma -reactive ion etching (ICP-RIE) and wet-chemical etching (using buffered hydrofluoricacid) of soda-lima glass for the formation of the photonic integrated circuit. The etch rate andmorphology of the photonic structures were determined for both types of etching methods. However, the etch rate of buffered hydrofluoric acid was quite fast which means that this method might be difficult to reproduce if the samples are being etched for a short time to obtaindesired width and depth of groove. Therefore, we intend to extend our research by diluting theBHF acid and obtaining a slow etch rate to have better control over the obtained grooves.

Also, we have shown that optical waveguides can be formed as a groove in the glass substrate by depositing a high-index film inside it. Furthermore, SiO2:TiO2 and polymer thin-films can be deposited on the wet-etched glass sample by utilizing the dip-coating method,which results in the formation of reversed rib waveguide structures. The above-mentioned waveguide structures are supported by performing numerical simulations via the finite elementmethod. We believe that this work will be highly beneficial for the researchers working on theetching of glass substrates. Besides that, the waveguides configurations concluded in this research are attractive for on-chip communication.

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PREPARATION AND SPECTROSCOPIC INVESTIGATIONS OF NANO/MICRO-CRYSTALLINE YPO_4 CO-DOPED WITH Yb^{3+} AND Nd^{3+} IONS

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At the turn of the last few decades, due to rapid technological development, scientists have particularly focused on compounds doped with RE^{3+} ions, that showed efficient laser properties. Recently, research on high-performance diode-pumped solid-state lasers has promoted the preparation of Yb^{3+}-doped materials such as vanadates [1] and tungstates [2], co-doped with other various lanthanides ions. Among these ions, neodymium ion Nd^{3+} is one of the most efficient RE for doping in different host matrix [3].

In this study we present the preparation and analysis of structural and spectroscopic properties of Nd^{3+};Yb^{3+}-co-doped YPO4 nano/micro-materials, obtained by various methods of synthesis – microwave -assisted hydrothermal method and solid-state synthesis. Materials with different concentrations of activators were used in order to examine possible changes in structural and spectroscopic properties and study quantum cutting phenomenon between $Nd^{3+}$and Yb^{3+} ions.

XRD technique confirmed that obtained YPO_4 powders crystallize in tetragonal system(*I*41/*amd*) and their phase purity. Electron microscopy, SEM and TEM, was used to demonstrate the differences in the morphology and size of micro/nano-materials, which brings the consequences in the spectroscopic properties. The spectroscopic properties and possible energy transfer were analyzed by using low-temperature high-resolution techniques like absorption spectroscopy at 4.2 K and tunable laser site-selective spectroscopy at 77 K. The strong multi-wavelength emission of Yb^{3+} and Nd^{3+} ions was successfully achieved simultaneously for both, nano and micro-materials. Energy transfer mechanism between theseions was proposed for studied host matrix.

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HIGH SHEAR MIXING GRANULATION METHOD TO PRODUCE POWDER MATERIALS USED FOR THERMAL SPRAY COATING

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Wet granulation is widely used in the industry as a method to increase powder particle size.
High-shear wet granulation is one of the methods of agglomerating powders. In this process, powder particles are mixed, densified and joined due to shear forces exerted on the particles by an impeller of a high-speed mixer. This technique is commonly used in the pharmaceutical industry and its use is aimed at improving powder properties such as homogeneity, flowability and compressibility.
High-shear wet granulation consists of three process steps: I) wetting and nucleation, during which binder is distributed in the powder and granule nuclei are formed, II) consolidation and growth, during which nuclei grow due to collisions with each other and free powder particles, resulting in densification and growth of the granules, III) attrition and cracking. In the last stage, final granulate properties are obtained. Final properties are dependent on the process parameters used.
High-shear wet granulation can be carried out with the use of Eirich mixer, which consists of a movable sloped bowl (provides a volume in which powder flows in a way that ensures proper mixing), a rotor (blades provide high shear needed for the process; it can work clockwise or counterclockwise to increase or decrease the shear force) and a scraper localized at the side of the bowl (helps with introduction of the powder into the high-shear zone).

In this work, a method of preparation of composite materials using high-shear wet granulation is presented. The idea is based on joining powders – in this case, Ni-NiB-Si powders – with micropowders of hard ceramics, such as CrB, ZrB_2, AlN, with submicron powders such as B_4C, Si_3N_4 or nanopowder such as Al_2O_3. Resulting composite powder materials are potentially suitable for coatings preparation by the use of thermal spraying methods.
Schemes of granulate preparation process, microstructure of selected base powders and obtained granulates are presented on the poster.

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DECORATED POWDERS – A COMPOSITE WAY TO BETTER METAL 3D PRINTS

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Selecting Laser Melting is an Additive Manufacturing process, in which a final product is formed by selectively melting successive layers of powder by a laser beam. SLM can be used to produce very intricate parts. One of the most limiting factors of this technology is a limited choice of different materials. This is due to the fact, that many traditional materials cannot be processed by SLM due to hot cracking. The reason behind this phenomenon is the microstructure of the material – large columnar grains are formed when the material crystalizes, leading to thermal stress and cracking along grain boundaries.
Decorating base powders can be a way to prevent hot cracking in SLM produced parts. Decorated powders consist of a base powder, such as an aluminium alloy with size suitable for SLM printing (usually 15–45µm or 20–63µm) and a smaller decorating powder (few microns to nanopowders) that is distributed on the surfaces of the base powder particles. Decorating powder is made of a material that has a higher melting point then base alloy. Decoration prevents forming of columnar grains in the material during SLM and can also act as a reinforcement in a composite, resulting in higher strength of the finished product.

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INTERACTION OF POLYPHENOL DENDRIMERS WITH HUMAN SERUM ALBUMIN

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Nanotechnology is a discipline that brings hope for improving therapeutic systems. One promising nanoparticles are dendrimers. These are spherical compounds with a highly branched and symmetrical structure. The functional groups, which can be chemically modified enable the attachment of metals and various biomolecules, such as genes or drugs to the dendrimer structure [1]. Since the dendrimers can be used as drug delivery agents, we have analyzed their interaction with human serum albumin (HSA) using circular dichroism, zeta-potential, transmission electron microscopy and fluorescence techniques. HSA is one of the most important serum proteins which plays a role of transport protein [2]. The polyphenolic carbosilane dendrimers G2[(NMe3Cl) 7(PEG-NH-CA)] (17) and G2[(NMe3Cl) 6(PEG-NH-CA)2] (18) containing one or two caffeic acid moieties were used in this study.

The aim of the study was to check interaction between poliphenolic dendrimers and human serum albumin. In the present study, the interaction of dendrimers with HSA was verified by methods such as circular dichroism, quenching of protein fluorescence and structure changes observed on electron microscopy. In addition, the potential and diameter of the dendrimers with human albumin were also measured.

The zeta size of the dendrimer complexes with HSA at the highest molar ratio was around 500 nm. The polydispersity index was about 0.5, which may suggest aggregation. In all cases studied we observed a decrease in fluorescence intensity of tryptophan in HSA with increasing dendrimer concentration. For each dendrimer, no significant changes were observed in the CD spectra with increasing dendrimer/HSA ratio.

Both tested dendrimers interacted with HSA. The results showed that there are interactions between dendrimers and HAS. The presence of dendrimers in the HSA suspension slightly modified the characteristic spectrum of the secondary structure of the protein. As changes in the secondary structure of the protein could result in a loss of biological activity, the results obtained indicate that the studied dendrimers probably have little effect on the biological properties of the protein, indicating their potential use in further studies as biomedical agents.

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INFLUENCE OF THE SYNTHESIS METHOD ON THE SPECTROSCOPIC PROPERTIES OF ND^{3+}-DOPED GDPO4 NANO-PARTICLES

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In the recent years, the development of functional nano-particles has become a key issue in modern material chemistry, mostly due to the influence of morphology *i.e.* grain size and shape on the physico-chemical properties of these materials. Among many inorganic compounds the rare earth orthophosphates ($REPO_4$) are of particular interest. When prepared in nano-crystalline form, they can find application in drug-delivery carriers, catalysis, sensor or photonic crystals. They can be also used in medicine, especially in bio-imaging as a safer alternative to fluorides. Therefore, it is important to find a new reproducible methods of producing nano-materials with controlled morphology and required optical properties.

Our studies presents a detailed analysis both of structural and spectroscopic properties of Nd^{3+}-doped $GdPO_4$ nano-powders obtained *via* three different synthetic methods.

Three series of Nd^{3+} -doped nano-materials with different concentrations of activator (1-10%) were obtained using ionic liquid assisted hydrothermal (IL HT) and microwaves method (IL MW) as well as oleic acid assisted hydrothermal method (OA HT).

PXRD technique confirmed that obtained $GdPO_4$ nano-powders crystallize in monoclinic system ($P2_{1/n}$) and no other phase has been detected. Electron microscopy techniques (SEM and TEM) have shown that each proposed method of synthesis leads to a different morphology of material grains, what find the consequences in their spectroscopic properties. Gd^{3+} ion in $GdPO_4$ is easily substituted by Nd^{3+} with the C_1 symmetry, nine-fold coordinated ion, due to their similar ionic radius values ones, so that high-resolution low-temperature absorption and emission spectra did not show any structural distortion. The $^4F_{3/2}$ excited level decay times recorded at 77 K have also shown an abnormal temporal behavior of Nd^{3+} photoluminescence similar as it was already observed for YPO_4 and $LuPO_4$ tetragonal orthophosphates crystallizing in xeno-time-type system [1].

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NANOPARTICLES CONCENTRATION MONITORING USING AN IONISATION DETECTOR

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Innovation in nanotechnology should be accompanied by advances in the monitoring of nanomaterials, especially the concentration of nanoparticles (NPs) in the air, because of the risk to human health that their use may pose [1, 2]. There is therefore a growing demand for monitoring devices suitable for larger-scale use.

Current solutions for determining nanoparticles concentration are mainly used in research laboratories and may not be the best choice that help monitor the NPs concentration in a large production facility, especially due to the costs i.e. purchase, conservation and maintenance of equipment. Study on the use of the ionisation sensor (same as for detecting fires at an early stage) conducted in Laboratory of Nanoaerosols in the Central Institute for Labour Protection – National Research Institute, confirmed it can be used to measure the concentration of nanoaerosols [3]. Tests were performed with soot nanoparticles generated by GFG 1000 generator and a reference device – Grimm MiniWRAS 1371 due to its capability of measuring wide range of particle sizes.

Ionisation detector prototype has two air ducts that lead into a ionisation chamber where the actual measurement takes place: first with high efficient filter (clean air) and second with electrovalve (air with particles). NPs have an impact on voltage measured between electrodes in the chamber resulting in its growth. To eliminate the influence of other factors, such as environmental conditions, type of aerosol and air speed, the difference between signals from clean air and air with particles is measured in still air. Knowing the dependence of the output signal from the chamber, nanoparticles concentration can be determined and shown on LCD display with customisable backlight colour depending on the concentration. The device also allows several measurement parameters (such as purging and air intake time) to be set, depending on the chosen place of use.

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THE SYNERGISTIC EFFECT OF PROTEASOME INHIBITOR MG-132 WITH REDUCED GRAPHENE OXIDE ON APOPTOSIS IN BREAST CANCER CELLS

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Breast cancer is the most common cancer diagnosed in women [1]. Nanotechnologies are emerging for important new applications of nanomaterials in various field. Nanomaterials, such as graphene and reduced graphene oxide (rGO) have attracted much attention due their unique properties, such as their physical, chemical, and biocompatibility properties [1]. rGO and proteasome inhibitor MG-132 has already been reported as potential cytostatic agent in various cancers. However, the mechanisms underlying rGO's with MG-132 cytotoxicity are still insufficient understood [1,2]. Thus, the aim of the study was to investigate the cytotoxicity and apoptotic effects of rGO with MG-132 in breast cancer MDA-MB-231 cells.

We investigated the effect of 3h, 6h, 12h, 24h and 48h exposure of breast cancer MDA-MB-231 cells to rGO with MG-132. The lactate dehydrogenase (LDH) test was performed to evaluate the viability of rGO with MG-132-treated cells. Apoptosis and necrosis were tested by flow cytometry and fluorescence microscope.

We tested the ability of rGO with MG-132 to affect in vitro toxicity and cell apoptosis in MDA-MB-231 cells. The exposure of the cells to rGO with MG-132 resulted in evident dose- and time-dependent leakage of LDH. Our findings demonstrate that rGO with MG-132 treatment induces apoptosis in MDA-MB-231 cells. Moreover, a strong synergistic effect of rGO with MG-132 action was observed.

We suggest that rGO with MG-132 can induce cytotoxicity effect in MDA-MB-231 cells. We observed up-regulation of apoptosis and necrosis in MDA-MB-231 cells. Except that, we demonstrated nuclear condensation and marginalisation of chromatin. These results may indicate that rGO with MG-132 is a promising therapeutic option in the fight against breast cancer cells.

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TEXTRONICS FOR HOLTER-TYPE ELECTROCARDIOGRAPHY: T-SHIRT CONTAINING CARBON NANOTUBE COATING

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A growing population suffering from cardiovascular disorders/diseases needs swift, precise, and readily available diagnostics [1]. Electrocardiography (ECG) is the most convenient and the most frequently used diagnostic technique aiming now at textronic solutions. Expedient manufacturing, adaptation to human subjects, sustained operational stability toward Holter-type data acquisition, reproducibility, and compatibility with the existing e-solutions remain the key challenges [2].

Our work demonstrates easily-paintable 600 μm-thick ECG-coatings (from paints allowing application by other techniques) on T-shirts [3]. The coatings encompass electrodes (60 W sq^{-1}) sheathed in the insulated pathways – conjugable with a wireless, certified multi-channel recorder. In-house 800 mm-long multi-wall carbon nanotubes constituted the electroactive components embedded isotropically into screen-printing acrylics. The paints were applied via brush-paintings what is important if advanced techniques are inaccessible.

The amplified, not digitally processed ECG-signals were recorded under dry-skin conditions. The system enabled collection of ECG-signals from two channels, allowing the acquisition of six ECG-leads of medical quality. The Holter-type ECG allowed ambulatory recording >24 h-long under various patients' activities (sitting, sleeping, walking, running) for three different subjects, while the ECG-signal was stable in >5 washing cycles. Such complex but reproducible characteristics bring the herein solutions to the next level of technological readiness.

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FACILE ROUTE TO PREPARE HYBRID TiO_2-SnO_2 DSSCS

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Using a hybrid sol–gel and electrospinning method one-dimensional SnO_2 nanostructures were manufactured, with average diameters of 86 and 53 nm after calcination at 500 and 600 °C, respectively. The morphology and structure of the prepared materials were analyzed using transmission and scanning electron microscopy (TEM, SEM) and X-ray diffraction (XRD). Moreover, the chemical composition was confirmed using Fourier-transform infrared spectroscopy (FTIR) and Raman spectroscopy. Based on BET and BJH analysis, the specific surface area and porosity of SnO_2 nanowires were evaluated. The optical properties of the prepared materials were investigated by UV–Vis spectrophotometer. The analyses confirmed that polycrystalline SnO_2 nanostructures composed of two polymorphic varieties tetragonal and rhombohedral were derived, whose calcination temperature had a significant effect on the diameter, specific surface area and energy gap width. The obtained nanowires were added at 5 and 10 mg to TiO_2 nanlparticles paste and screen-printed onto FTO substrate. After drying and calcination, the TiO_2 NPs-SnO_2 NWs hybrid photoanode was charged with dye, electrolyte and platinum electrode were applied and its performance was investigated in a dye-sensitized solar cell (DSSC). The study showed that the addition of 5 mg SnO_2 increased the cell efficiency by 12% compared to the standard P25.

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PREPARATION AND CHARACTERIZATION OF RE-DOPED ZINC OXIDE NANOFIBERS

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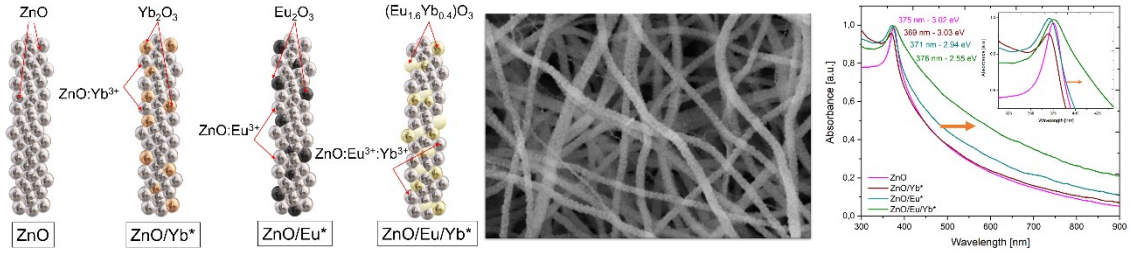
Zinc oxide, next to titanium dioxide, is one of the most widely researched and described in the literature photocatalytically active materials. However, more and more often the ZnO crystal lattice is modified with foreign ions and/or atoms in the form of dopants in order to improve its photocatalytic properties. First of all, its optical properties are modified, with particular emphasis on the absorption range of electromagnetic radiation, which in undoped ZnO structures is limited to a narrow ultraviolet range. It is assumed that rare earth metals can significantly improve optical properties, including reducing the width of the optical ZnO band gap, due to their unique properties.

Based on the above-described possibilities of producing ZnO nanofibers doped with lanthanide elements in the electrospinning process, the authors of this paper presented a method of producing thin fibrous polymer-ceramic mats, which were then subjected to a high-temperature thermal treatment process in order to obtain ceramic nanofibers. An attempt was made to dope the ZnO crystal structure with foreign atoms in the form of ytterbium (Yb), europium (Eu) and both of these elements, and the effect on the morphology and structure of electrospun nanomaterials was determined (SEM, TEM, FTIR, Raman, UV/Vis). In order to determine the optimal calcination temperature, a thermogravimetric analysis of the fibrous films was performed (TGA, DTG, DTA). The structural tests were performed based on the analysis of X-ray diffraction patterns (XRD), absorbance spectra obtained with the use of infrared spectroscopy and transmission electron microscopy. The average size of the 1D crystallites of ZnO nanostructures doped with lanthanides and the stresses in the zinc oxide crystal lattice caused by the presence of atoms and/or foreign ions were determined based on the Halder-Wagner (H-W) method.



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THE NEWLY DEVELOPED TEST STAND FOR INVESTIGATION OF NANO-OBJECTS RELEASE FROM COATED PRODUCTS

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The growing popularity of nanomaterials stems from the fact that their use allows to obtain products with improved properties. However due to the potential health effects, there is growing concern about the release of nano-objects (into the air, water or soil) from such products, especially during their use by customers [1].
The new modular test stand for investigation of nano-objects release to air from materials coated with functional layers and from materials containing nano-objects was developed in the Laboratory of Nanoaerosols, which is a part of the Aerosols, Filtration and Ventilation Laboratory in the Central Institute of Labour Protection - National Research.
The test stand consists of a chamber with a volume of about 1 m^3 and module that allows for process simulation such as e.g. abrasion, friction, impact of samples and others. Sample can be also blown with controlled air stream. Part of these processes is recommended in ISO 21683:2019(E) [2]. The chamber ventilation system equipped with high-efficiency filters allows the test to start when the background particle concentration is. (below <10 #/cm^3)
The module is equipped with a tensometric balance enabling measurement and control of the contact force of the working tool on the sample.
During experiment Scanning Mobility Particle Sizer (SMPS) is used to investigate number concentration and size distribution of released particles. Depending on the test requirements, other devices can also be used, such as: ELPI+ (Electrical Low Pressure Impactor), DiscMini and others. Aerosol sample is also collected on a copper mesh for analysis using an electron microscope (SEM) in terms of size, shape, degree of agglomeration of the particles. The chemical composition can be determined using energy-dispersive spectroscopy (EDS).
The chamber can be connected to an additional test stand for determining the filtration parameters of flat air filters during filtration of released nano-objects from samples.

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3D PRINTING TECHNOLOGY FOR MANUFACTURINGNANOSTRUCTURED GLASS PREFORMS

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SYGLASS enables the automatization of glass preforms manufacturing with high precision by using the LTG 3DP low-temperature glass 3D printing technology. The process is based on a direct application of melted glassin a predetermined pattern, allowing it to be more efficient andreducing the number of equipment needed to produce a single all-fibre preform. Presented technology allows the manufacturing of nanostructured preforms consisting of two thermally matched materials. Asa consequence, arbitrary shaping of various imperative optical properties including parameters such as refractive index and dispersion characteristics is made possible, opening anew direction for the advancement of the photonics field. Optical devices, that can be manufactured using our technology, include photonic crystalfibers, nanostructured microlenses, and supercontinuum sources [1].

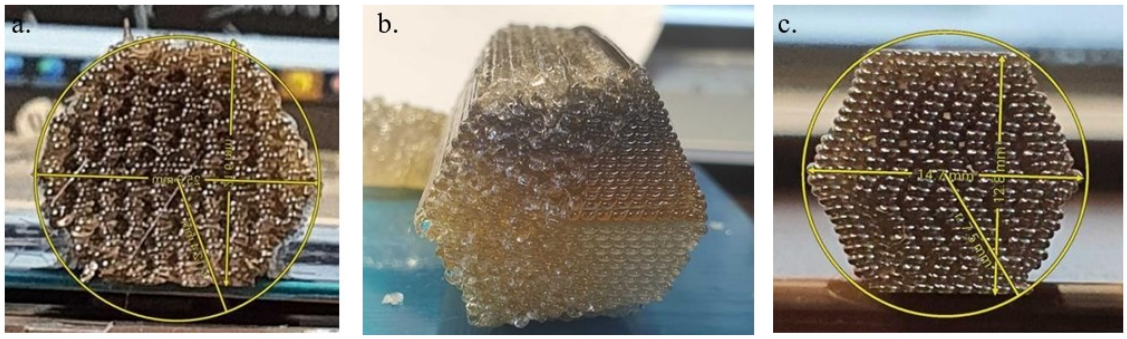

Figure 1. Glass preforms manufactured using the 3D printing technology: a) photonic crystal fiber (PCF), cross-section; b) vortex; c) air-core photonic crystal fiber, cross-section

By uniting the world of photonics with 3D printing manufacturing, SYGLASS technology has abroad range of potential applications: from the medical field, including non-invasive cancer diagnostics and optical coherence tomography systems operating in the mid-infraredregion, to cybersecurity and environmental monitoring.

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GRAPHENE APPLICATION IN CONCRETE - A STEP IN THE RIGHT DIRECTION FOR REDUCING CARBON FOOTPRINT OF BUILDING INDUSTRY

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Globally the construction industry is one of the biggest offenders in terms of CO_2 emissions. It amounts to approximately 39% of global CO_2 with 8% of global CO_2 attributed to concrete itself. If it were a separate country it would come third in terms of emissions after USA and China. Any optimisation of materials, durability, process efficiency would be dearly cherished by the whole sector. This talk is looking at the impact of Graphene and its derivatives on formation and use of concrete. Key advantages and barriers of the use of this technology will be described.

SYNTHESIS AND PHYSICOCHEMICAL STUDIES OF 1,8-NAPHTHALIMIDES AND THEIR APPLICATION IN OPTOELECTRONIC DEVICES

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1,8-Naphthalimide is a common system in the compounds with a wide range of applications, for example in, organic electronics (e.g., organic light emitting diodes (OLEDs), bulk heterojunction solar cells (BHJs), dye-sensitized solar cells (DSSCs), etc. or cellular imaging [1]. It is the appropriate nano-layers obtained in the construction of optoelectronic devices can have importance for the effective operation of the device. Synthesis and studies of physicochemical properties of 1,8-naphtalimides derivatives enables their classification for applications in optoelectronic devices.

Research focuses on the synthesis of derivatives of 1,8-naphthalimides and characteristics of these compounds, defining the scope of their use, among others in bioimaging or organic electronics. Thermal, physicochemical, optical, electrochemical, electroluminescence, and biological properties of a series of derivatives containing the 1,8-naphthalimide unit were tested and compared. In optoelectronic devices, salicylic and β-ketoenamine of 1,8-naphtalimides derivatives were used as active layers in organic light-emitting diodes [2], while imine derivatives (symmetrical and asymmetrical) were used as HTM layers in peroscite solar cells [3]. All investigated 1,8-naphthalimide (imine and β-ketoenamine) appear as a crystalline form and can be easily transformed into molecular glasses. The imines showed high thermal stability, and 5% weight loss occurred above 300 ◦C and was characterized by one-stage thermal decomposition. The EL studies showed that all β-ketoenamines showed electroluminescence properties at low current voltages (ca. 10 V). On the other hand, in the case of the tested imines, one with a benzyl substituent showed excellent electroluminescent properties [2]. In contrast, in studies of 1,8-naphthalimides as as holetransporting materials (HTMs) in the perovskite solar cells (PSCs) showed that the presence of the triphenylamine structure in bis-imines has a beneficial effect on the PCE values [3].

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GRAPHENE – THE MATERIAL OF THE FUTURE

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Graphene is one of the better recognizable forms of carbon. Through intensive research, it made its way to industrial applications, mainly in the form of nanoflakes and multi-domain surface layers. Nevertheless, researchers worldwide are still working on its other uses, especially electronics. More sophisticated uses are much harder to prepare and demand the best quality graphene available.

We will present the BeeGraphene company, especially our main product – graphene on silicon carbide produced with an improved method of SiC graphitization in a flux of Si atoms. This patented method gives better control over the graphene growth compared to SiC graphitization in the atmosphere of buffer gases such as argon.

BeeGraphene can provide single-domain 1-5 layered graphene on SiC wafers up to 2 inches in diameter. Smaller sample sizes are also available, with 7x7 mm being the standard size. Additionally, our graphene is minimally step-bunched, leading to genuinely anisotropic properties. As a confirmation of the quality of our product, we will provide examples of its successful incorporation in various settings.

HIGH SAFETY HOGER GLOVEBOXES ADJUSTED TO PERFORM OPERATIONS IN ROBOTIC MANNER

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Gloveboxes, as instruments securing operators working with harmful materials but also isolating sensitive compounds from oxygen and moisture, must be designed and produced according to strict requirements ensuring their high safety and reliability. Such approach focused on high quality, as well as increased work ergonomics is implemented by HogerBox Ltd. - polish manufacturer producing individually designed gloveboxes and isolators dedicated for application in scientific laboratories, R&D departments and specialized production lines from pharmaceutical, medical, automotive and other materials related sectors [1].

Safety of the operator working with harmful compounds, but also protection of the stored sensitive materials is ensured by extremely high leak tightness of both gloveboxes and antechambers (class I according to ISO 10648-2 standard), integration of advanced sensors which continuously monitor internal environment (oxygen, moisture, VOC, etc.) and enable precise regulation of the working pressure adjusted for operation mode (operator or product protection) but also by optimalization of operating parameters of filtration and ventilation systems [1].

Designing of HOGER gloveboxes is proceeded taking into account not only safety of operation but also convenience of work with the system. Consequently, considered devices exhibits increased ergonomic obtained by integration of worktop height regulation system, adjustment of gloveports size and position, as well as replacement of standard stainless steel door covers with transparent glass [1], but also by implementation of advanced control systems adopting voice and gesture recognition enabling executing of selected operations (such as change of working pressure, opening of the door or turning the light on) with arms still placed inside gloveports. Additionally, integration of HOGER gloveboxes with cobots (i.e. cooperating robots) allows for automatic performing of repetitive operations while granting safety of its simultaneous work with men.

References:
[1] www.hogerbox.com

NEW DIW TECHNOLOGY 3D PRINTER FOR CHEMISTRY AND MATERIALS LABORATORIES

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Additive technologies allow various industrial and scientific entities to optimize their manufacturing processes and to work on materials previously unattainable enhancing the geometry complexity of manufactured parts. This in turn affects the overall acceleration of research and development processes both on the level of scientific inquiries and ready-to-implement solutions for mass production. One of the companies working on discovering new methods in 3D printing technologies is Sygnis S.A - Polish deeptech company specializing in hardware R&D in four main sectors: new additive manufacturing, power engineering, biotechnology and nanotechnology. The company not only creates new specialized machines, high tech solutions and R&D projects, but also offers 3D printing services for various industries and delivers cutting-edge technological solutions for production lines, universities and scientific institutes. For chemistry and materials laboratories Sygnis has prepared a unique, budget solution which is the result of many consultation sessions and development projects.

Sygnis' original Direct Ink Writing 3D printer – F-NIS 23151 – is a gateway machine for everyone conducting material research and those working with flexible electronics and robotics. It allows them to work on their terms with i.e. pastes, gels and resins. Sygnis' DIW 3D printer is a simple and reliable tool, helpful in the initial stages of proof-of-concept or as a versatile base for prototyping proprietary 3D printing materials.

F-NIS 23151 will find its use in chemistry and materials laboratories, among research groups working on new materials, flexible robots, flexible electronics, ceramic insulators, UV-curable materials, silicones, conductive pastes and research on new kinds of bateries. As a universal Direct Ink Writing 3D printer, F-NIS 23151 fits perfectly with the needs of universities, laboratories and research groups in various areas of science. Several universities and scientific groups have already adopted this machine in their research, i.e.: AGH University of Science and Technology, Adam Mickiewicz University Poznań and Cracow University of Technology.

In the presentation, Sygnis' representative will introduce the F-NIS 23151 3D printer showing its possible applications and allow the audience to get a glimpse of various Sygnis' R&D projects outlining the vast spectrum of their scientific, industrial and social impact.

NANOMATERIALS (MODIFICATIONS) FOR MACRO EFFECTS

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High temperature processes are very demanding in terms of material life due to the combined stresses of corrosion, wear, erosion, impact, and mechanical stresses associated with harsh operating conditions. Plant design and material selection, both together encompass many criteria that need to be carefully considered, such as: mass, volume, temperature, pressure, flexibility of process control, capital and operating costs, maintenance, service life... Usually, the selection of materials is mainly focused on mechanical properties, very often at the expense of corrosion problems due to the cost of high strength materials. This is counterbalanced by the addition of thin coatings or surface engineering to provide the underlying materials with new characteristics such as low wettability, better corrosion protection, insulating capability.

Three examples will be presented:

i) Development of nano-dispersed catalysts: the manufacturing of metallic nano-dispersed catalysts onto oxide support enables to reach high level of catalytic activity, resistance to carburizing environment, selectivity...

ii) Surface engineering of steels to reduce wettability: structuring of low-grade steels with corrosion resistant steels increases the contact angle from less than 80° (hydrophilic state) to 155° (superhydrophobic state), which significantly reduces contact and adhesion to/with corrosion agents on the steel surface.

iii) Surface modification of flexible materials for insulation: the manufacture of a thin IR-reflective coating on flexible materials opens the way to the manufacture of thin, high-performance insulation systems for power generation and oil and gas applications.

This presentation provides an overview of some key recent developments using nanomaterials or nanomodifications of materials to improve the performance of high temperature plants / facilities in harsh environments from an academic up to an industrial point of view.

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Maciej J. Nowakowski,

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SCANNING MOBILITY PARTICLE SIZED, A SOLUTION FOR HIGH RESOLUTION ON-LINE DETECTION OF ENGINEERED NANOPARTICLES STARTING FROM 1 NM

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Introduction

The benefits of sizing nano particles using an electrical mobility sizing technique have been well documented (Knutson & Whitby, 1975; Wang & Flagan 1990). The technique is highly accurate and has been shown to size 60 nm and 100 nm standard reference material with an uncertainty of only 1% (G. Mulholland et al., 2006). The National Institute of Standards and Technology (NIST) has been using electrical mobility to measure its 100 nm standard reference material particles for well over a decade (P. Kinney et al., 1991.; Mullholand et al., 1999).

Lately, the electrical mobility technique has increased use in the in-situ near real-time sizing of engineered nanoparticles synthesized by a variety of aerosol-based processes like diffusion flame synthesis, spray pyrolysis, thermal plasma, combustion processes etc. (TSI SMPS Bibliography).

With the commercialization of nanotechnology and increasing interest in nanoparticles monitoring, the demand on precise sizing of nano particles has grown. This contribution provides a brief overview of the electrical mobility technology as integrated in TSI Scanning Mobility Particle Sizer™ (SMPS™, model 3938) spectrometer.

Principles

The SMPS™ spectrometer consists of a sample preconditioner, a bipolar charger, a nanoparticle size classifier and a nanoparticle detector. Figure 1 depicts a schematic of the entire system. The pre-conditioner eliminates large micrometer sized particles. The bipolar charger (also referred to as neutralizer) establishes bipolar charge equilibrium on the particles. This defined charge condition is necessary for the size classification using electrical mobility. Particles are size classified in a Differential Mobility Analyzer (DMA). The electric field inside DMA separates the particles according to their electrical mobility which is inversely related to the particle size. The monodisperse particle stream exiting the DMA is counted by a Condensation Particle Counter (CPC). In the CPC, single Nano particles grown to micrometer size by means of condensation of a working fluid (alcohol or water) on the particles. The CPC then optically counts these particles.

Figure 2 shows particle size distributions measured by changing the applied high voltage in the DMA, which changes the electrical field, thus scanning the whole size distribution in a short time (Tröstl J.,2015).

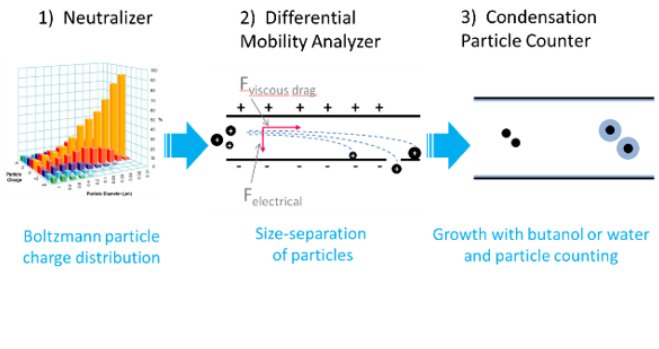

Fig.1: Basic principle of SMPS™ spectrometer operation.

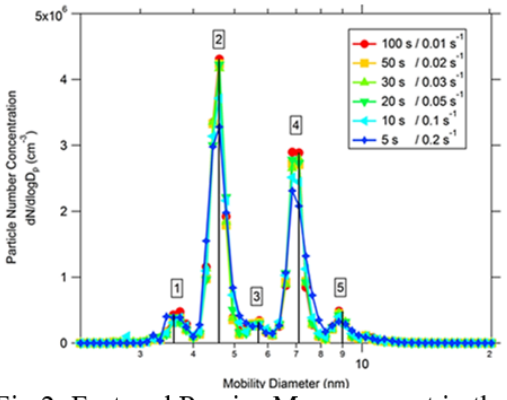

Fig.2: Fast and Precise Measurement in the sub-20 nm Size Range using a SMPS.

Conclusion

The SMPS combines strengths in particle classification and counting. It is used to study particle nucleation and particle growth from sources such as flame synthesis, laser ablation, spark generation and nucleation/ condensation. The main strength is in high resolution of size distributions with excellent peak-to-peak resolving power and ability to resolve multi-modal distributions in short time. On-line aerosol measurements using SMPS are a powerful tool in nanoparticle synthesis characterization. The main advantage is in real time feedback that can significantly speed up both product and research process.

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STRUCTURE AND PROPERTIES OF AlCoFeNITi AND AlCoFeNITiSi HIGH-ENTROPY ALLOYS

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High entropy alloys are a new and interesting group of metal engineering materials. In the simplest definition, they are alloys of 5 or more elements with a similar atomic fraction (from 5 to 35 at%). The limited number and simplicity of the phases in these alloys may seem surprising The work presents the results of structure research and selected proprerties on AlCoFeNiTi and AlCoFeNiTiSi alloys produced at different cooling rates of the liquid alloy. The alloys were made of pure elements with a purity of at least 99.99% by induction melting. High rate cooling samples were made by pressure casting into a water-cooled copper mold. The melting process was performed in an Ar atmosphere to avoid oxidation of the alloys. Structure studies (SEM, X-ray) reveal significant differences resulting from the addition of silicon. The differences are manifested in the phase structure and the distribution of elements. The addition of silicon promotes spinadal decomposition and the production of areas more varied than in the case of an alloy without the addition of Si. The tests of the corrosive properties show a large influence of the cooling rate on the corrosion resistance of the analyzed alloys. In addition, studies of the catalytic activity of the material related to the decomposition of impurities difficult to remove with other techniques were carried out.

THE INFLUENCE OF ZINC OXIDE LAYER ON THE PHYSICOCHEMICAL PROPERTIES OF TI6AL4V TITANIUM ALLOY

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The problems associated with maintaining the proper condition of the area of contact between tissues and the implant surface remain and are recognized as a challenge due to the possibility of infection, inflammation, and biomaterial wear. Generally, titanium and its alloys have been regarded as inert and biocompatible materials with good corrosion resistance due to the ability to form a TiO_2 oxide layer. However, titanium biomaterials degradation in the human body environment causes the release and accumulation of elements/corrosion products, which causes metallosis. In patients with metallic implants, the released metal ions initially cause local toxic reactions in the surrounding tissues. The number of ions released into the bloodstream allows for the assessment of implant wear and tear, but it is also a serious problem that, if understated, can lead to tissue necrosis and, as a result, implant failure and/or other serious complications. Titanium and its alloys' toxic metabolites, such as titanium particles, metal-protein complexes, inorganic salts, and ions, may be detrimental to the human body [1]. Titanium, unlike cobalt, is not readily soluble and is not easily eliminated in urine from the human body. Instead, it gradually accumulates in detoxifying organs, causing tissue harm. In order to minimalize the toxicity reaction, surface modification could be performed. The use of inorganic oxide layers in biomedical applications has attracted interest due to their high chemical stability, satisfactory biocompatibility, and possible high antibacterial potential. The purpose of the research was to analyze the physicochemical properties, including wettability and corrosion resistance of the uncoated Ti6Al4V alloy and alloy with zinc oxide ZnO layer, deposited by atomic layer deposition method (ALD). The AFM microscope was used to analyze the surface of the tested samples.To investigate, the contact angle measurements and surface free energy calculation was made. Additionally, the corrosion resistance in the Ringer solution was analyzed using the anodic polarization method. The number of ions released after the potentiodynamic test was measured using the inductively coupled plasma atomic emission spectrometry (ICP–AES) method. Based on the obtained results it can be concluded that the surface conditions have a significant effect on the corrosion resistance of Ti6Al4V titanium alloy. The optimum physical- and electrochemical properties were recorded for the samples with the ZnO layer. The contact angle measurements showed that the surface modification by the ALD method affected the increase in wetting angle. It was concluded that the surface wettability conversion reactions on the tested samples are directly related to the morphology of the samples, especially to surface roughness. The AFM surface roughness calculation showed that the samples with the ZnO layer were characterized by close to three-fold higher values of surface roughness parameters in the nanoscale as compared to the samples in the initial state. The hydrophobic character of the surface and high value of surface free energy is associated with better corrosion resistance and can lead to reduced bacterial adhesion thereby, in effect, reducing biocorrosion.

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3W IDEA — AN OPPORTUNITY FOR THE POLISH ECONOMY AND A RESPONSE TO CLIMATE CHANGE

Bank Gospodarstwa Krajowego, Idea 3W, M. Jankowski, D. Bogdał, Ł. Szelecki, A. Żelezik, K. Pala

Today – not only as Poland, but as the whole world – we are facing huge civilisation challenges, because climate change is moving faster than we initially assumed. Societies in developed countries already expect us not to develop at the expense of future generations and the environment, and the coming years and decades will be crucial in this regard. Big changes are ahead of us, linked above all to the transformation of the economy towards zero carbon. Modern civilisation is based on creating added value: making new things, transforming simple substances into increasingly complex materials, products and services. All this requires resources and a huge amount of energy. **The 3W Idea responds to this challenge: it is a vision** of the future in which we, as a whole society, responsibly manage the resources at our disposal and in which we can maintain and improve our quality of life while using less energy and fewer non-renewable resources. 3W focuses on 3 resources that will have a huge impact on our future: they are water, hydrogen and carbon. Hence 3W: from water, hydrogen and carbon.

First of all, hydrogen solutions will help to replace emission-intensive energy sources with zero-emission hydrogen – provided, of course, that it is green hydrogen. However, our thinking is much broader than just hydrogen. There is a great deal of work going on around the world in which the element carbon is used to capture and store CO2 generated in various technological processes. These are still expensive technologies, but many experts predict that with advances in technology and economies of scale, it could become cost-effective. W technologies can also reduce CO2 emissions in other – and quite surprising – ways. In our report, for example, we describe graphene concrete – that is, concrete reinforced with graphene. To construct the same building with graphene concrete technology, 30 percent less material is needed than with classic concrete. And if less concrete is needed, less CO2 will be emitted in its production.

References:

[1] https://idea3w.org/en/idea-3w

COMPARISON OF BATCH AND CONTINUOUS-FLOW POLYOL SYNTHESIS OF SILVER NANOWIRES

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Synthesis of silver nanomaterials with a high aspect ratio, i.e. nanowires, is currently the subject of intense research, due to their unique catalytic, optical, magnetic and electrical properties. The morphological characteristics of the final product determine the directions of potential applications of these nanomaterials in optoelectronic and microelectronic solutions, energy conversion systems and many more [1]. This implies an increase in demand for these nanostructures and the need to work on efficient methods for their synthesis.

While there are many descriptions in literature regarding production of silver nanowires in batch reactors, the amount of information on continuous-flow synthesis remains very limited. The shift from batch to continuous systems requires a detailed optimisation in terms of reactor geometry, reagent concentration, temperature profile and residence time [2]. The aim of this research is to compare preliminary studies on the continuous flow synthesis in a tubular reactor with synthesis carried out in a periodic system.

Results presented provide information on morphological characteristics of the final product based on measurements using SEM, UV-Vis, EDS and ionometric techniques. Results of the work show that it is possible to control the final shape of the product and can be used as initial assumptions for further research regarding process optimisation and scale-up.

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