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Searching for biologically active peptide fragments of hACE2 for nanogold-covered biosensor development

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The ongoing progress of technical, biological and chemical sciences provides new possibilities in the development of fast and reliable analytical methods. Over time, more and more popularity has gained the idea of creating a biosensor – a small device in which the detecting system is based on natural compounds such as proteins, peptides, antibodies, enzymes, DNA and RNA particles or even cells and cell organelles [1]. The immobilization of the active entity on the solid support would allow to observe the interaction with the estimated compound and generate a signal delivering qualitative and quantitative information about the interaction of molecules. Received data would be characterized by high sensitivity (ppm/ppb scale [2]), and specificity without the necessity to extract analyte from a biological mixture.

Research conducted at the Institute of Organic Chemistry focuses on the development of biosensor for the identification of disease entities (especially COVID-19) by recognizing characteristic compounds present in physiological fluids (e.g. blood, urine, exhaled air with saliva particles). One of the idea concern the use of biologically active peptide fragments of human angiotensin-converting enzyme type 2 (hACE2) responsible for binding the S1 protein subunit of the SARS-CoV-2 virus. Their latter immobilization on the solid support with a gold layer will be possible through the formation of a covalent bond between the thiol group of cysteine residue and nanogold particles. Ligand-receptor interaction should be observed as the result of peptide conformational changes in the form of electrical resistance.

The search for potentially active fragments of protein that are involved in protein-protein interaction was based on the dot-blot methodology [3]. The procedure includes the SPOT synthesis of a library of overlapping fragments of protein immobilized on a cellulose matrix by using DMT/NMM/TosO$^-$ [4] as a coupling reagent and further incubation of 399-element library with HRP labelled S1 subunit of the SARS-CoV-2 virus. As a result, 32 peptide fragments with various lengths of peptide chains were selected, in which 16 fragments were characterized as structures strongly interacting with virus spike protein. The synthesis of chosen fragments is performed with the use of the SPPS method to confirm their biological activity towards the SARS-CoV-2 virus particles.

References

[1]. N. Bhalla, P. Jolly, N. Formisano, P. Estrela. *Essays Biochem.*, **2016**, *60*, 1-8.
[2]. A. J. M. Barbosa, A.R. Oliveira, A.C.A. Roque. *Trends Biotechnol.*, **2018**, *36*, 1244-1258.
[3] B. Kolesińska et al. *Engineering of Biomaterials*, **2018**, *148*, 41.
[4] J. Frączyk, M. Walczak, Z.J. Kamiński. *J. Pept Sci.,* **2018**, *24*, e3063.

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Low Cytotoxicity Conjugated Polymer Nanoparticles as Imaging Agents

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Conjugated Polymers (CPs) are a class of organic nanostructures with extensive backbone of alternating single-multiple bonds. The delocalized π-electrons, resulting electronic conductivity. In addition, CPs are emerging materials for electronic, energy and biological applications due to their unique optoelectronic properties.[1] Moreover, conjugated polymer nanoparticles (CPNs) are ascending nanomaterials with excellent optical properties and low cytotoxicity effect, enhancing their utility as imaging agents.[2] Our work focuses on the rational design, synthesis and characterization of new improved CPNs that would be applied as imaging probes. Hence, we are representing two CPs consisting of electron donating-electron withdrawing system (D-A) building blocks and one conjugated homopolymer.

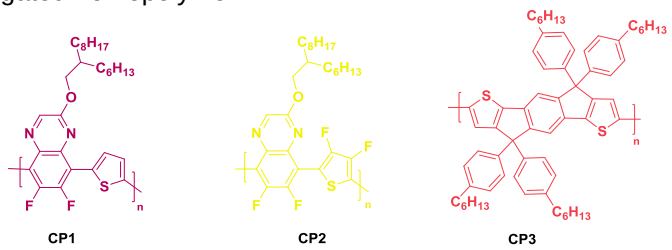

Figure 1. Chemical structures of CPs.

The above polymers were characterized, using NMR, GPC, UV-Vis and their corresponding nanoparticles UV-Vis and DLS. In vitro tests took place in Wharton's Jelly-Derived Mesenchymal Stem Cell's and colorectal cancer cell lines, demonstrating that the CPNs do not induce cytotoxicity.

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References

[1]. a. Hobbs S. K. et al., *Proc. Natl. Acad. Sci.*, **1998**, 95 (8), 4607-4612. b. Muller P., *Pure and Applied Chemistry*, **1994**, 66, 5, 1077-1184.
[2] Wiemann S., Chochos C. L. et al., *Mater. Chem. Front.*, **2021**, 5, 4950.

Organic bio-mimetic electronics

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Nowadays, the importance of electronics is rising increasingly, offering many applications in biology, engineering, environment, everyday life, etc. Specifically, bioelectronics is a rapidly advancing field of interdisciplinary research that merges biology and electronics.[1,2] Of particular interest to bioelectronics is related to biointerfaces, which refer to the interfaces or contact points where electronic devices interact with biological systems. These interfaces are designed to establish a seamless connection between the electronic components and the biological entities, enabling the exchange of information, signals, or energy.[1,2]

More specifically, cells are comprised by an external membrane which creates a complex network facilitating communication between external stimuli and internal components. Consequently, the development of an artificial membrane capable of mimicking its natural counterpart becomes crucial, serving as a versatile interface for bioelectronic devices. [3,4] One of the ways to accomplish that is by creating a Supported Lipid Bilayer (SLB), consisting of a thin lipid bilayer immobilized on a solid substrate, providing a stable and controlled environment for studying biological processes and interfacing with electronic devices, such as biosensors, neuromorphic and other bioelectronic devices.[4]

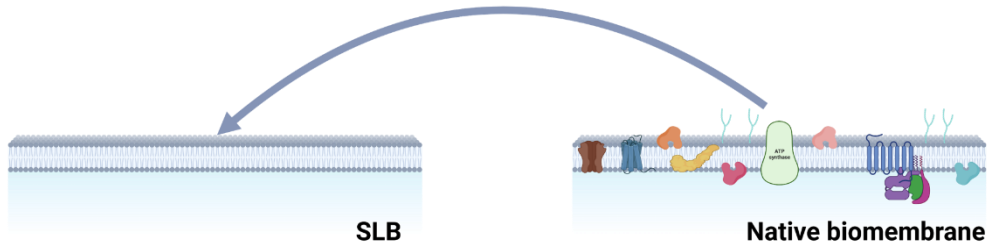

Figure 1. Schematic representation of how an artificial membrane can be synthesized (created with Biorender).

References

1. Berggren, M. & Richter-Dahlfors, A. Organic bioelectronics. *Adv. Mater.* **19**, 3201–3213 (2007).
2. Malliaras, G. G. Organic bioelectronics: A new era for organic electronics. *Biochim. Biophys. Acta - Gen. Subj.* **1830**, 4286–4287 (2013).
3. Park, Y., Luo, L. & Rolandi, M. Integrating Ion Channels with Bioelectronics for Biotic – Abiotic Systems. **2200312**, (2023).
4. Pitsalidis, C. *et al.* Organic Bioelectronics for In Vitro Systems. *Chem. Rev.* **122**, 4700–4790 (2022).

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Development of Carbon-based materials by upcycling Kevlar fibrous wastes through Pyrolysis

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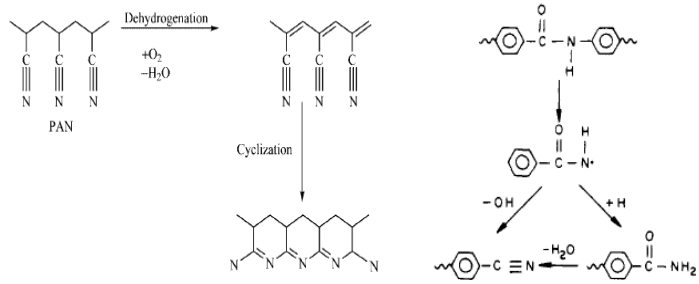
Taking into consideration environmental safety due to the discarding of textile waste, it becomes critical to recuperate useful products from such waste for economic reasons. In contrast to the conventional recycling mechanism, the most innovative and cutting-edge approach to managing fibrous wastes is 'upcycling' into solid carbonaceous materials. The primary method of upcycling is carbonization, or pyrolysis, which calls for high heat (>800 °C), a variable heating rate, and an inert environment [1]. Pyrolysis involves the elimination of moisture and volatile components from fibrous materials by cleavage of molecular bonds to finally obtain carbon-rich residues [2]. Over the years, there have been numerous studies on the pyrolysis of poly (1,4 phenylene terephthalamide) (Kevlar) and the characterization of volatile products by using various analytical techniques. Carbon-based materials are typically produced using a range of complex and multistep procedures from polyacrylonitrile (PAN), or isotropic coal tar pitches. However, due to the rigid-rod structure and high degree of aromaticity, direct carbonization is applicable in the case of Kevlar in order to obtain carbon. Progressive decomposition of amide groups occurs at temperatures between 550 and 575 ºC, resulting in the formation of intermediate aryl nitrile species [3].

Fig. 1. Upcycling of Fibrous wastes to Carbon-based functional materials.



(a) (b)

Fig .2. Chemical process of producing carbon materials from (a) PAN-based precursor by two-stage carbonization and (b) Kevlar-based precursor by direct carbonization.

References

[1] J. Choi et.al, *Macromol. Rapid Commun.*, vol. 43, no. 1, 2022.
[2] A. Ramgobin et.al, *Polym. Rev.*, vol. 59, no. 1, pp. 55–123, 2019.
[3] D. Karthik et. Al, *Materials*, vol. 14, p. 6433, 2021.

Effect of stabilizing agent on the synthesis of ZnO nanoparticles

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ZnO nanoparticles are widely used in opto- and microelectronics for photodetectors and in transparent electronics for TFT arrays [1]. As they are a biocompatible material, they can also be used in medicine.[2]

The purpose of our research was to produce and characterize ZnO nanoparticle suspensions using a stabilizing agent (carboxylic acids) in different proportions relative to the ZnO precursor. The synthesis was carried out according to the following method: zinc acetate was dissolved in ethanol, carboxylic acid was added and refluxed, then a solution of tetramethylammonium hydroxide was injected into the reaction mixture, the whole was heated for 2 minutes and then quickly cooled to 0°C. The resulting precipitate was centrifuged, washed with ethanol and finally dispersed in toluene.

The particles obtained were characterized in terms of structure and morphology both as a suspension and as a thin film produced by drop casting and by spin coating method. The following techniques were used for the study: FT-IR and UV-VIS spectrophotometry, as well as an optical microscope (Fig. 1) and an atomic force microscope.

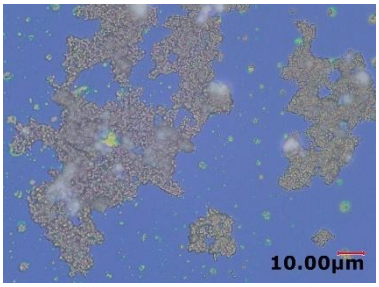

Figure 1. Microscopic photo of ZnO layer obtained by spin coating method.

Acknowledgement

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References

[1].A. Galdámez-Martinez, G. Santana, F. Güell, P.R. Martínez-Alanis, A. Dutt, *Nanomaterials*, **2020**, 10(5), 857.

[2]. Moussodia, Ralph-Olivier, et al. *Journal of Materials Chemistry*, **2010,** 20.6, 1147-1155.

Difference in oil sorption properties of expanded graphite due to intercalation.

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Expanded graphite is a unique form of graphite due to its porous structure. One of its most practical applications is its use in oil spill control and water purification due to its ability to absorb large quantities of oil and heavy metals (1). Because of its high degree of exfoliation, expanded graphite is also used as a precursor in the production of graphene and exhibits comparable properties when used in composite materials. There are many different methods and chemicals used to intercalate graphite; however, impurities are sometimes left behind in the final product (2). This work focuses on the effect the different methods of intercalation have on the oil and heavy metal sorption properties of expanded graphite. The intercalation process is illustrated in figure 1.

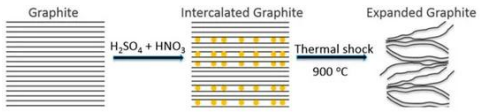

Figure 1: Intercallation of graphite to form expanded graphite (3)

Acknowledgement

This work is supported by the Czech Ministry of Education, Youth and Sport under the project registration number SGS-2023-6384.

References

1. Wu KH, Huang WC, Hung WC, Tsai CW. Sorption and regeneration of expanded graphite/Fe3O4 composite for removal of oil pollution from the water. Materials Express. 2021;11(4):579–85.

2. He J, Song L, Yang H, Ren X, Xing L. Preparation of Sulfur-Free Exfoliated Graphite by a Two-Step Intercalation Process and Its Application for Adsorption of Oils. Journal of Chemistry. 2017;2017:1–8.

3. Mazela B, Batista A, Grześkowiak W. Expandable Graphite as a Fire Retardant for Cellulosic Materials—A Review. Forests. 2020 Jul 13;11(7):755.

Synthesis of novel copolymers containing photoacids moieties.

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This study presents the synthesis of novel copolymers containing photoacid moieties for the development of photo-responsive materials, such materials demonstrate great potential for biomedical applications, including wound dressing [1,3], drug delivery systems, fluorescence readout-based 3D optical data storage systems [1,2], etc. The incorporation of photoacid units into the polymer chain allows tuning the acidity of the particular environment via photo-induced proton release [3].

The copolymerization of the photoacids containing monomers with other methacrylates via atom transfer radical polymerization (ATRP) and reversible addition-fragmentation chain transfer polymerization (RAFT) will be reported herein. The characterization and photo-responsive behavior will be discussed within the current work.

Acknowledgement

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References

[1]. Nina A. Kuznetsova, Russ. Chem. Rev., 2020, 89 (2) 173-190.
[2]. Yu Cheng, Chem. Commun., 2023,59, 1805.
[3]. Jiacheng Zhao, Macromolecules 2021, 54, 4860−4870.

Influence of ZnO and TiO_2 nanoparticles on performance of PVA active layer membranes for use in the water desalination process by pervaporation

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Due to the shortage of water in the world, new solutions for its acquisition are sought. One possible way is the desalination of seawater. Our studies focus on the effect of zinc oxide (ZnO) and titanium dioxide(TiO_2) nanoparticles (NPs) on the efficiency **(J),** expressed by a permeate flux, and the selectivity **(R),** i.e., by a retention degree - in the pervaporation process (PV). The PV process belongs to the low-pressure membrane separation techniques, mainly used in the separation of azeotropes. The active layer of the PV membrane, prepared by the dry phase inversion method, were effectively modified with NPs of the above metal oxides.

A commercial ultrafiltration membrane, based on polysulfone, were coated with a suspension of ZnO or TiO_2 nanofillers in the 5 wt.% PVA membrane-forming water solution, containing a surfactant (in order to obtain a greater degree of hydrophilicity) which was earlier sonicated at 25 °C for 30 min., followed by addition of glutaraldehyde as cross-linking agent and drying at 80 °C for 30 min. The PV process was carried out with a model seawater solution (of 3.5 wt.% NaCl content). The contact angles and the degree of swelling in water were also examined. The content of NPs is given as weight % with respect to the amount of PVA. The degree of swelling (S) of the obtained novel PV membranes was also determined.

Table 1.

Summary of the results of efficiency, selectivity and parameters characteristic for PV membranes (modified with ZnO and TiO_2 NPs), produced by the dry phase inversion method.

Membrane	Weight % of n-ZnO	Contact angle [°]	Swelling degree [%]	**J** [kg/m^{2}h]	**R** [%]
M31	50.0	57.06	50.32	9.62	99.34
M36	25.0	38.05	61.13	11.60	99.87
M41	12.5	25.59	66.49	21.24	69.29
Membrane	Weight % of n-TiO_2	Contact angle [°]	Swelling degree [%]	**J** [kg/m^{2}h]	**R** [%]
M35	50.0	45.75	74.18	8.28	99.65%
M38	25.0	26.54	63.32	6.88	94.83%
M42	12.5	11.86	59.61	15.36	9.83%

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Results in the Table 1 show that smaller additions of ZnO or TiO_2 cause sharp decreases in the selectivity **R**, while increasing the efficiency **J** of the PV process. The optimal ZnO content was 25 wt.% based on the amount of PVA in the membrane-forming solution (for membrane M36). For membrane M35, containing 50 wt.% TiO_2, the highest selectivity **R** was observed at the relatively large flux **J** of the obtained permeate. With the decrease in the content of ZnO or TiO_2, the hydrophilicity of the studied membranes increased, which was confirmed by the decreasing value of decreasing value of their contact angles, simultanously with the increasing degree of swelling. The topic requires more research and energy optimization.

Shear Angle Effect on the Engineering Properties of Woven Fabrics

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In application and usage, the angle between weft and warp, described as the shear angle, changes dues to the dynamic forces of tension and pure shear. This tends to have a significant impact on the behaviour and response of the fabric in usage. It is paramount to determine how this constant change in angle affect the geometry of the fabric and how it affects the textile formed from this fabric. Fabric properties including weave type and setting have significant effects on the shear response of fabrics [1]. A number of experimental methods proposed fpr measuring shear deformation in woven fabrics include the picture frame test method (PFTM), the Kawabata evaluation system for fabrics (KEF) and the bias-extension test method (BETM). Most other research works have delved into experimental investigation of the shear angle, displacement, tensile and shear forces of the fabric. There is a relationship between wrinkling and shear angle. The study showed how the critical shear angle called locking angle has a high dependence on such parameters as yarn spacing, tow size and friction [2]. In both applications as textiles in clothing and reinforcements in composites, wrinkling and *drapeability* play a big role in terms of shear angle, although the latter carry more load. The pin-join model is famous in determining the deformation of woven fabrics based on kinetic-geometric analysis [3]. The main assumption is that yarns, inextensible and incompressible, are pinned at points of intersection and are free to relocation spatially but not translate in real time.

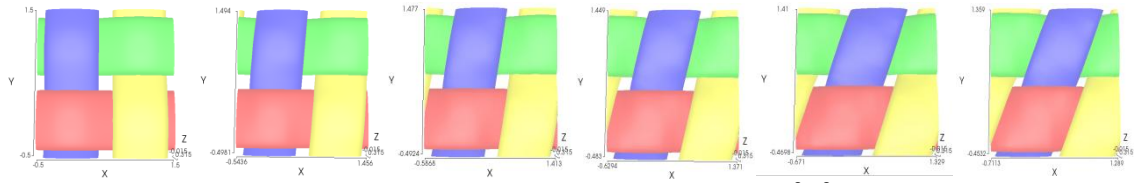

Figure 1. Shear Angle [From Left to right (0 – 25^o:5^o)].

This work will investigate the effect of the shear angle in a 2x2 plain-woven fabric. The model is composed of lenticular-cross section yarns generated from TexGen. The geometrics of the yarn are 1.0 mm for the yarn spacing, 0.8mm for the yarn width, 0.3 mm for the fabric thickness and 0.1mm for the yarn height. It is also technically desirable to rework the process in Ansys 2022 R2, where the shear angle is initially zero and then parametrically ramped to 30^o.

Acknowledgement

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References

[1] R. B. Büyükbayraktar. The J. Textile Inst., **2022**, *113*, 2249-2262.
[2] A. G. Prodromou & J. Chen. Composites Part A, **1997**, 28, 491 – 503
[3] C. Mark & H. M. Taylor. J. Textile Inst., **1956**, 47, 477 – 488.

Thermodynamic study of linear nanofibrous materials

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Sutures are the most commonly used medical devices for wound closure as they facilitate the creation of a stable environment for wound healing. Nonetheless, bacteria can make their way or be trapped in the wound site which increases the chance of infection, these are called suture site infections (SSI) and are reported to happen in more than 5% of suture sites [1], [2]. In order to reduce the prevalence of SSIs, we are focusing on braided 100% nanofibrous yarns (nanoyarns). Electrospun nanofibrous materials made from biocompatible polymers have improved tissue integration and drug delivery, which promotes wound healing and reduces the risk of infection [3].

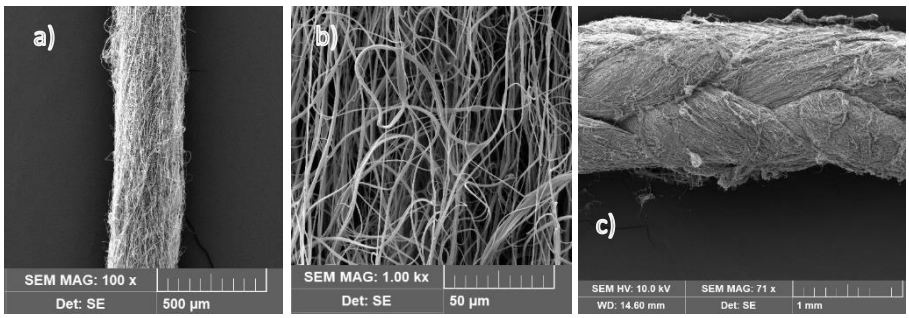

Figure 1. a) 100% Nanoyarn, b) Nanofibers in the nanoyarn, c) Braided 100% nanoyarn.

The nanoyarns are composed of nanofibers produced by a needless AC electrospinning setup, and are able to be processed by a braiding machine, the individual nanoyarns and the braided version are shown in Fig 1.

Acknowledgement

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References

[1] W. G. Cheadle, “Risk factors for surgical site infection,” *Surg Infect (Larchmt)*, vol. 7 Suppl 1, pp. S7-11, 2006, doi: 10.1089/sur.2006.7.s1-7.

[2] C. E. Edmiston *et al.*, “Microbiology of Explanted Suture Segments from Infected and Noninfected Surgical Patients,” *J Clin Microbiol*, vol. 51, no. 2, pp. 417–421, Feb. 2013, doi: 10.1128/JCM.02442-12.

[3] X. Liu, H. Xu, M. Zhang, and D.-G. Yu, “Electrospun Medicated Nanofibers for Wound Healing: Review,” *Membranes (Basel)*, vol. 11, no. 10, p. 770, Oct. 2021, doi: 10.3390/membranes11100770.

Thermal Behaviour of Sandwich Fibrous PCM Encapsulations

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Phase change materials (PCMs) textiles have been developed for personal thermal management (PTM) while limited loading amount of PCMs in textiles reduced thermal buffering effect [1]. In this work, we firstly prepared a sandwich fibrous encapsulation to store various PCMs (e.g., paraffin wax, PEG etc.), which consisted of polyester (PET) fabrics with hydrophobic coating as protection layers, polyurethane (PU) nanofibrous membranes as barrier layers and PCM-loaded viscose fabric as a PCM-loaded layer [2]. The leakage was totally avoided by controlling weak interfacial adhesion between protection layer and melting PCM. The sandwich fibrous PCM encapsulations had an overall melting enthalpy value ranging from 50 J/g to 78 J/g and melting points ranging from 20 ^{o}C to 63 ^{o}C by selecting PCMs. We believe that the sandwich fibrous PCM encapsulation has a great potential in various fields.

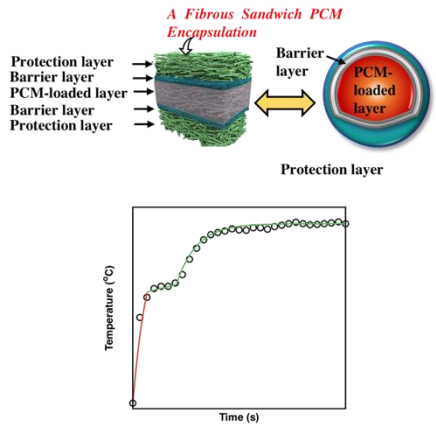

Figure 1. Diagram for the sandwich fibrous PCM encapsulations (SFPE)

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References

[1]. K. Yang, M. Venkataraman, X. Zhang, J. Wiener, G. Zhu, J. Yao, J. Militky. *J Mater Sci.*, **2022**, *57*, 798–847.

[2]. K. Yang, X. Zhang, J. Wiener, M. Venkataraman, Y. Wang, G. Zhu, J. Yao, J. Militky. *Chemnanomat*. **2022**, *8*, e202200352.

Lubrication properties of diblock bottle-brush polymer with boronic acid – preliminary studies

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The loss of synovial fluid and abnormalities in cartilage structure can lead to changes in the mechanism of joint functioning and its tribological properties [1]. Such disruptions lead to degeneration of joint surfaces and the formation of arthritis. This degenerative joint disease (osteoarthrosis) is one of the leading causes of disability in the world population.

An important objective of this work is the evaluation of the possibility of using bottle-brush polymers as lubricants in the joints. New class of material can be synthesized by reversible-deactivation radical polymerization [2]. These polymers have wide-ranging application possibilities, and due to their structure, they have very good lubrication properties which could be crucial in the treatment of the early stages of osteoarthrosis [3]. New advanced bottle-brush polymers seem to show the ability to be used to lower friction coefficient between surfaces.

Surface Force Apparatus (SFA) allows the measurement of surface forces between surfaces such as friction or lubrication[4]. Friction of polymer was measured on silver-coated mica surfaces using the SFA 2000 equipped with digital camera. The preliminary studies show that diblock polymer reduces the friction coefficient and provides better film stability than monoblock polymer.

Acknowledgement

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References

[1] D. R. Chery et al. *Acta Biomaterialia*, **2020**, 110, 267-278
[2] S. Shanmugam and K. Matyjaszewski, *ACS Symposium Series*, **2018**, 1284, 1, 1-39
[3] W. Yan, S.N. Ramakrishna et al., *Langmuir* **2019**, 35, 35, 11255–11264
[4] J. Israelachvili *et al., Rep. Prog. Phys.* ***2010****, 73, 3*

Unlocking Cyan Electroluminescence: Exploring Intramolecular Interactions for Concentration-Insensitive TADF Emitters

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Thermally activated delayed fluorescence (TADF) organic compounds have emerged as the promising "third-generation" emitters, offering exceptional emission dynamics. TADF compounds are highly regarded for their superior luminescence efficiency, remarkable color properties, and overall stability, making them the preferred choice for the development of high-quality organic light-emitting diodes (OLEDs) [1, 2].

In this study, we present a series of three novel symmetric TADF emitters with a donor-acceptor-donor architecture. These emitters are based on a new acceptor molecule, namely 1,4-bis(trifluoromethyl)benzene, in combination with well-established donor units, namely phenoxazine, phenothiazine, and 9,9-dimethyl-9-10-dihydroacridine. Through comprehensive investigations employing low-temperature, steady-state, and time-resolved spectroscopic techniques, we extensively characterized the newly synthesized emitters.

The synthesized compounds exhibited a narrow singlet-triplet energy gap, measuring below 21 meV, and demonstrated a high reverse intersystem crossing rate exceeding $5.45 \cdot 10^5\ s^{-1}$. These properties establish them as highly promising candidates for integration into OLED devices. To evaluate their practical applicability, we fabricated vacuum-deposited OLEDs utilizing a carefully selected emitter. The resulting devices exhibited exceptionally stable cyan-colored electroluminescence, peaking at 477 nm, across various emitter concentrations and applied voltages.

Moreover, our OLEDs showcased minimal efficiency roll-off even at a brightness level of up to 1000 cd/m^2. The external quantum efficiency of these devices reached a value of almost 6%. These findings underscore the significant potential of the newly developed TADF emitters for practical OLED applications, demonstrating their enhanced performance and stability in real-world device configurations [3].

Acknowledgement

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References

[1]. G. Hong, et al., *Adv. Mater*., **2021**, 33(2005630), 1–24.
[2]. Teng, J. et al., *Journal of Materials Chemistry C*, **2020**, *8*(33), 11340–11353
[2]. Skhirtladze, L. et al., *Journal of Materials Chemistry C*, **2022**, *10*(12), 4929–4940.

Synthesis and characterization of substrates for the synthesis of long-acting insulin analogs. Triazine coupling reagents in the synthesis of insulin analogs

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Epidemiological and statistical data indicate that insulin is a life-saving medicine for 30 million people suffering from type I diabetes and many millions with type two diabetes. Unfortunately, the predictions about diabetes are alarming, these data are prompting many research units and pharmaceutical companies to search for new insulin analogs as well as to develop the most efficient methods of producing them. As part of the work conducted at the Institute of Organic Chemistry of Lodz University of Technology, an efficient method for synthesizing a long-acting insulin analog known as Degludec has been developed. This is the currently available drug Tresiba, but the developed synthesis method is more efficient and more economically viable. The synthetic strategy is based on the use of triazine coupling reagents to obtain the active ester with the ligand IP13, which is used for the incorporation of hydrophobic ligand to desB30 protein, ultimately leading to the expected product (Figure 1).

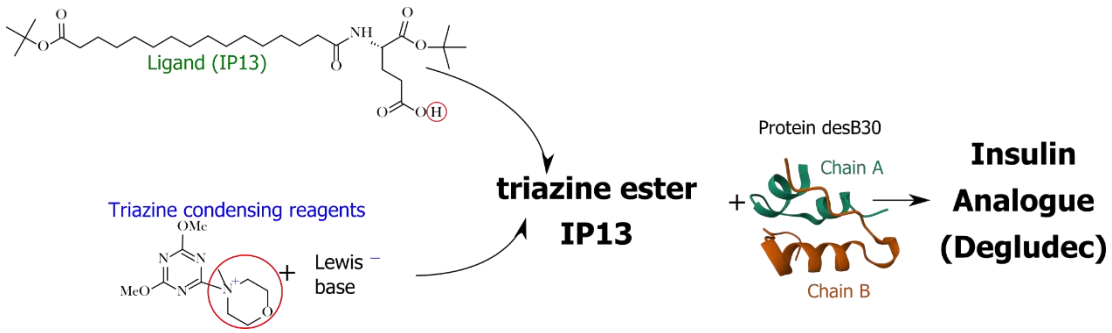

Figure. 1 Insulin analog synthesis strategy - Degludec.

In this study, three different triazine coupling reagents were used Taking advantage of the literature indicating that the *in vivo* activity of the Degludec analogue is related to its interaction with plasma albumin (HSA) [1], three amides (analogues of Ligand IP13, H_2N-Glu-OtBu amides of stearic, palmitic and 2-ethylhexanoic acids) were obtained and used to synthesize further insulin derivatives. Measurements confirmed the receipt of the assumed structures.

Acknowledgement

Thank you to the entire peptide and protein team that contributed to this work.

References

[1].B. Ahrén, B. Burke, Blackwell Publishing Ltd, **2012**, *14*, 121-129.

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Stability of Collagen Sponge Under Ionizing Radiation – SDS PAGE Electrophoresis

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Electron beam irradiation is a sterilisation technique of choice for a variety of biomaterials. The influence of the method on wound dressings fabricated using collagen derived silver carp fish skin (*Hypophthalmichthys molitrix*, obtained from Sancoll, Poland) was the main purpose of the project, whereas the described part tackles the changes in the molecular weight of the irradiated peptide in forms of a hydrogel and a freeze-dried solid sponge by the use of using sodium dodecyl sulphate – polyacrylamide gel electrophoresis (SDS – PAGE). The research showed the dry sponge material was affected by the radiation to a lower degree than the gel samples. The sterilisation-effective doses in the range 15 – 35 kGy were shown to cause both chain scission and cross-linking of peptides, but to a degree acceptable for the desired biomedical application. Future research should focus on the optimisation of the parameters of the electron beam irradiation to decrease the detrimental influence while maintaining its sterilisation properties.

Acknowledgement

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Feasibility of Fish Gelatin Bioinks for Medical Applications

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Starting as a novel invention, 3D printing has grown into a fabrication method that can allow for improved medical care. Presently, many researchers are utilizing 3D bioprinting for tissue engineering, drug delivery systems, and diagnostic technology. 3D bioprinting has the ability to provide more customized treatments and care for patients, which allows for safer and better quality medicine overall. With the growing interest in 3D bioprinting, many compositions for hydrogel inks are being developed. A popular substance for 3D bioprinting has been sodium alginate (Alg). Alg is a low cost material that has great success in terms of printability and biocompatibility. Porcine gelatin (PGel) has been utilized in congruence with Alg to successfully produce biomaterials. An alternative to PGel is fish gelatin (FGel). FGel is a newer option, but one that is gaining strong interest due to its ethically responsive nature and economical feasibility. In this work, hydrogels composed of Alg/PGel and Alg/FGel were compared. The hydrogels were printed into tubular structures and chemically crosslinked with calcium chloride. To evaluate their biological capabilities, each type of hydrogel was evaluated with two cell lines: 3T3 and Saos-2. Fluorescent microscopy was utilized at each milestone to determine cell proliferation. The results determined that FGel is a feasible option for 3D bioprinting and should be examined further regarding its potential medical applications.

Acknowledgement

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References

[1]. Wierzbicka, A., Bartniak, M., Rosińska, K., & Bociąga, B. (2022). Optimization of the preparation process stages of the bioink compositions based on sodium alginate and gelatin to improve the viability of biological material contained in hydrogel 3D printouts. *Engineering of Biomaterials, 25*(165), 7-16. 10.34821/eng.biomat.165.2022.7-16.

Dielectric Barrier Discharge Plasma with Nano-Catalysts for Methane Conversion

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In recent years, the scientific community has worked to address the critical issue of the effect of greenhouse gases on our environment [1]. The specific greenhouse gas, methane, is one of the greatest contributors to issues like global warming, the depleting ozone, and climate change. Although methane makes up less than 10^{-4} % of our atmosphere, it is one of the most potent and damaging gases. Amongst many ways to convert methane into various beneficial forms, plasma catalytic processing of CH_4 is relatively new and presents itself as one of the most environmentally and economically friendly options for the conversion of methane. Nonthermal plasmas (NTPs) with mean energy of 1-10 eV have the potential to activate and dissociate ground-state gas molecules at relatively low temperatures [2]. NTPs have been shown to break the CH_4 molecules without the presence of a supporting nanostructured catalyst to produce high value products, like H_2. This study utilizes a specific type of NTP known as dielectric barrier discharge (DBD). DBD reactors with different configurations were tested for methane conversion. The process parameters such as frequency, pressure, and DBD voltage were varied to further understand how each parameter would affect the activated CH_4 gas and the associated plasma species. The species within the plasma were observed and identified using optical emission spectroscopy (OES). The results from this study have proven that our reactors can successfully activate and dissociate methane to produce H_2.

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References

[1]. Rita, V. D., Monica, C., Greet, J., Diego, G., & Franciscus, D. (2018a). Global trends of methane emissions and their impacts on ozone concentrations. Joint Research Center.
[2]. Yamamoto, T. (1997). VOC decomposition by nonthermal plasma processing — a new approach. Journal of Electrostatics, 42(1–2), 227–238.

Quantum mechanical approach to the hydration of 2-aminopyridine in aqueous solutions.

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Heterocyclic compounds are organic molecules that are important components of natural substances, e.g. hormones or vitamins and thus, have great biological significance [1]. A special subgroup of such compounds are nitrogen-containing heterocycles since they are widely used in the pharmaceutical industry due to their desirable properties, among others: antihistamine or anti-infective. An example of such compounds are pyridine and its derivatives which are frequently used in pharmaceuticals [2].

2-aminopyridine (2AP) is commonly found in antibiotics [3], for example sulfonamides - a group of drugs dedicated for treatment of different types of infections. Even though 2AP is a relatively simple molecule, its hydration mechanisms are still not fully known. That is why, the goal of the research was to analyse the intermolecular interactions between 2AP and water molecules.

At first, aqueous solutions of 2AP with different concentrations underwent the UV-Vis spectroscopic analysis which has shown significant changes in the electronic structure of the molecule. With the increase of the concentration of the solute, both hypso- and bathochromic shifts were observed in the spectra simultaneously. To further analyse these phenomena, DFT calculations were performed on systems with different 2AP-to-water ratios, including various 2AP tautomers.

It was found that the hypsochromic effect can be explained by the phenomenon of tautomerism, while the bathochromic shift probably corresponds to both tautomerism and/or 2AP-water formation of complexes.

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References

[1]. V. Sharma, N. Chitranshi, A. K. Agarwal. *Int J Med Chem.*, **2014**.
[2]. E. Vitaku, D. T. Smith, J. T. Njardarson. *J Med Chem*., **2014**, 57, 10257–10274.
[3]. A. Ovung, J. Bhattacharyya. *Biophys Rev.*, **2021**, 13, 259.

Thermally-Induced Conformational Equilibration for Enhanced Efficiency and Color Purity in Organic Light-Emitting Diodes

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Organic light-emitting diodes (OLEDs) have traditionally depended on amorphous emitting layers, which limits the use of crystalline emitters [1]. In this research, we show how controlled thermal treatments on phenoxazine-substituted acridones can lead to considerable improvements in photo- and electroluminescence efficiency. Three acridone derivatives exhibit narrow photoluminescence spectra (FWHM<60 nm) with high photoluminescence quantum yields (PLQY approaching 100%). These spectra may be reversibly modified with suitable thermal treatment, yielding changes of up to 92 nm when the materials transition from amorphous to crystalline states. When compared to conventional systems, the acridone derivatives display strong thermally activated delayed fluorescence (TADF) with a much greater reverse intersystem crossing rate. These enhancements are due to annealing-induced conformational equilibration, which is aided by crystallization or hosting. When these treated emissive layers are included into OLED devices, they achieve record-breaking external quantum efficiencies (EQE) of up to 20.7% for OLEDs with crystalline emitting layers. Our findings show that by accurately manipulating the conformation and static dielectric disorder of phenoxazine-substituted acridones in the condensed state, we may achieve tremendous improvements in efficiency and color purity, opening up new avenues for efficient OLED design.

References

[1]. C.-Y. Chan et al. Nat. Com., **2018** 9 p. 5036

Photophysical Investigations of Dibenzothiophene and Diphenylamine Derivatives as Emitters for Electroluminescence Devices and Optical Oxygen Sensors

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Organic luminophores with a donor and acceptor structure have garnered significant attention for their potential application in organic light-emitting diodes (OLEDs), sensors, photonic devices, etc. [1]. Such interest is partly explained by the useful photophysical properties of donor-acceptor-type organic compounds such as room-temperature phosphorescence (RTP), thermally activated delayed fluorescence (TADF), or long persistent luminescence (LPL) [2]. Improved efficiency of TADF, RTP and LPL can be achieved for organic luminophores via molecular and/or film-forming engineering if it leads to improved efficiency of intersystem crossing and suppressed non-radiative relaxation processes [3]. For example, Adachi *et al*. observed efficient LPL for guest-host organic systems [4, 5]. Considering such examples, the invention of new compounds as well as film-forming approaches may lead to further improvement in the efficiency of organic luminophores.

In this work, we investigated photophysical properties of four derivatives of triphenylamine and dibenzothiophene dispersed in different liquid and solid media. Depending on the molecular structure and media used, the tested compounds exhibited either TADF, RTP or LPL. The derivatives were utilized as green emitters in OLEDs showing maximum external quantum efficiency of 13.9% in the best case. One compound with the most efficient RTP and LPL was selected as the active layer of optical oxygen sensors with a linear sensitivity in the range of oxygen concentrations of up to 10000 ppm. The Stern–Volmer constant of the best sensor was 4.55×10^{-4} ppm.

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References

[1]. J. Sun, J. Jia, B. Zhao, J. Yang, M. Singh, Z. An, H. Wang, B. Xu, W. Huang. Chi. Chem. Lett., **2021**, 32, 1367-1371.
[2]. X. Wang, M. Dong, Z. Li, Z. Wang, F. Liang., Dyes Pigm., **2022**, 204, 110400.
[3]. T. Wang, M. Liu, J. Mao, Y. Liang, L. Wang, D. Liu, T. Wang, W. Hu., Chin. Chem. Lett., **2023**, 108385.
[4]. R. Kabe, C. Adachi. Nature, **2017**, 550, 384-387.
[5]. P. Alam, T. S. Cheung, N. L. C. Leung, J. Zhang, J. Guo, L. Du, R. T. K. Kwaok, J. W. Y. Lam, Z. Zeng, D. L. Pholips, H. H. Y. Sung, I. D. Williams, B. Z. Tang., **2022**, 144, 3050-3062.

UV-Mediated Photochemical Synthesis and Antiviral Characteristics of AgNP-PVB Nanocomposite Coatings

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Silver nanoparticles (AgNPs) have emerged as a promising approach to combat highly resistant bacterial and viral strains [1]. However, it is crucial to carefully assess the acceptable toxicity levels of NPs with two or more dimensions ≤ 100 nm. In recent years, there has been a growing interest in the use of AgNPs as potential antibacterial agents [2], leading to an increased use of Ag-based biocides. The synthesis of AgNPs can be achieved through various techniques, including physical, chemical, and biological methods.

In this study, a UV-mediated photochemical synthesis approach was employed to prepare coatings on quartz glass substrates using the modified doctor blade coating technique. The structural characteristics of the coatings were analysed through multiple methods, including atomic force microscopy (AFM), ultraviolet-visible spectroscopy (UV-Vis), X-ray diffractometry (XRD), and water contact angle (WCA) measurements. To evaluate the antiviral properties, synthetic SARS-CoV-2 virus was use in real-time one-step reverse transcription PCR assays.

This study investigated the impact of ultraviolet (UV) irradiation on the structural and antiviral properties of AgNPs. Extended UV exposure reduced the size of AgNPs from 120 nm to 20 nm, with slight changes in elasticity and significant variability in the adhesion force. AgNP size and adhesion force were controlled by UV exposure duration. UV-Vis spectroscopy and AFM measurements correlated specific wavelengths with AgNP size ranges. The contact angle of the PVB coating decreased as the duration of UV exposure increased and the AgNP size decreased. Antiviral properties were evaluated using one-step qRT-PCR, where the coating exposed to 30 minutes of UV light and an average height of 8.16 nm exhibited the highest effectiveness. Different AgNP concentrations (150 ppm, 200 ppm, 500 ppm, and 1000 ppm) were tested. The highest concentration (1000 ppm) completely eliminated viral material, while lower concentrations also significantly reduced viral presence. The control wells had higher Ct values, indicating reduced viral material.

References

[1]. K. Khoshnevisan, et al., Nanoscale Res. Lett., **2021**, *16*(1).
[2]. M. Hemmati, et al., Nanomed Res J., **2016**, *1*(1), 23-29.

From Math to Physics: Electrospinning Parameters Optimization (Nanofibers Diameter Control Approach using MATLAB Multivariate Optimization)

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Nanofibers are one-dimensional (1D) polymeric nanostructures with a high aspect ratio and surface area [1]. Compared to other fibrous structures, nanofibers have a diameter of less than 1 μm, and their porosity can be tuned, making nanofibers promising in many applications such as filtration, sensing, medicine, textiles, and energy storage.

Optimization of electrospinning has been an active area of research in recent years [2]. Researchers have used various optimization techniques, such as genetic algorithms and artificial neural networks, to optimize the electrospinning process parameters [3]. These techniques have successfully found the optimal combination of electrospinning parameters, which results in the production of high-quality nanofibers with desired properties.

This study aims to optimize the electrospinning governing equations (experimental/empirical or theoretical equations). Hence, a multivariate approach using MATLAB was used to optimize the diameter of the nanofiber; the diameter function was minimized to find the optimum electrospinning parameters that would produce the finest possible nanofibers.

References

[1]. M. M. Leena, K. S. Yoha, J. A. Moses, and C. Anandharamakrishnan, Innov. Food Proc. Tech., **2021**, 634–650.
[2]. Pan, S., Yu, H., Zhang, Y., & Fan, L. *J. of App. Pol. Sci.* **2020**, 137, 49026.
[3]. Zhang, Y., Venugopal, J., Huang, Z. M., Lim, C. T., Ramakrishna, S., & El-Amin III, S. F. *Biomacromolecules*, **2006**, 7, 986-991.

Effects of TiO_2 NPs on nutritional quality and photosynthesis of two crop plants, pea and bean

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Nowadays, synthetic nanoparticles (NPs) are finding applications in almost all material aspects of human life and are particularly vital for contemporary technology and medicine. Their widespread use raises fundamental questions related to the environment, pollution, and safety. The increasing flux of diverse nanomaterials approaching soil and plant environments should not be left without comprehensive studies on their migrations, uptake, and toxicities [1].

In this work, the influence of titanium oxide nanoparticles (TiO_2 NPs) applied on green pea (*Pisum sativum* L.) was studied and thoroughly compared to that induced on bean (*Phaseolus vulgaris*). Special emphasis was directed towards metal homeostasis and photosynthesis. The methodology was based on hydroponic pot experiments as developed recently by Skiba et al. [2]

Figure 1. Appearance of bean (*Phaseolus vulgaris*) and green pea (*Pisum sativum* L.) cultivated in hydroponic culture.

TiO_2 NPs tended to increase the relative chlorophyll content in leaves compared with the respective control. However, in the case of bean, TiO_2 NPs treatment boosted the photosynthesis rate by promotion of Rubisco activity. Enhancement of pea photosynthesis was less evident. Overall, the results suggest that TiO_2 NPs showed similar but not identical effects on bean and pea plant's metabolism. TiO_2 NPs affect the nutritional quality of crop plants in a species-dependent manner.

References

[1]. E. Skiba, M. Pietrak, S. Glińska, W.M. Wolf. *Cells* **2021**, 10, 3105.
[2]. E. Skiba, M. Pietrak, M. Gapińska, W.M. Wolf. *Int. J. Mol. Sci.* ***2020****, 21, 8497.*

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Dynamics of Pickering-stabilized antibubbles

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There is currently no way to specifically target and destroy only malignant cells inside the body. This leaves those undergoing treatment for diseases such as cancer to suffer the effects of toxic therapeutic chemicals destroying healthy cells, along with the bad ones. The use of ultrasound to safely manipulate targeted drug delivery agents containing such drugs has the potential to greatly reduce the tissue damage caused by current systematic drug delivery methods in use [1]. Ultrasound drug delivery agents that are capable of safely and reliably transporting, and then releasing a therapeutic dose of a drug at a target site have not yet been identified. Antibubbles have been suggested as a potentially viable agent, although their acoustic properties are not yet fully understood [2].

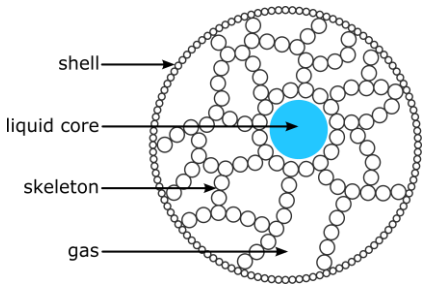

Figure 1. Schematic representation of an endoskeletal antibubble.

Antibubbles are microscopic gas bubbles comprising one or multiple liquid or solid cores, typically surrounded by stabilising shells. Hydrophobised silica nanoparticles can be used to create this stabilized shell in a process called Pickering-stabilisation. This research aims to determine the dynamic response of Pickering-stabilised antibubbles to pulsed ultrasound and identify and quantify the contribution of the shell and core to that behaviour.

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References

[1] S. Kotopoulis, K. Johansen, O. H. Gilja, A. T. Poortinga, and M. Postema, “Acoustically active antibubbles,” Acta Physica Polonica A, 127 (2), 99-102, 2015.

[2] M. Postema, A. Novell, C. Sennoga, A. T. Poortinga, and A. Bouakaz, “Harmonic response from microscopic antibubbles,” Applied Acoustics, 137(1), 148–150, 2018.

Synthesis of various nano-sized Ru/TiO_2 catalysts and their study in the hydroxymethylfurfural hydrodeoxygenation

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Hydroxymethylfurfural (HMF) is a platform chemical derived from biomass and can be used to produce various value-added chemicals. In this work, nano-sized ruthenium (Ru) particles supported on TiO_2 were used for the selective synthesis of industry-important chemicals such as bis(hydroxymethyl)tetrahydrofuran (BHMTHF), hydroxyhexane-2,5-dione (HHDione) from the hydrogenation of HMF. The different-sized Ru nanoparticles were synthesized by thermal treatment in H_2 of the catalyst, at a temperature range of 200ºC - 600ºC, which strongly impacted the catalytic activity. It was shown that in optimized reaction conditions 100% BHMTHF yield can be achieved. Moreover, when the reaction was carried out in an aqueous system then the selectivity shifted towards HHDione, and in 2.5-hour 81% of the HHDione was obtained. Further prolonging the reaction to 24 hours resulted in an optimum yield (51%) of 1,2,5-Hexanetriol in a one-pot reaction. The catalyst reduced at 400ºC having the smallest well-dispersed nanoparticles of Ru (average size of 1.62 nm) over the catalyst's surface demonstrated the highest catalytic activity. It was also found that the catalyst's lower acidity, residual chloride ions on the surface, and reaction solvent can significantly affect the activity and selectivity of the catalyst.

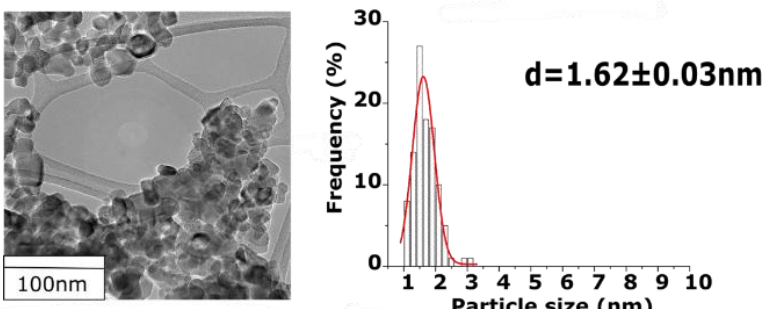

Figure: TEM image and Ru nano-particle distribution of catalyst reduced at 400ºC.

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Characterization of Boron Oxide – Aluminum Oxide System of Ceramic Nanofibers

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Boron alumina with various compositions is part of a B_2O_3-Al_2O_3 system of ceramic materials, where the primary phase ($Al_{18}B_4O_{33}$) is most stable and useful for many structural, insulating, and filtering applications. In nanofiber form, the material exhibits exceptional mechanical and thermal properties and can be stronger than pure alumina nanofibers. This study explores the structure and morphology characteristics of boron alumina nanofibrous ceramic fabricated using alternating field electrospinning (AFES) followed by thermal processing of as-spun precursor fibers. Boron alumina of usable quality have been successfully produced by AFES at promising and scalable production rates. It has been determined that the AFES production rates of 4.2 g/h in terms of the resulting ceramic can be obtained using a single electrode. The nanofiber crystallization starts at about 800 ^oC with the formation of $Al_4B_2O_9$ phase, and a partial loss of boron is observed above 1000 ^oC with the formation of $Al_{18}B_4O_{33}$ phase. Future studies will be focused on further optimization of the electrospinning process and on investigating the mechanical properties of 3D structures composed of this ceramic material to evaluate the applicability potential in membranes and catalyst support.

Acknowledgement

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References

[1]. Park, J.-S. Electrospinning and Its Applications. *Advances in Natural Sciences: Nanoscience and Nanotechnology* **2010**, *1* (4), 043002.
[2]. Stanishevsky, A.; Brayer, W. A.; Pokorny, P.; Kalous, T.; Lukáš, D. *Ceramics International* **2016**, *42* (15), 17154–17161.
[3]. Stanishevsky, A., Wetuski, J., Walock, M., Stanishevskaya, I., Yockell-Lelièvre, H., Košťáková, E., & Lukáš, D. (2015). *RSC Advances*, *5*(85), 69534-69542.
[4]. Yager, R., Nealy, S., Day, R., Severino, C., Stanishevsky, A. (2022). *Cer. Int. (in press)*.

Testing of Fish Gelatin as a Base for Nanofibrous Capillary Grafts

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Vascular system disease is the number one cause of death globally. Despite the numerous treatment methods, there is a considerable lack of accessibility to healing from vascular diseases in small-diameter blood vessels. A possible solution is to replace small blood vessels with artificially fabricated grafts using biopolymers. Nanofibrous biopolymer structures are being broadly explored due to their ability to mimic the structure and function of natural blood vessels. Direct current (DC) electrospinning has mostly been used to prepare such nanofibrous structures. In this project, the capabilities of a novel, high-productivity alternating current (AC) electrospinning process in fabrication of small (3 - 6 mm) diameter vascular grafts have been assessed for the first time. AC electrospinning generates a dense flow of nanofibers, which do not carry residual electric charge and can be easily collected and manipulated into a desired shape, thus eliminating the major drawbacks of DC-electrospinning. Using fish gelatin as a model biopolymer, vascular grafts with up to 30 cm length and 0.1 - 0.5 mm wall thickness were fabricated within time intervals of a few minutes. The samples were characterized using infrared spectroscopy (FTIR), cell seeding, and mechanical testing in radial and axial directions in both dry and wet conditions. Both fibroblasts and adipose stem cells (ADSC) were embedded into the inner surface of the samples for individual periods of time. The viability of the cells was analyzed using a Live/Dead assay and fluorescence microscopy. The samples were also imaged using a scanning electron microscope (SEM). The preliminary results indicate the efficacy of AC electrospinning in fabrication of small diameter engineered vascular grafts on demand.

Acknowledgement

Sarah Wolnski has been supported through the NSF International Research Experience for Students award to UAB (OISE-1852207).

References

[1]. Lukin, I.; Erezuma, I.; Maeso, L.; Zarate, J.; Desimone, M.F.; Al-Tel, T.H.; Dolatshahi-Pirouz, A.; Orive, G. Progress in Gelatin as Biomaterial for Tissue Engineering. Pharmaceutics 2022, 14, 1177.

[2]. Mallis, P.; Kostakis, A.; Stavropoulos-Giokas, C.; Michalopoulos, E. Future Perspectives in Small-Diameter Vascular Graft Engineering. Bioengineering (2020).

Characterization of Copper Nanoparticles Synthesized via Metal Target Laser Ablation in Liquid

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Nanoparticles (NPs) with significant antimicrobial and antiviral properties are extensively studied in the last two decades [1, 2]. Copper (Cu) NPs were found to have antiviral properties against a range of viruses [3]. The NPs can increase the drug solubility in water and the drug uptake by the infected cell, increasing the biomedical application in drug delivery systems [4].

In this work, Cu NPs were synthesized by femtosecond laser ablation of the pure Cu target in water. The resulting pale green color of the colloid indicated the formation of the Cu NPs which was also confirmed by the Raman and XRD measurements. It was obtained that NPs consist of metallic Cu in a mixture with Cu_2O. The Cu NPs were spray coated on the Polyvinyl butyral coated glass substrates aiming to develop antiviral surfaces. The antiviral efficacy was tested against model Infectious Bronchitis and Bovine herpesvirus viruses of animal origin. Figure 1 shows the peak positions of the Cu and Cu_2O in the XRD diffractogram.

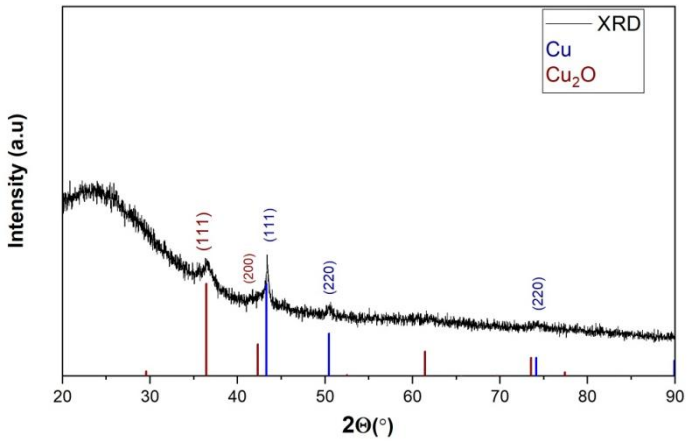

Fig. 1. XRD Characterization of Cu NP.

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References:

[1] Rajesh, K.M., et al. Optik, 2018. 154: p. 593-600.
[2] Salavati-Niasari, et al. Polyhedron, 2008. 27(17): p. 3514-3518.
[3] Tavakoli, A., et al. Journal of virological methods, 2020. 275: p. 113688.
[4] Tortella, G., et al. Critical Reviews in Biotechnology, 2022. 42(3): p. 431-44

Synthesis and characterization of EGFR-targeted magnetic nanomaterials as an effective tool for lung cancer treatment

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Nanotechnology has been shown to be beneficial for different specialties that include drug delivery, purification of water, data management, and the creation of nanoscale materials for healthcare and other industrial applications. Nanotechnology involves the creation and control of material properties at the nanometer scale either by scaling up from a single collection of nanoparticles(NPs) or by refining/diminishing bulk materials into a desired nanoscale. Nanometric materials due to their small size, large surface area, and the capability of changing their surface properties via modification, have significant potential to exhibit unprecedented capacities for drug delivery. Among all nanosized materials, magnetic nanoparticles (MNPs), especially superparamagnetic iron oxide nanoparticles (SPIONs), are at the top of the biomedical research trends [1, 2].

The aim of this project is to synthesize and characterization of novel, intelligent hybrid nanomaterials (MNP-CPP-TM-drug), which are a combination of magnetic nanoparticles (MNP) and active anti-cancer multifunctional compounds (conjugates) (Fig. 1). The finished structure should display anti-cancer efficacy and have fewer side effects thanks to improved transport to cancer cells and greater selectivity and specificity of interaction with cancer cells.

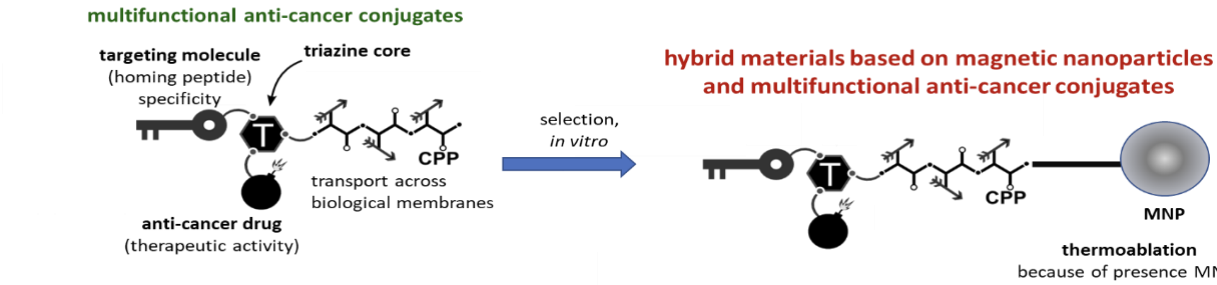

Fig. 1. The hybrid nanomaterial is composed of multifunctional compounds attached to a magnetic core.

We aimed to coat our magnetic nanoparticles with proteins or polysaccharides via cross-linker, therefore the coating must be biodegradable and enable the attachment of the linker, to which the anticancer drug conjugate and targeting peptides are later attached. Additionally, the coating should eliminate the release of iron ions from the MNP and reduce the cytotoxic effect. Targeting molecules are EGF fragments capable of interacting with the EGF receptor (EGFR). Docetaxel was used as an anticancer drug in this research. The presence of the magnetic nanoparticle in the target material should also allow for their use in thermal ablation, which is targeted thermos-ablation due to the presence of the targeting peptide guaranteeing interaction with overexpressed receptors in cancer cells.

Acknowledgement
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References

[1]. L. Zhou et al. J. Mater. Chem., **2011**,21, 9, 2823-40.
[2] M. Ziegler-Borowska et al., Catalysts. **2017**, 7, 1, 26.

Silver coated knitted fabric for contactless deformation sensor

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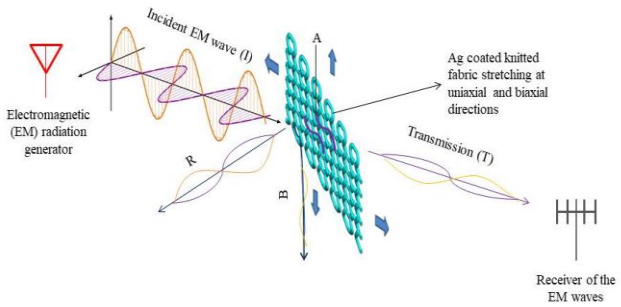
The work deals with the development of electrically conductive knitted fabrics and their deformation characteristics. The effect of deformation on changes in electrical characteristics is measured by the high-frequency electromagnetic radiation (EM) shielding method. EM radiation of these frequencies penetrates electrically non-conductive materials and is reflected or absorbed by electrically conductive materials. This makes it possible to monitor the change in electrical resistance of textiles, which characterizes the deformation of the sample in tension [1]. The silver coated yarns were procured and used it to develop the plain "single jersey" fabric using flat knitting machine. Three different densities were produced for plain jersey: low, medium and high. The effectiveness of the electromagnetic shielding (SE) of knitted fabrics was tested using a frequency range of 30 MHz to 1.5 GHz according to the ASTM D4935-18 standard. It was found that the higher the sample density, the higher the SE. A special device with four independent jaws was used for tensile deformation of knitted samples in one direction (transverse and longitudinal) and in two directions (biaxial). The knitted fabrics were stretched up to 25% strain and electromagnetic shielding, and electrical resistances were measured. "Single Jersey" shielding efficiency has an increasing trend in all stretching directions. It was found that the electrical resistance and shielding effectiveness are indirectly proportional to each other [2].



Total shielding effectiveness (SE) [dB] = Reflection (R) + Absorption (A) + Multiple reflection (B)

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References

[1] S. Palanisamy, V. Tunakova, M. Tunak, and J. Militky, “Textile-based weft knit strain sensor: Experimental investigation of the effect of stretching on electrical conductivity and electromagnetic shielding,” *J. Ind. Text.*, 52, 1–23, 2022.

[2] H. W. Ott, *Electromagnetic Compatibility Engineering*. Hoboken, NJ, USA: John Wiley & Sons, Inc., 2009.

Preparation of hybrid materials based on carbon non-woven fabric and polysaccharide-peptide conjugates, with potential in bone and/or cartilage tissue regeneration

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Composites based on fibrous structures are increasingly popular in medical applications, due to the possibilities offered by these materials, i.e. directional surface modification and obtaining structures with anisotropic properties. Moreover, the use of natural polymers is associated with a reduced risk of side effects on the body. Natural polymers used on an industrial scale, such as chitosan and alginate, are characterized by low toxicity, lack of immunogenicity and antibacterial and antifungal properties. Thanks to the cooperation between the Institute of Organic Chemistry at TUL and Łukasiewicz Institute of Technology in Lodz, attempts have been made to obtain fibrous structures modified with polysaccharide-peptide conjugates. The aim of the research is to obtain a stable structure mimicking the physiological conditions of cell adhesion and proliferation, necessary in the process of bone and/or cartilage tissue regeneration. The use of carbon nonwoven provides a number of useful properties, both mechanical and electrical, including excellent electrical conductivity or a very good ratio of mechanical strength to product weight. Moreover, from the medical point of view - it is a biomaterial with osteoconductive and osteoproductive properties [1]. Providing conditions suitable for tissue regeneration is also ensured by the use of polysaccharide-peptide conjugates. The specific application of such systems requires the stable structure to be ensured. For this purpose, the process of chemical crosslinking of natural polymers on the material surface is used. This process can be carried out in two ways: by introduction of crosslinking agent directly into the solution, from which the coating is made, or by immersion of the material with polymeric layer into the solution with this agent [2]. Compounds used as crosslinking agents may or may not be part of the crosslinking bond. The first group includes, but is not limited to, citric acid, the second group includes acyl azides and carbodiimides (most commonly used is 1-ethyl-3(3-dimethylaminopropyl)carbodiimide (EDC)). The hybrid materials obtained in this way follow the trend of designing biomimetic materials that are capable of tissue formation mediated by biomolecular recoginition.

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References

[1] Frączyk J. et al., *Materials* **2021**, 14(12), 3198
[2] Tropini V. et al., *Industrial Crops and Products* **2004**, 20, 281–289

Water dispersable, non-cross-linked polymeric nanocapsules synthesized from amphiphilic diblock copolymer brushes

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In this work, we report the synthesis of non-cross-linked, hollow polymeric nanocapsules, dispersible in aqueous media, using silica spheres as the template. For this, well-defined amphiphilic diblock copolymer brushes, comprising a hydrophobic poly(methyl methacrylate) (PMMA) inner block and a hydrophilic poly(2-(dimethylamino) ethyl methacrylate) (PDMAEMA) outer layer, were grafted from the surface of the silica spheres via surface-initiated atom transfer radical polymerization (SI-ATRP) [1,2]. The hybrid particles were exploited towards the synthesis of robust, water-dispersible hollow polymeric nanocapsules, through etching of the inorganic core. The hydrophobic PMMA block is crucial for the structural stability of the obtained hollow polymer capsules in the absence of chemical cross-links, while the hydrophilic PDMAEMA block provides their dispersability in aqueous media. Two main parameters were investigated in terms of influence on morphology of the obtained structures: diblock copolymers composition and the grafting density of the polymer chains. The present work constitutes a proof-of-principle study of a generic approach that can be applied for the preparation of non-cross-linked polymer nanocapsules of low polydispersity and controlled morphological features in any solvent medium, upon the appropriate selection of the solvent-incompatible inner block and the solvent-compatible outer block.

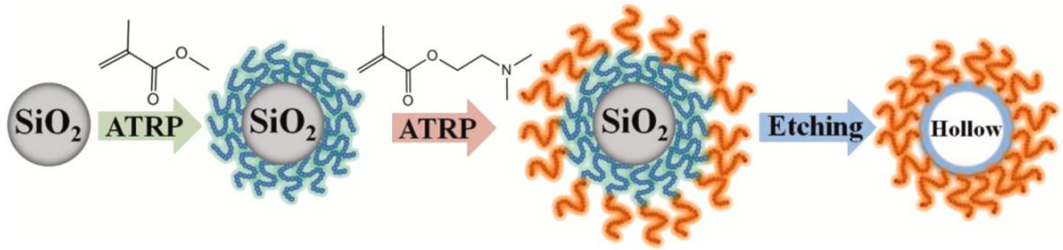

Figure 1. Schematic representation of the synthetic procedure followed for the preparation of the hollow polymer nanocapsules.

Acknowledgement

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References

[1]. S. Yamamoto, J. Pietrasik, K. Matyjaszewski, Macromolecules, **2008**, 41, 19, 7013.
[2]. V. Goel, J. Pietrasik, R. Poling-Skutvik, A. Jackson, K. Matyjaszewski, R. Krishnamoorti, Polymer, **2018**, 159, 138.

The implication of PMMA molecular weight within SAN/PMMA blends containing GO-*g*-PMMA hybrids on the blends' rheological behavior.

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Polymer blends have gained significant attention because they are an inexpensive and simple way to produce new materials with novel properties. For example, combining two different polymers is an effective way to improve a polymer's mechanical properties, miscibility, and thermal stability while maintaining the original properties of the parent homopolymers. The performance of polymer blends is strongly influenced by the blend's composition, processing condition, and the presence of additives that play a key role as blend compatibilizers, fillers, or stabilizers [1]. Most polymer blends undergo phase separation. In order to delay or eliminate this phenomenon, it is necessary to use compatibilizers, which can be, nanoparticles, i.e. silica, carbon nanotubes, or graphene oxide. They can improve the mechanical properties of the polymer blends, delay phase separation, and influence the morphology of the blend [2]. An important problem that is a limitation of the use of nanoparticles is their tendency to agglomeration. An interesting idea for preventing agglomeration and at the same time improving the desired properties and morphology of the final blend is the modification of the surface of nanoparticles with polymer chains.

Graphene oxide (GO) is a material that gained a lot of attention because it possesses high mechanical strength, good barrier properties, and in its reduced form it exhibits conductive properties. It has numerous hydroxyl groups on its surface which allows for anchoring the ATRP initiator on its surface [3]. Modified graphene oxide could be localized at the interface, lowering the surface tension between the blend components, or located in the polymer phase due to the preferential wettability between the compatibilizer and the polymer. The authors will discuss the effect of hybrid particles containing GO and poly(methyl methacrylate) (PMMA) on the miscibility and rheological properties of poly(styrene-*co*-acrylonitrile)/poly(methyl methacrylate) (SAN/PMMA) blends.

References

[1] T. Ribeiro, C. Baleizão, J.P.S. Farinha, Functional films from silica/polymer nanoparticles, Materials (Basel). 7 (2014) 3881–3900. doi.org/10.3390/ma7053881.
[2] V. V. Ginzburg, Influence of nanoparticles on miscibility of polymer blends. a simple theory, Macromolecules. 38 (2005) 2362–2367. https://doi.org/10.1021/ma0482821.
[3] G. Eda, M. Chhowalla, Chemically derived graphene oxide: Towards large-area thin-film electronics and optoelectronics, Adv. Mater. 22 (2010) 2392–2415. https://doi.org/10.1002/adma.200903689.

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Experimental and Theoretical Analysis Considering Noise, Vibration and Thermo-physiological Comfort of Car Seat.

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The car seats are made from multiple kinds of textile materials like Polyurethane foam, leather, 3D spacer fabric or densely woven fabric. These materials are selected based on comfort, safety, aesthetics, and functionality. Generally, the car seats must last for 10-15 years. For this reason, the durable long-life material like Polyurethane (Pu Foam) is the first choice. The performance of these materials needs an in-depth experimental and theoretical approach.

Objectives:

- Analyzing the materials
- Optimizing the materials
- Theoretical prediction

Testing:

- Required testing for thermo-physiological comfort.
- For noise insulation properties
- Vibration properties

Possible outcome: A seat cover with better comfort related to vibration absorption, heat & moisture permeability, and noise cancellation properties.

References

[1] Buyuk Mazari Funda, Mazari A, Havelka A, Wiener J. Effect of a Superabsorbent for the Improvement of Car Seat Thermal Comfort. Fibres & Textiles in Eastern Europe 2017; 25, 2(122): 81-85. DOI: 10.5604/12303666.1228187 (Impact Factor:0.7)

[2] P. Lepšík, V. Fliegel, A. Lufinka, *Effect of Dynamic Biaxial Loading of Car Seats*, Processes, MDPI, p. 2483, 10 pages, ISSN: 2227-9717, n. 11, [Online], 2022

[3] Tao Yang, Lizhu Hu, Xiaoman Xiong, Deyou Yu, Michal Petrů, Kai Yang, Jan Novák & Jiří Militký (2021): Sound Absorption Properties and Accuracy of Prediction Models on Natural Fibre Based Nonwoven Materials, Journal of Natural Fibres,

Thin-film nanofibrous composite membrane for saltwater filtration

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Because of their unique physical properties fabrication of nanofibrous material has become famous, for instance, highly porous and super thin fiber diameter. Besides physical ones, the Electrospinning of various polymers has gained advanced chemical properties in nanofibrous materials. Using of nanofibrous material in water treatment has gained more attraction in the last decade. Hence, the primary motivation of this work was to overcome the weak mechanical properties issue of the nanofibers layer and prepare them as a nanofiltration membrane for the separation of salt.

The main objective of this work is to prepare the thin-film composite (TFC) on a nanofibrous web and high-strength fabric for mechanical support. TFC membranes are primarily used in reverse osmosis (RO). To separate salty water, a thin-film nanofibrous composite membrane (TFNC) will be prepared onto a nanofiber web. The TFNC membranes will be prepared using water-soluble monomers piperazine (PIP) and Trimethyl Chloride (TMC) in organic solvents on a nanofiber web surface. The three different TMC monomer concentrations of 0.2%, 0.4%, and 0.6% were used to prepare TFNC. It was found that a 0.4% concentration of TMC has the best filtration efficiency for separating salt from water.

Acknowledgment

I want to thank Doc. Baturalp Yalcinkaya for his support throughout this work.

References

[1]. *B. Yalcinkaya et* al*. Desalination and Water Treatment., 2016, 1–13.*

[2]. A. L. Ahmad, B. S. Ooi, A.W. Mohammad, and J. P. Choudhury, Desalination, 2004, 168, 215‑221.

Optimization of Dielectric Barrier Discharge Plasma for Improved Gas Conversion with Nanostructured Catalysts

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In dielectric barrier discharge (DBD) plasma, an alternating current across a capacitive circuit is used to excite the gas molecules inside the reactor. A dielectric material (glass, plastic, etc.) is placed in between two electrodes to create the capacitance needed. This is a primary method of producing plasma at atmospheric conditions with a large volume [1]. DBD plasma at atmospheric pressure in air and other gases is used for disinfection of surfaces and stimulation for seed growth [2-3]. The focus of this research is to utilize DBD plasma along with electrospun nanofiber catalysts for gas conversion, in part at reduced pressures. The efficiency of DBD plasma improves at reduced pressures, but DBD plasma itself is not a selective process. It is hypothesized that the ultraporous nano-catalysts will optimize gas conversion in reduced pressure DBD plasma [4] and will allow better materials, e.g., biomaterials, treatment downstream.

To begin our experiment, we are optimizing our reactions for low pressure plasma with argon and methane gas. The instability and complexity of methane-based plasma requires careful attention and manipulation as compared to plasma from noble gases. The nanostructured catalysts will help stabilize the methane DBD plasma along with enabling the gas conversion process, in part, for producing bioinert and bioactive carbon coatings.

Acknowledgement

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References

[1]. Turner, M. (2016). Physics of Cold Plasma. In Elsevier eBooks (pp. 17–51).
[2]. Pavlovich, M. J., Chen, Z., Sakiyama, Y., Clark, D., & Graves, D. B. (2012). Effect of Discharge Parameters and Surface Characteristics on Ambient-Gas Plasma Disinfection. Plasma Processes and Polymers, 10(1), 69–76.
[3]. Meng, Y., Qu, G., Wang, T., Sun, Q., Liang, D., & Hu, S. (2017). Enhancement of Germination and Seedling Growth of Wheat Seed Using Dielectric Barrier Discharge Plasma with Various Gas Sources. Plasma Chemistry and Plasma Processing, 37(4), 1105–1119.
[4]. Gallon, H. J., Tu, X., Twigg, M. V., & Whitehead, J. C. (2011). Plasma-assisted methane reduction of a NiO catalyst—Low temperature activation of methane and formation of carbon nanofibres. Applied Catalysis B-environmental, 106(3–4), 616–620.