A. Podklady pro habilitační a jmenovací řízení (kvalitativní hodnocení)

Uchazeč: **M.Sc. Rafael Omar Torres Mendieta, Ph.D.**

Podpis:

Hodnocené období: 2018-2023

A1. Vědecko výzkumná činnost

Základní výzkum (hodnocený především na základě publikací nových poznatků)
1) výsledek **R. Torres-Mendieta**, O. Havelka, M. Urbánek, M. Cvek, S. Wacławek, V. V. T. Padil, D. Jasikova, M. Kotek, M. Černík, Laser-assisted synthesis of Fe-Cu oxide nanocrystals. Applied Surface Science, 2019, vol. 469, pp. 1007-1015, DOI: 10.1016/j.apsusc.2018.11.058

Charakterizace

In the current paper, the production of homogeneously mixed nanocrystals based on Fe and Cu was successfully accomplished for the first time despite these two transition metals exhibiting extremely low miscibility in their phase diagram. The synthesis was carried out by the laser-mediated reduction of metal salts that were dissolved in different kinds of solvents, water, acetone, and ethylene glycol. The greatest value and novelty of the methodology is that it allows the generation of mixed nanocrystals formed by transition metals with low miscibility in the presence of different solvents, taking metal salts as precursor agents, which are conventionally used in traditional wet synthesis techniques, but in contrast with the most popular approaches, the process requires neither special conditions nor hazardous reducing agents. Therefore, the presented methodology represents a clean and promising alternative for the synthesis of mixed nanocrystals composed of materials with low miscibility. With this manuscript, I formally opened the research line of laser-mediated synthesis of nanomaterials at the Technical University of Liberec. My contribution to the current manuscript is bringing the original idea, performance of most of the experiments, analysis and interpretation of most data, writing the whole first draft, and finishing the manuscript in collaboration with all coauthors. However, for transparency, my individual contribution is also presented according to the relevant CRediT roles (https://www.elsevier.com/authors/policies-and-guidelines/credit-author-statement), which all coauthors agree on before the final publication:

R. Torres-Mendieta contribution:

- Conceptualization
- Methodology
- Validation
- Formal analysis
- Investigation
- Data Curation
- Writing - Original Draft
- Writing - Review & Editing
- Visualization
- Supervision
- Project administration

Number of citations according to WoS: 8

2) výsledek

R. Torres-Mendieta, F. Yalcinkaya, E. Boyraz, O. Havelka, S. Wacławek, J. Maryška, M. Cernik, M. Bryjak, PVDF nanofibrous membranes modified via laser-synthesized Ag nanoparticles for a cleaner oily water separation. Applied Surface Science, 2020, vol. 526, pp. 146575, DOI: 10.1016/j.apsusc.2020.146575

Charakterizace

The relatively new exploitation of nanoassemblies used to recover clean water from oily emulsions has recently received much attention. Among the different innovations, nanofibrous membranes decorated with NPs seem to be the most promising option due to their versatility, recyclability, and high oil/water separation performance. In the current study, we introduce a laser-mediated strategy to produce polyvinylidene fluoride nanofibrous membranes decorated with a low loading of Ag NPs. An alkaline treatment first modified the pristine membranes to obtain hydroxyl groups on their surface, facilitating nanoparticle decoration. Then, the synthesis and decoration of the NPs were achieved by the laser-mediated reduction of silver nitrate dissolved in water, while no hazardous reducing or stabilizing agents were employed in the process. Compared with the unmodified membrane, the modified one displayed exemplary hydrophilic behavior and a remarkable 3.9-fold improvement in water separation from oily emulsions with a nearly negligible permeability decline over time. In sum, the introduced methodology enables the improvement of the oil/water separation performance in polymer-based membranes and promises to reduce the environmental impact related to the design of nanotechnology-based solutions used in the sector. The most significant novelty of the current study lies in the possibility of achieving a remarkable oil-water separation improvement in polymeric membranes while using extremely low NPs loadings. Unlike the typical procedures for producing such nanocomposites, the laser-based methodology employed permits the creation of NPs with a ligand-free surface, making them more reactive when in contact with water, resulting in a more pronounced super hydrophilic performance and thus, oil/water separation. This manuscript constitutes my first work about laser-synthesized NPs toward technology transfer, and my contribution is bringing, together with doc. Fatma Yalcinkaya, Ph.D., M.Sc., the original idea, involvement in the performance of the experiments, analysis and interpretation of data, writing together with doc. Fatma Yalcinkaya, Ph.D., M.Sc., the first draft, and finishing the manuscript in collaboration with all coauthors. In terms of the relevant CRediT roles that all coauthors agreed on before the final publication, my contribution is the following:

R. Torres-Mendieta contribution:

- Conceptualization
- Methodology
- Validation
- Formal analysis
- Investigation
- Resources
- Writing - Original Draft
- Writing - Review & Editing
- Visualization
- Supervision
- Project administration

Number of citations according to WoS: 8

3) výsledek

R. O. Torres-Mendieta, M. M. Teixeira, G. Mínguez-Vega, D. de Souza, Y. G. Gobato, M. Assis, H. Beltran-Mir, E. Cordoncillo, J. Andres, M. Cernik, E. Longo, Toward Expanding the Optical Response of Ag_2CrO_4 and Bi_2O_3 by Their Laser-Mediated Heterojunction. The Journal of Physical Chemistry C, 2020, vol. 124, Issue 48, pp. 26404-26414, DOI: 10.1021/acs.jpcc.0c08301

Charakterizace

The current work deals with the combination of two rapidly growing technology areas, the formation of heterojunctions and the laser-mediated synthesis of nanomaterials. In particular, this technology merge is employed to expand the optical capabilities of Ag_2CrO_4 and Bi_2O_3, two ubiquitous yet extensively used photosensitive semiconductors in light-powered environmental remediation and energy-related applications. Unlike conventional pathways, ultrashort pulsed laser radiation's employment has allowed us to reach a profound degree of structural modification resulting in tight junctions between the irradiated semiconductors and induced metal nanoparticles' production on their surface. Such results allowed modulating the material's bandgap to the narrowest value found in the composing elements and suppressing photo-induced charge carriers' recombination, two critical aspects that can increase the semiconductors' usefulness in light-powered applications. The most critical novelty of this work is the discovery that the irradiation of the semiconductors by extreme light can modulate both semiconductors' bandgap, turning them into very appealing photocatalysts because the recombination of their photo-induced charge carriers is suppressed. This work brings together all data obtained and analyzed during my most recent postdoctoral internship at the Federal University of São Carlos in Brazil. My contribution to the manuscript is by being involved in the experiments, analysis and interpretation of all data, writing most of the first draft, and finishing the manuscript in collaboration with all coauthors. In terms of the relevant CRediT roles that all coauthors agreed on before the final publication, my contribution is the following:

R. Torres-Mendieta contribution:

- Conceptualization
- Methodology
- Validation
- Formal analysis
- Investigation
- Data Curation
- Writing - Original Draft
- Writing - Review & Editing
- Visualization
- Supervision
- Project administration

Number of citations according to WoS: 1

4) výsledek

O. Havelka, M. Cvek, M. Urbánek, D. Łukowiec, D. Jašíková, M. Kotek, M. Cernik, V. Amendola, **R. Torres-Mendieta**, On the Use of Laser Fragmentation for the Synthesis of Ligand-Free Ultra-Small Iron Nanoparticles in Various Liquid Environments. Nanomaterials, 2021, vol. 11, Issue 6, pp. 1538, DOI: 10.3390/nano11061538

Charakterizace

This work explores the implications of using laser fragmentation in liquids (LFL) to synthesize ligand-free ultra-small iron nanoparticles in solvents with different dipolar moments. As extensively discussed by the community working in the field, the selection of polar solvents while using LFL should enable the production and stabilization of these appealing nanomaterials while suppressing chemical waste production. Besides, unlike most traditional synthesis approaches, it also brings the promise of a ligand-free surface, a fundamental matter in application sectors requiring a large number of chemically active sites. In the current work, we proved this hypothesis by reducing the size of micrometric carbonyl iron to the regime of 1-3 nm. Besides, we also found that the solvent's selection can enable precise control over the synthesized nanomaterial's chemical structure (Fe, Fe_2O_3, and Fe_3O_4) and production rate. These findings culminated in the evidence that solvents with a large dipolar moment, like ethylene glycol or polyethylene glycol 400, are the most optimal liquid environments for producing highly stable colloids composed of ligand-free ultra-small iron nanoparticles. This manuscript's most critical outcome is identifying the required aspects of the solvents to permit the fabrication of stable colloids of ultra-small NPs. This manuscript constitutes my first published work being the leader of the research group; as such, my contribution was bringing the original idea, involvement as manager and supervisor in the performance of the experiments, analysis, and interpretation of data, writing together with my students the first draft, and finishing the manuscript in collaboration with all coauthors. In terms of the relevant CRediT roles that all coauthors agreed on before the final publication, my contribution is the following:

R. Torres-Mendieta contribution:

- Conceptualization
- Methodology
- Validation
- Formal analysis
- Writing - Original Draft
- Writing - Review & Editing
- Visualization
- Supervision
- Project administration
- Funding acquisition

Number of citations according to WoS: 2

5) výsledek

D. Ettel, O. Havelka, S. Isik, D. Silvestri, S. Wacławek, M. Urbánek, V. V. T. Padil, M. Cernik, F. Yalcinkaya, **R. Torres-Mendieta**, Laser-synthesized Ag/TiO nanoparticles to integrate catalytic pollutant degradation and antifouling enhancement in nanofibrous membranes for oil-water separation. Applied Surface Science, 2021, vol. 564, pp. 150471, DOI: 10.1016/j.apsusc.2021.150471

Charakterizace

In the current study, we explored the use of an eco-friendly laser-based methodology to fabricate Ag/TiO nanoparticles (NPs) with a highly controlled chemical composition, which served to decorate the surface of Polyvinylidenefluoride (PVDF) nanofibrous membranes. Since these NPs can enhance the membranes' oil-water separation performance and independently act as catalysts with the ability to purify water, we studied the samples' separation capacity and, in parallel, the NPs pollutant degradation ability. Our findings evidenced that membranes decoration by NPs with a medium size (6.6 +/- 2.2) nm, element composition 93.8 wt% Ti and 6.2 wt% Ag, where Ag located in the surface, lead to a membranes' loading of $1.31 \cdot 10^{11}$ particles/cm^2 or 0.13 mu g/cm^2. Such a superficial modification provided the membranes super-hydrophilicity resulting in improved oil-water separation performance through time and oil rejection percentage while the membrane's fouling was negligible. Besides, the unique composition of these NPs brought a highly competitive catalytic activity (κ_c factor) of 2.82 $L \cdot g^{-1} \cdot s^{-1}$, implying that their multifunctional nature could expand the cleansing capabilities of nanofibrous membranes by separating water from oily polluted sources and separately catalyze the degradation of water dissolved organic pollutants. Thus, providing a groundwork for future developments in the true cleansing of oily polluted water. The key discovery in this manuscript was finding how to precisely engineer NPs with the technique known as reactive laser ablation in liquids for a specific aim, such as cleaning oily polluted water. This manuscript constitutes my second published work being the leader of the research group; as such, my contribution was bringing the original idea, involvement as manager and supervisor in the performance of the experiments, analysis, and interpretation of data, writing together with my students the first draft, and finishing the manuscript in collaboration with all coauthors. In terms of the relevant CRediT roles that all coauthors agreed on before the final publication, my contribution is the following:

R. Torres-Mendieta contribution:

- Conceptualization
- Methodology
- Validation
- Investigation
- Resources
- Writing - Original Draft
- Writing - Review & Editing
- Visualization
- Supervision
- Project administration

Number of citations according to WoS: 10

Aplikovaný výzkum (hodnocený především na základě realizací nových technologií, konstrukcí, apod.)
1) výsledek (projekt, realizace) HYBRID MATERIALS FOR HIERARCHIC STRUCTURES, (01.01.2018 - 31.12.2022) CZ.02.1.01/0.0/0.0/16_019/0000843 https://www.isvavai.cz/cep?s=jednoduche-vyhledavani&ss=detail&n=0&h=EF16_019%2F0000843
Charakterizace (V-V přínos, uplatnění, patent, osobní podíl, ...) : The aim of the project is to support interdisciplinary problem-oriented material research which will dramatically improve the efficient use of Technical University of Liberec's R&D activities, leading to internationally compatible quality of research. The R&D research intent is divided into three mutually linked research programmes: Flexible hierarchical structures, Composite materials and structures, and Functionalized nanomaterials. The sub-objectives, the development of interdisciplinary teams, relation with international research partners and equipment will lead to new results and joint projects. (Project completed with outstanding results)
2) výsledek (projekt, realizace) Studium rolí ferátů a modifikovaného nanoželeza v aktivačním procesu persulfátů, (01.06.2019 - 30.06.2022) LTAUSA18078 https://www.isvavai.cz/cep?s=jednoduche-vyhledavani&ss=detail&n=0&h=LTAUSA18078

Charakterizace (V-V přínos, uplatnění, patent, osobní podíl, ...) :

Persulfates are one of the newest oxidants that are used in in-situ chemical oxidation. Although persulfates chemistry has been researched for some years, there are still many unknowns that should be investigated. The broader impacts of this joint project will include, but will not be limited to, creation (1) of new approaches for persulfates activation [with the iron in various oxidation states (modified nano zero-valent iron and ferrates)] and use of thus activated persulfates for remediation of toxic organic and inorganic substances e.g. organic contaminants that are on the list of persistent organic pollutants, (2) of a novel way for determination of persulfates that will be developed and protected during the project timebeing. The created method will be facile and fast and will allow for detection of persulfates in a double oxidant system (e.g. persulfates and ferrates) and will be required for evaluation of the persulfates reaction kinetics in the researched matrices. In the long term, this joint project will further a broader synergistic coupling between US and Czech researchers in the persulfates and nanomaterial domain by bringing new collaborators and facilitating new international links between the researchers and students in related areas at multiple institutions.

(Project completed with outstanding results)

3) výsledek (projekt, realizace)

Porézní biologické 2D membrány a 3D struktury vystavěné z polysacharidů funkcionalizovaných rostlinných gum a jejich environmentální aplikace, (01.01.2020 - 31.12.2022)

LTAUSA19091

https://www.isvavai.cz/cep?s=jednoduche-vyhledavani&ss=detail&n=0&h=LTAUSA19091

Charakterizace (V-V přínos, uplatnění, patent, osobní podíl, ...) :

The proposed project aims to develop ultra lightweight, high-strength, bio-based, biodegradable, porous, and tuneable two-dimensional (2D) membranes and three-dimensional (3D) sponges with facile synthetic schemes based on eco-friendly polysaccharide gums. The proposed 3D sponges and 2D porous membranes will be fabricated via self-assembly-freeze-drying, cryogelation and electrospinning from tree gum exudates (e.g. arabic, karaya, tragacanth, ghatti, and kondagogu) as well as their blends with other renewable natural/synthetic biodegradables polymers. The enhancement of functional properties (physicochemical, mechanical, thermal, hydrophobicity/hydrophilicity and surface area) will be investigated by applying the environmental friendly “green technologies” such as plasma treatment, laser ablation, γ-ray irradiation, UV initiation and microwave treatment. Furthermore, the hierarchical porous structure and functional groups of gum will be used for functionalization of porous membranes and sponges with various metal/metal oxide or core-shell nanoparticles, and other organic/polymeric molecules. The ensuing porous functionalised structures will form an integral part of applications for sustainable development under the umbrella of green chemistry and technology, specifically heterogeneous catalysis (greener catalytic degradation) and extraction of environmental contaminates of various types (heavy metals, pesticides, and organic dyes).

(Project completed with outstanding results)

4) výsledek (projekt, realizace)

Nanomateriály a nanotechnologie pro ochranu životního prostředí a udržitelnou budoucnost, (01.01.2020 - 31.12.2022)

LM2018124

https://www.isvavai.cz/cep?s=jednoduche-vyhledavani&ss=detail&n=0&h=LM2018124

Charakterizace (V-V přínos, uplatnění, patent, osobní podíl, ...) :

The main objective of the Research Infrastructure NanoEnviCz (RI) is creation of the efficient platform both for the partners of the project as well as for the external users. The RI will primary aim at the development and preparation of high-performance and conceptually innovative nanostructured materials for sustainable future with particular interest in the development of novel technologies for the protection and remediation of the environment. RI will offer services in the fields of heterogenous catalysis for environmental protection, technologies for renewable energy resources and storage, nanotechnology for trapping and chemical degradation of pollutants and technologies for sensing and monitoring of pollutants. The development of new nanotechnology will always undergo objective assessment not only the benefits but also potential risks that may be associated with nanomaterials.

(Project approved for economic support continuation)

5) výsledek (projekt, realizace)

SURRI: Sustainable Remediation Of Radionuclide Impacts On Land And Critical Materials Recovery, (01.01.2023 - 31.12.2025)

101079345

https://cordis.europa.eu/project/id/101079345

Charakterizace (V-V přínos, uplatnění, patent, osobní podíl, ...) :

Radioactive contamination of the environment including soil and groundwater is not uncommon since there are numerous sources of radionuclides from human activities, including defence-related, power production, medical, industrial and research activities. The contamination poses a long-term hazard to human and environmental health. Remediation of contaminated soil layers with various conventional physical and chemical treatments is difficult and expensive. The EU-funded SURRI project will investigate sustainable electrochemical and microbiological interventions enabling improved remediation while recovering materials resources including rare earth elements from radionuclide-impacted waste. This will be done in the context of a twinning programme to strengthen the capacity of the Technical University of Liberec in Czechia.

(Running project)

A2. Pedagogická a vzdělávací činnost

Přednášková činnost (garance a vedení přednášek)
1) Lecturer of the theoretical "Functionalization of Nanomaterials" course though in the summer semester, and considered a fundamental subject for the Nanotechnology (N0719A270001) program students and offered as an optative one to the Bioengineering (N0519A270001), Industrial Engineering (N3957), and Textile Engineering (N3106) programs. The subject is currently under the Department of Chemistry from the Faculty of Science, Humanities and Pedagogy and takes 2hrs per week per semester. I have been the lecturer of this course for the period 2018-present.
2) Invited lecturer of a short course taught at the Federal University of São Carlos during the summer semester 2020. The title of the course is "Laser-mediated Synthesis of Nanomaterials: a Clean Pathway", and it lasted 15 hrs. The course was offered to students of the graduate program in chemistry at the Federal University of São Carlos under the discipline Topics in Chemistry (CEM.200-11/20).
3) Invited lecturer of a short course taught at the Rajamangala University of Technology Thanyaburi during the summer semester 2023. The title of the course is "Laser-mediated Synthesis of Nanomaterials", and it lasted 10 hrs. The course was offered to all graduate students of the Faculty of Engineering and Faculty of Science and Technology. The students involved in the course came from the programs Chemical Engineering, Electrical Engineering, Industrial and Manufacturing Engineering, Materials Engineering, Master of Engineering Program in Mechatronics Engineering, and Applied Physics.
Učebnice a výukové pomůcky (charakteristika učebnice, výukové pomůcky)

1) Teaching material, including presentations, exercises, laboratory reports, and videos for the lecture "Functionalization of Nanomaterials" (KCH/FCN) (2020-2023)
https://elearning.tul.cz/course/view.php?id=7902

https://elearning.tul.cz/course/view.php?id=13207

https://elearning.tul.cz/course/view.php?id=13202

https://elearning.tul.cz/course/view.php?id=13205

All links direct to the pedagogical material created for the subject "Functionalization of Nanomaterials" for each academic year starting from 2020 when we finally had the transition from nanoedu platform to e-learning.tul.cz. Moreover, the following set of links direct to various pedagogical activities based on the given lectures:

https://create.kahoot.it/share/molecular-structure/c5a09f11-1326-4057-aec0-664c938fc968

https://create.kahoot.it/share/session-2-1/807f8222-0625-45c7-8a5a-5a1dd6c374b5

https://play.kahoot.it/v2/?quizId=dbdefddb-0823-4e70-961b-0b28fd5fe66c

https://create.kahoot.it/share/chapter-4/7e62b161-5fca-46bc-a35f-e959be8cbc85

https://create.kahoot.it/share/session-5/c5de946a-057d-40a3-92b4-02617882c611

2) Teaching material created exclusively for the short course taught at the Federal University of São Carlos during the summer semester 2020 under the discipline Topics in Chemistry (CEM.200-11/20). The material is a compilation of all presentations given during the short course named "Laser-mediated Synthesis of Nanomaterials: a Clean Pathway".
https://drive.google.com/drive/folders/1t_LPZtLvcOPYfeJFlwJk3DsjrQsQT6mJ?usp=sharing

3) Teaching material created exclusively for the short course taught at the Rajamangala University of Technology Thanyaburi during the summer semester 2023. The material is a compilation of all presentations given during the short course named "Laser-mediated Synthesis of Nanomaterials".
https://drive.google.com/drive/folders/1Pzx79Lt7m6KeBNiAT_ffyQHYrXbuGSoI?usp=sharing

Individuální vzdělávací činnost (vedení projektu, diplomové práce, doktoranda, kvantitativní i kvalitativní hodnocení)

1) Supervisor of 3 successfully defended master/diploma theses, one bachelor thesis, and co-supervisor of another bachelor thesis. Four of those theses got different distinctions (the list of trained students, topics, and awards is part of the overview of pedagogical activities)
2) Co-supervisor of 3 doctoral students; in all cases, the studies continue successfully within the given deadlines (the list of trained students and topics is part of the overview of pedagogical activities).

A3. Ostatní významné aktivity

Výkon funkce
1) Czech Member of Committee COST project CA19123 - Protection, Resilience, Rehabilitation of damaged environment, 21/09/2020 - 20/09/2024 Working Groups: 2. Bio-Electrochemical Systems to reduce the environmental impact of pollutants and bioresource valorization Contribution: My contribution to the PHOENIX action lies in exploring the use of laser micromachining to enhance exoelectrogen biofilm growth over anodes in microbial fuel cells. My involvement is framed in working group 2, working task 4; functionalized electrodes in bioelectrochemical systems. https://www.cost.eu/actions/CA19123/#tabs+Name:Description

Členství (ve vědeckých radách, v radách redakčních časopisů, funkce ve vědeckých společnostech atd.)
1) Evaluator of grant proposals in open calls of the National Science Centre panel ST8, Poland, in 2019. https://www.ncn.gov.pl/en/finansowanie-nauki/dla-ekspertow
2) Guest editor for the "Journal of Membranes", MDPI publishing, special issue name: Surface and Interface Engineering of Polymeric Membrane. The journal is Q1, and the link to the special issue is the following: https://www.mdpi.com/journal/membranes/special_issues/surface_interface_polymeric_membrane
3) Guest editor for the "Journal of Membranes", MDPI publishing, special issue name: Surface and Interface Engineering of Membrane Composites. The journal is Q1, and the link to the special issue is the following: https://www.mdpi.com/journal/membranes/special_issues/10SYH3W1X8

4) Mentor and commentator at the Bangkok International Intellectual Property, Invention, Innovation and Technology Exposition (IPITEx 2023), Thailand 2023. https://ipitex.nrct.go.th/

5) Reviewer of 51 manuscripts indexed in the web of science (WoS)

https://www.webofscience.com/wos/author/record/1504011

Jiné aktivity

1) Opponent of Ph.D. thesis of [redacted] from the University Jaume I, Spain, in (08.04.2019). Thesis: On the use of nanofluids to enhance the direct absorption of solar radiation. Certificate found in the document "dodatecne-podklady-pro-kvantitativni-hodnoceni-za-obdobi 2018-2023 - Torres".

2) Opponnt of master/diploma thesis of [redacted] from the Technical University of Liberec, Faculty of Science, Humanities and Pedagogy, Department of Chemistry (30.05.2019). Thesis: Molybdenum disulfide and molecular thin films integration into devices for molecular electronics and spintronics.
https://stag.tul.cz/portal/studium/prohlizeni.html?pc_pagenavigationalstate=AAAAAQAGMjI4NjA2EwEAAAABAAhzdGF0ZUtleQAAAAEAFC05MjIzMzcyMDM2ODU0Nzc0ODY0AAAAAA**#prohlizeniSearchResult

3) Moderator at the 2nd Global Summit and Expo on Materials Science and Nanoscience (GSEMSN2022) held at Dubai, UAE, in 2022. https://www.thescientistt.com/materials-science-nanoscience/2022/

4) Four invited talks at different conferences:
- At the "2nd International Conference on Nanomaterials, Nanofabrication, and Nanocharacterization (NANOMACH)" held in Turkey, title "Laser-mediated fabrication of nanoparticles for the decoration of nanofibrous membranes and their usage in the oil/water separation sector". (2021)

- At the "2nd Global Summit and Expo on Materials Science and Nanoscience (GSEMSN2022)" held in Dubai, title "Laser-assisted generation of ultra-small iron nanoparticles". (2022)

- At the "12th Annual World Congress of Nano Science & Technology (Nano-S&T)" held in Japan, title "On the Laser-Mediated Generation of Nanoalloys from Immiscible Elements like FeCu". (2023)

- At the "ANGEL satellite event Innovative biomedical applications of laser-generated colloids "held in Italy, title "Bacterial growth suppression by biofilm deterioration through magnetic element-doped silver nanoparticles". (2023)

Certificates found in the document "dodatecne-podklady-pro-kvantitativni-hodnoceni-za-obdobi 2018-2023 - Torres".