LU ASI Optisko biosensoru un funkcionālo nanomateriālu laboratorijas vadītāja ziņojums par darba izpildi 2024.gadā

Dr. Roman Viter
Vadošais pētnieks, Optisko biosensoru un funkcionālo nanomateriālu laboratorijas vadītājs

UNIVERSITY OF LATVIA
INSTITUTE OF ATOMIC PHYSICS AND SPECTROSCOPY

General info

- Darbnieki **9**
- Doktoranti **2**
- Studenti **6 (5 pharm.nod + 1 chem nod)**
- Publikacijas **8**
- Latvijas projekti **3**
- M-Era-Net **2**
- HE **1**
- Konferences **2**
- Patenti **1**

Publications

- Mitra Saffari, Zahra Hagheh Kavousi, Massomeh Ghorbanloo, Amr A Nada, Maged F Bekheet, Djamel Bezzerga, Jisang Hong, Ali Morsali, Yaovi Holade, Roman Viter, Heba H El-Maghrabi, Rasha Hosny, Fathi S Soliman, Igor Iatsunskyi, Emerson Coy, Mikhael Bechelany, Copper benzene-1, 3, 5-tricarboxylate based metal organic framework (MOF) derived CuO/TiO2 nanofibers and their use as visible light active photocatalyst for the hydrogen, Applied Surface Science 678, (2024) 161061
- P Wityk, M Kosowska, J Kwon, I Iatsunskyi, M Bechelany, R Viter, Celebrating biomimicry: bioinspired layers in optical biosensors, Optical and Quantum Electronics 56 (8), (2024) 1303
- Roman Viter, Iryna Tepliakova, Maryia Drobysh, Viktor Zbolotnii, Simas Rackauskas, Simonas Ramanavicius, Karlis Grundsteins, Viktorija Liustrovaite, Almira Ramanaviciene, Vilma Ratautaite, Ernestas Brazys, Chien-Fu Chen, Urte Prentice, Arunas Ramanavicius, Photoluminescence-based biosensor for the detection of antibodies against SARS-CoV-2 virus proteins by ZnO tetrapod structure integrated within microfluidic system, Science of The Total Environment, 939 (2024) 173333
- Viktorija Liustrovaite, Maryia Drobysh, Vilma Ratautaite, Almira Ramanaviciene, Agne Rimkute, Martynas Simanavicius, Indre Dalgediene, Indre Kucinskaite-Kodze, Ieva Plikusiene, Chien-Fu Chen, Roman Viter, Arunas Ramanavicius, Electrochemical biosensor for the evaluation of monoclonal antibodies targeting the N protein of SARS-CoV-2 virus, Science of The Total Environment, Volume 924, 10 May 2024, 171042
- Andrii Lys, Viktor Zabolotnii, Mária Čaplovičová, Iryna Tepliakova, Agris Berzins, Martin Sahul, Ľubomír Čaplovič, Alexander Pogrebnjak, Igor Iatsunskyi, Roman Viter, Core-shell nanofibers of ZnFe2O4/ZnO for enhanced visible-light photoelectrochemical performance, Journal of Alloys and Compounds, Volume 984, 15 May 2024, 173885
- Ramūnas Levinas, Vidas Pakstas, Algirdas Selskis, Tomas Murauskas, Roman Viter, Andris Anspoks, Inga Pudza, Alexei Kuzmin, Loreta Tamasauskaite-Tamasiunaite, Henrikas Cesiulis, Eugenijus Norkus, Plasma Electrolytic Oxidation Synthesis of Heterostructured TiO2/CuxO Films for Photoelectrochemical Water Splitting Applications, Journal of The Electrochemical Society, 2024 171 036501
- Fida Tanos, Elissa Makhoul, Amr A Nada, Maged F Bekheet, Wiebke Riedel, Sarah Kawrani, Habib Belaid, Eddy Petit, Roman Viter, Victoriia Fedorenko, Arunas Ramanavicius, Madona Boulos, David Cornu, Antonio Razzouk, Geoffroy Lesage, Marc Cretin, Mikhael Bechelany, Graphene oxide-induced CuO reduction in TiO2/CaTiO3/Cu2O/Cu composites for photocatalytic degradation of drugs via peroxymonosulfate activation, Applied Surface Science, Volume 656, 30 May 2024, 159698
- Cheng-Yang Tung, Tsung-Ting Tsai, Ping-Yeh Chiu, Roman Viter, Arunas Ramanavicius, Cheng-Ju Yu, Chien-Fu Chen, Diagnosis of Mycobacterium Tuberculosis Using Palladium-Platinum Bimetallic Nanoparticles on Paper-Based Analytical Devices, Nanoscale, 2024, 16, 5988-5998

Patent

Latvijas Republikas Patentu valde

Citadeles iela 7/70, Rīga, LV-1010, tālr. 67099600, fakss 67099650, e-pasts lietvedība@lrpv.gov.lv, www.lrpv.gov.lv

Adresēts:
Kristīne ČAPASE-JASTRŽEMBSKA
LU Zināšanu un tehnoloģiju pārneses centrs
Raiņa bulvāris 19
Rīga, LV-1586
kristine.capase_jastrzembska@lu.lv

PAZIŅOJUMS
Par patenta pieteikuma atbilstību Patentu likuma 34. pantam

Jūsu šifrs	Patenta pieteikuma numurs	Datums
LU-2024-008	LVP2024000064	23.01.2025.

Patentu valde paziņo, ka Jūsu iesniegtais patenta pieteikums

(21) Patenta pieteikuma Nr.	LVP2024000064
(22) Pieteikuma datums	01.11.2024
(51) Starptautiskās patentu klasifikācijas indekss	B82Y 30/00; D01D 5/00
(71) Pieteicēji	LATVIJAS UNIVERSITĀTE, Raiņa bulvāris 19, Rīga, LV-1586, LV
(72) Izgudrotāji	Roman VITER, Strēlnieku prospekts 58, Jūrmala, LV-2015, LV Viktor ZABOLOTNII, Ķekavas iela 3A - 9, Rīga, LV-1058, LV Iryna TEPLIAKOVA, Gaiļezera iela 2 - 36, Rīga, LV-1079, LV Kārlis GRUNDŠTEINS, Stūrīša iela 26 - 1, Rīga, LV-1006, LV Viesturs ŠINTS, Aleksandra Čaka 83/85 - 66, Rīga, LV-1011, LV
(54) Izgudrojuma nosaukums	OPTIMIZĒTA KODOLA METĀLA OKSĪDA NANOSTRUKTŪRU SAGATAVOŠANA AR PIELĀGOTĀM MAGNĒTISKĀM UN OPTISKĀM ĪPAŠĪBĀM
(74) Pārstāvis/patentpilnvarnieks	Kristīne ČAPASE-JASTRŽEMBSKA, LU Zināšanu un tehnoloģiju pārneses centrs, Raiņa bulvāris 19, Rīga, LV-1586, LV

atbilst Patentu likuma 34. panta pirmās daļas nosacījumiem.
Saskaņā ar Patentu likuma 35. panta pirmo daļu patenta pieteikums tiks publicēts 20.05.2026.

Informējam, ka, iesniedzot patenta pieteikumu Latvijā, Jums ir prioritātes tiesības attiecībā uz šo pašu izgudrojumu 12 mēnešu laikā no pieteikuma datuma iesniegt attiecīgo patenta pieteikumu jebkurā Parīzes savienības dalībvalstī, Pasaules tirdzniecības organizācijas dalībvalstī vai jebkurā citā valstī vai savienībā, ar kuru Latvija ir noslēgusi vienošanos par prioritātes tiesību atzīšanu.

Ja minētais 12 mēnešu termiņš tiek nokavēts, patenta pieteikumu uz šo pašu izgudrojumu citā valstī vairs iesniegt nevar.

Patentu departamenta vecākā eksperte

A.Lazareva
67099639
Aija.Lazareva@lrpv.gov.lv

Optical testing lab

- Absorbance/Transmittance (200-3300 nm) thin layers, solutions (Shimadzu UV3600)
- Integration sphere for diffuse/specular reflectance for powder /thin layer (200-2200 nm) (Shimadzu UV3600)

- FTIR (ATR, Transmittance) Bruker Alfa II
- Low temperature measurements of photoluminescence and transmittance (77-800 K) (Linkam), photoluminescence (LED, Laser, UV-Vis) 350-900 nm

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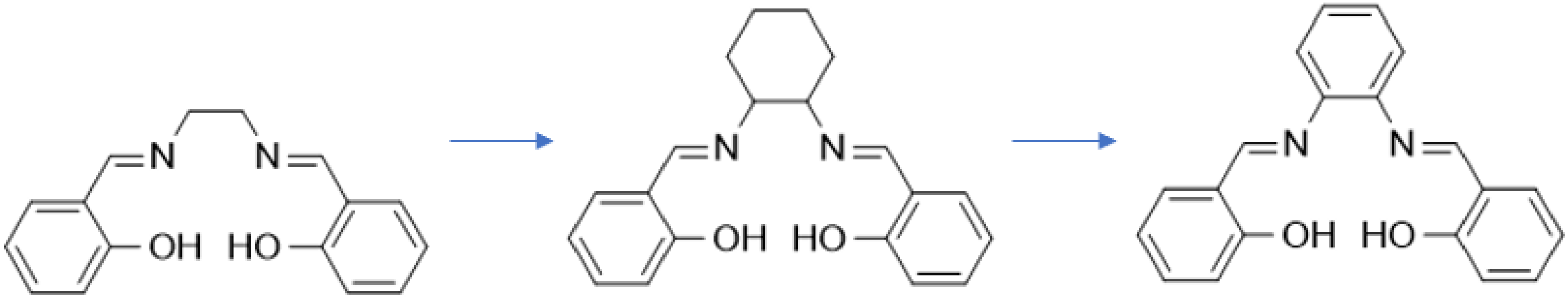
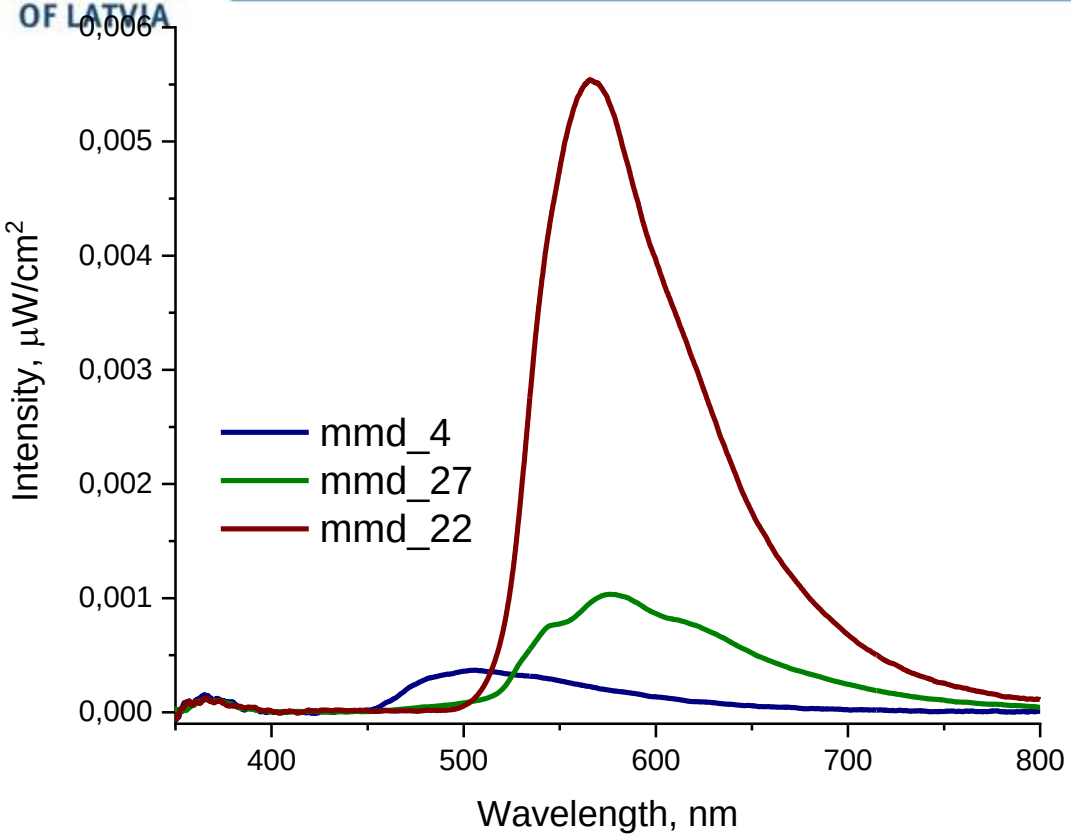
Materials for Sensors and Sensor testing

Changing of the imine-based ligand backbone

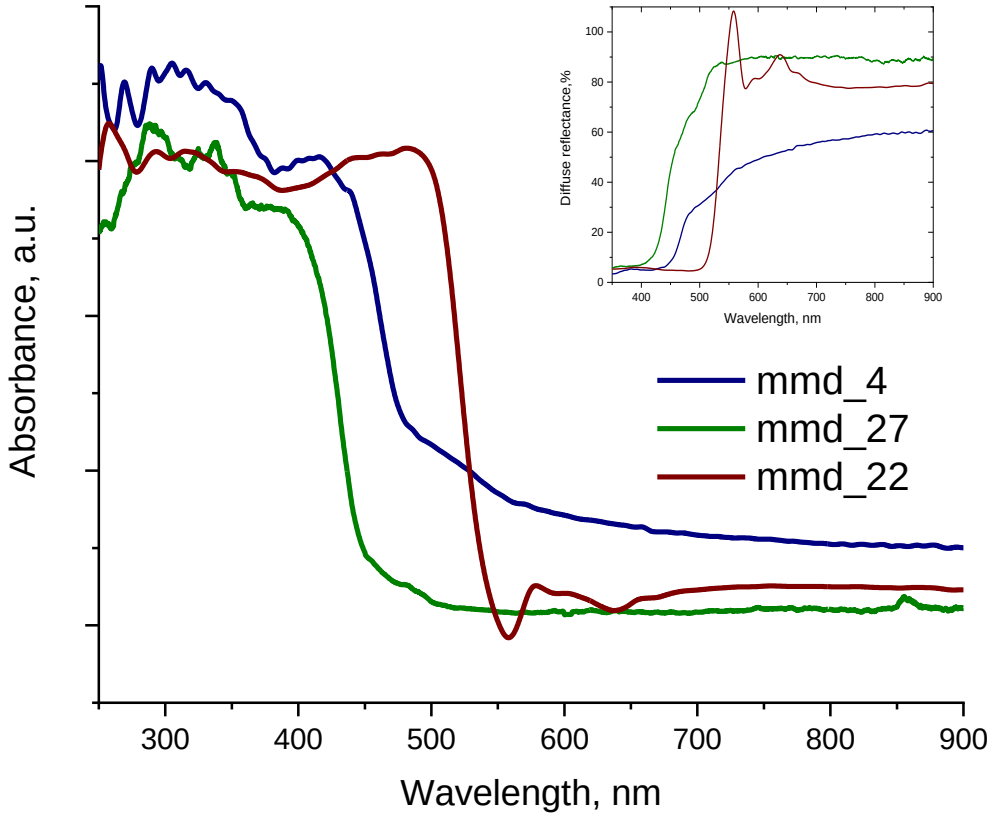


mmd_4 mmd_27 mmd_22

Optical properties

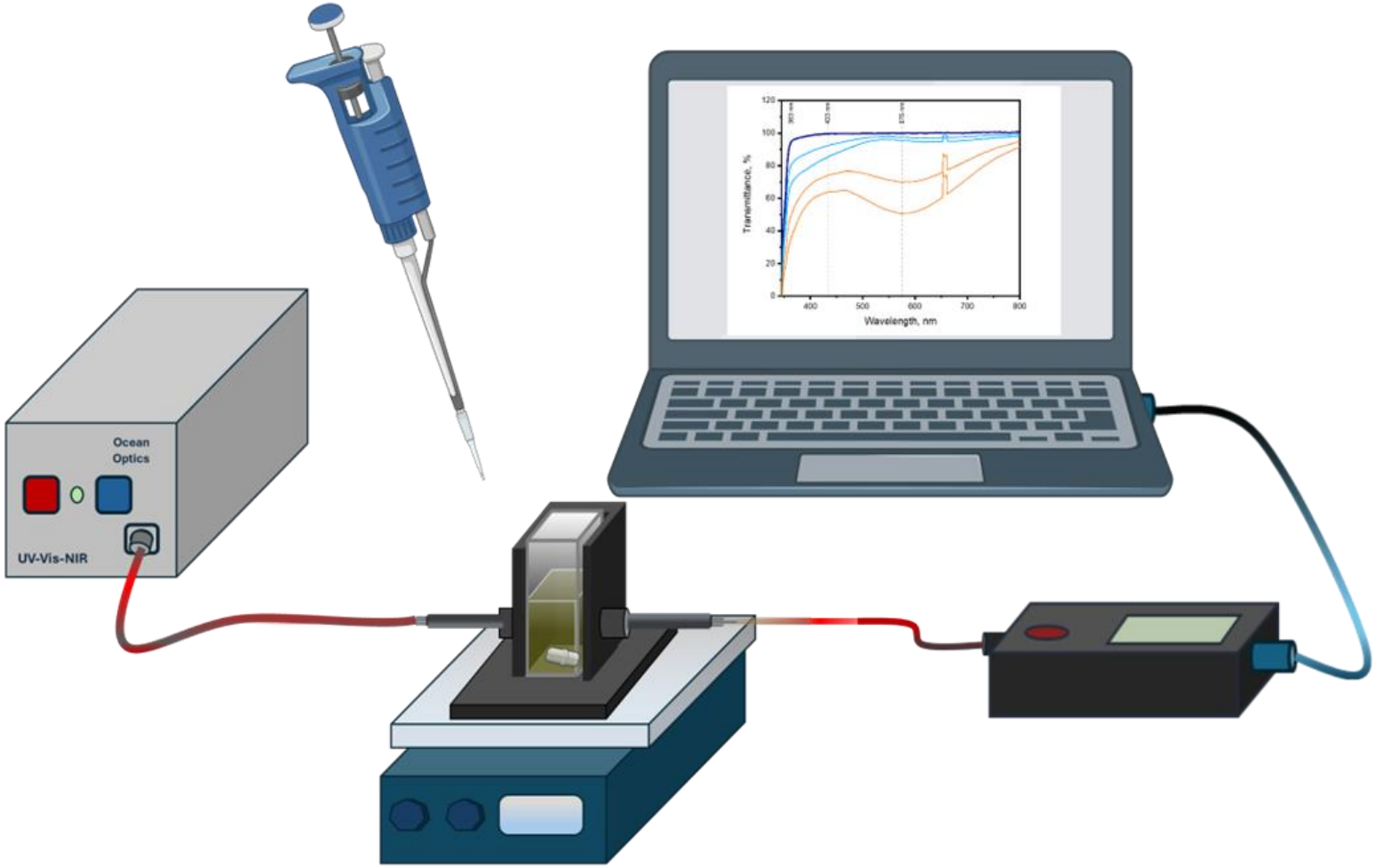


Photoluminescence spectra of imine-based ligands



\Absorption spectra of imine-based ligands

Experimental setup of sensitivity measurement by transmittance method



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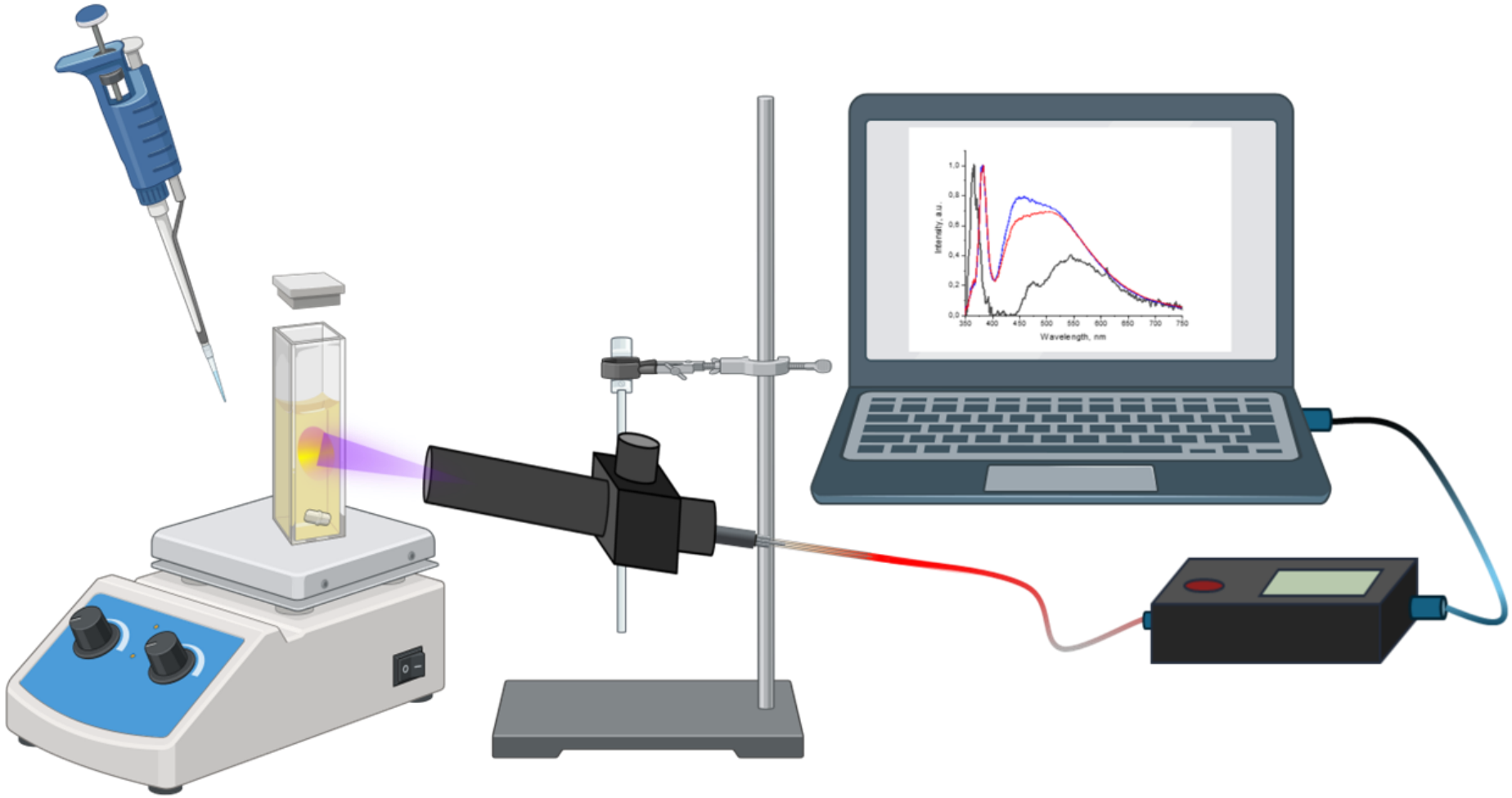
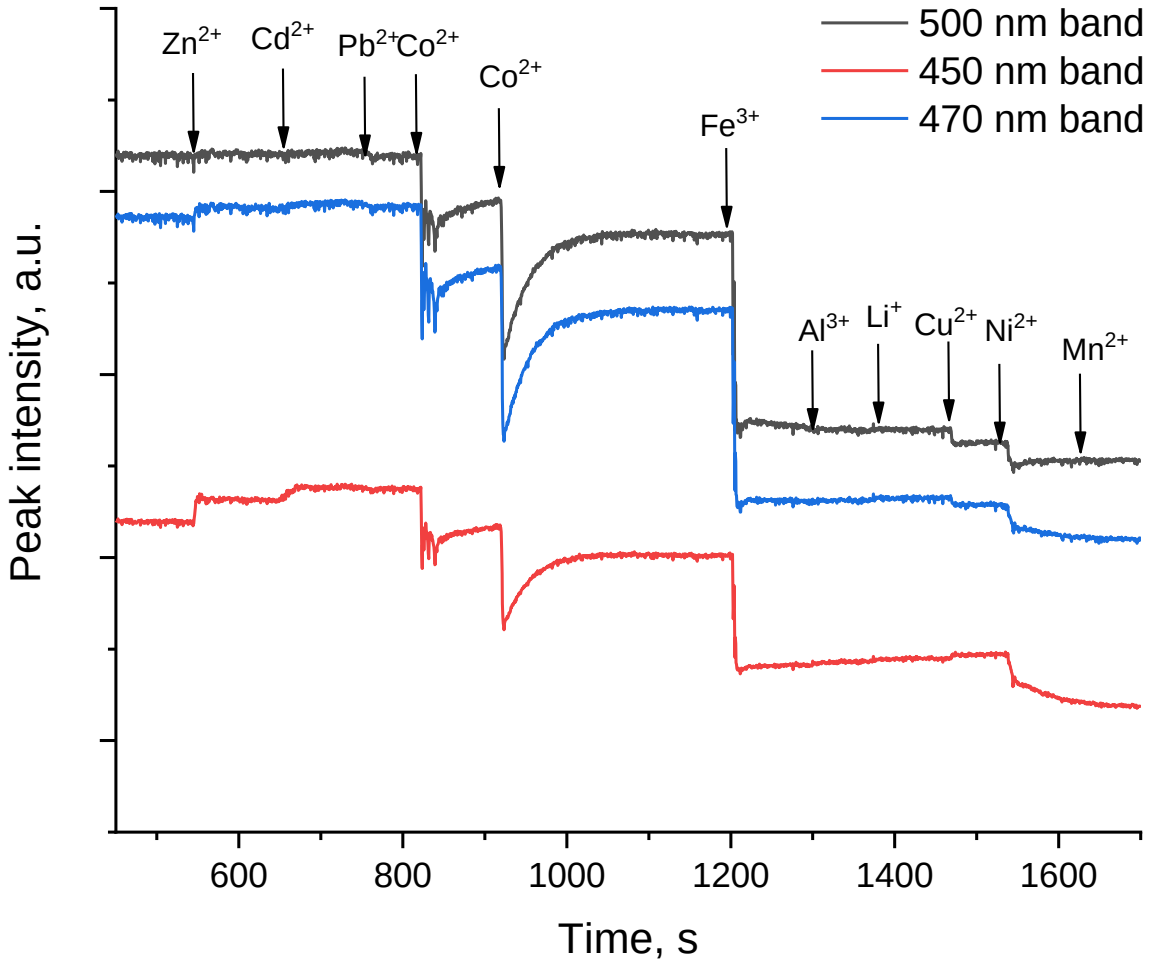
Experimental setup of sensitivity measurement by transmittance method



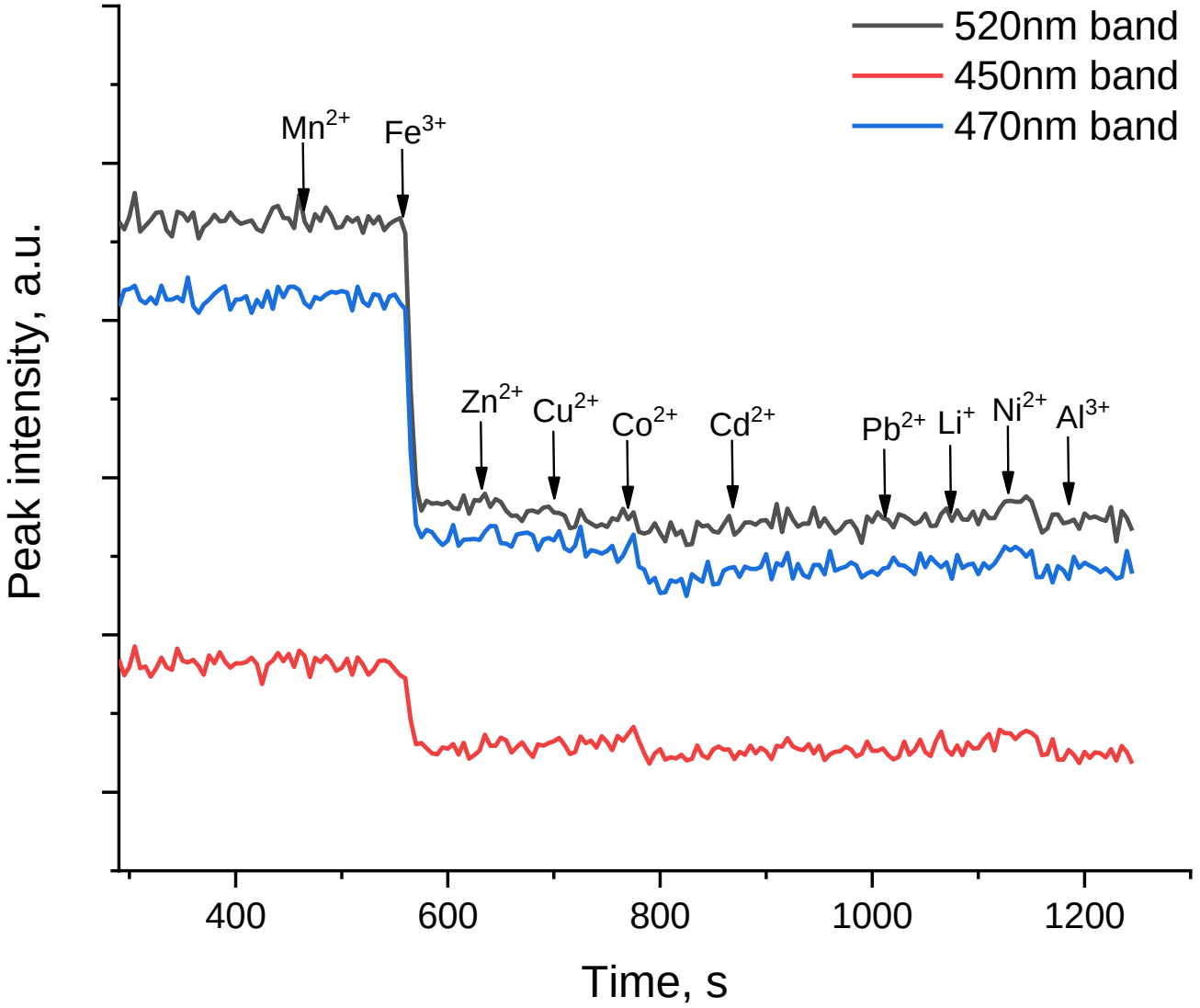
Sensor testing by transmittance



Ligand mmd_4, preliminary sensor testing to different ions. Kinetic of the transmittance on 500nm,450nm, 470nm bands.

Target ions for mmd_4: Co^{2+}, Fe^{3+}, Ni^{2+}, Cu^{2+}.

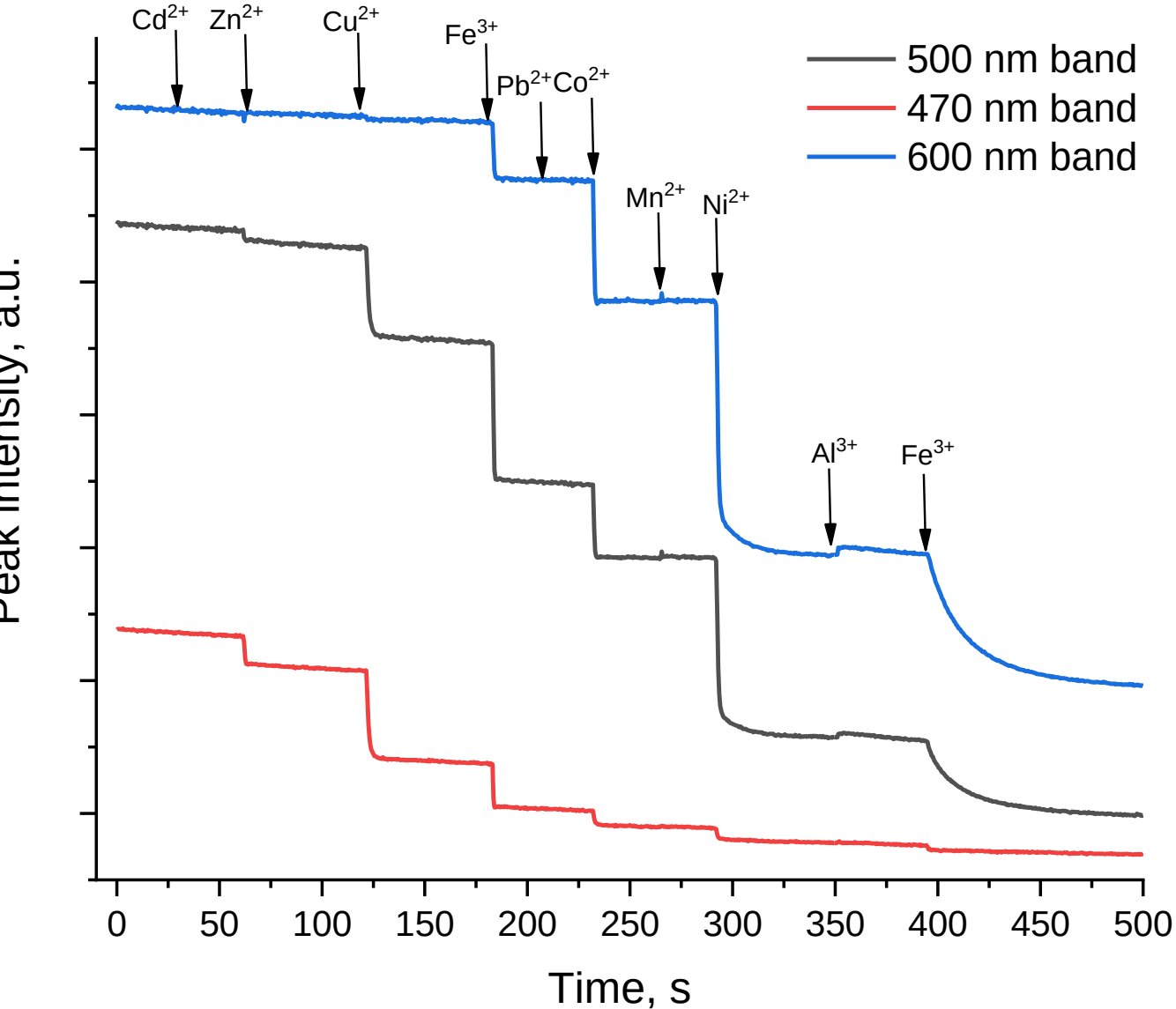
Sensor testing by transmittance



Ligand mmd_27, preliminary sensor testing to different ions. Kinetic of the transmittance on 520nm, 450nm, 470nm bands.

Target ions for mmd_27: Co^{2+}, Fe^{3+}, Ni^{2+}

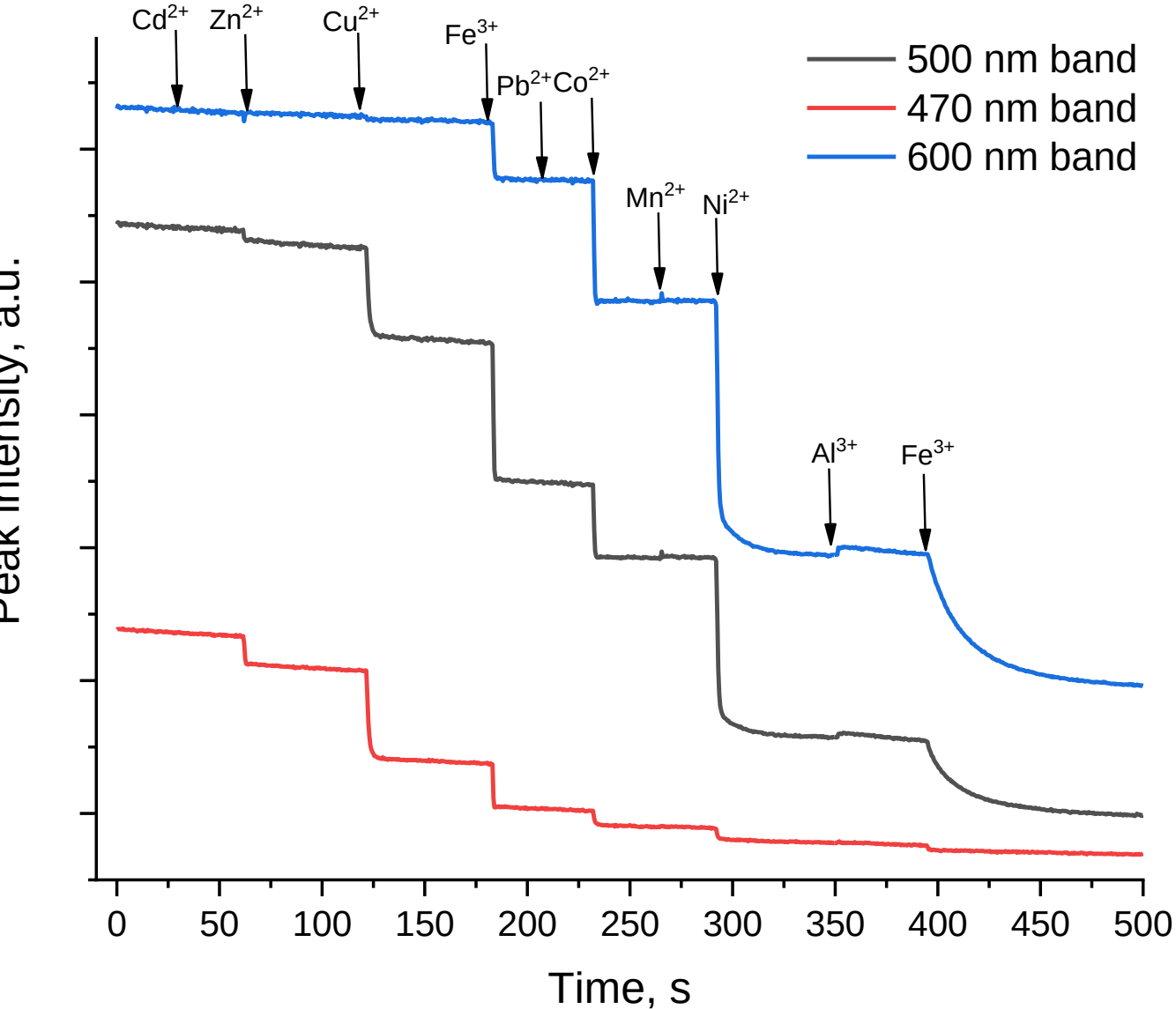
Sensor testing by transmittance



Ligand mmd_22, preliminary sensor testing to different ions. Kinetic of the transmittance on 470nm, 500nm, 600nm bands.

Target ions for mmd_22: Cu^{2+}, Fe^{3+}, Co^{2+}, Ni^{2+}.

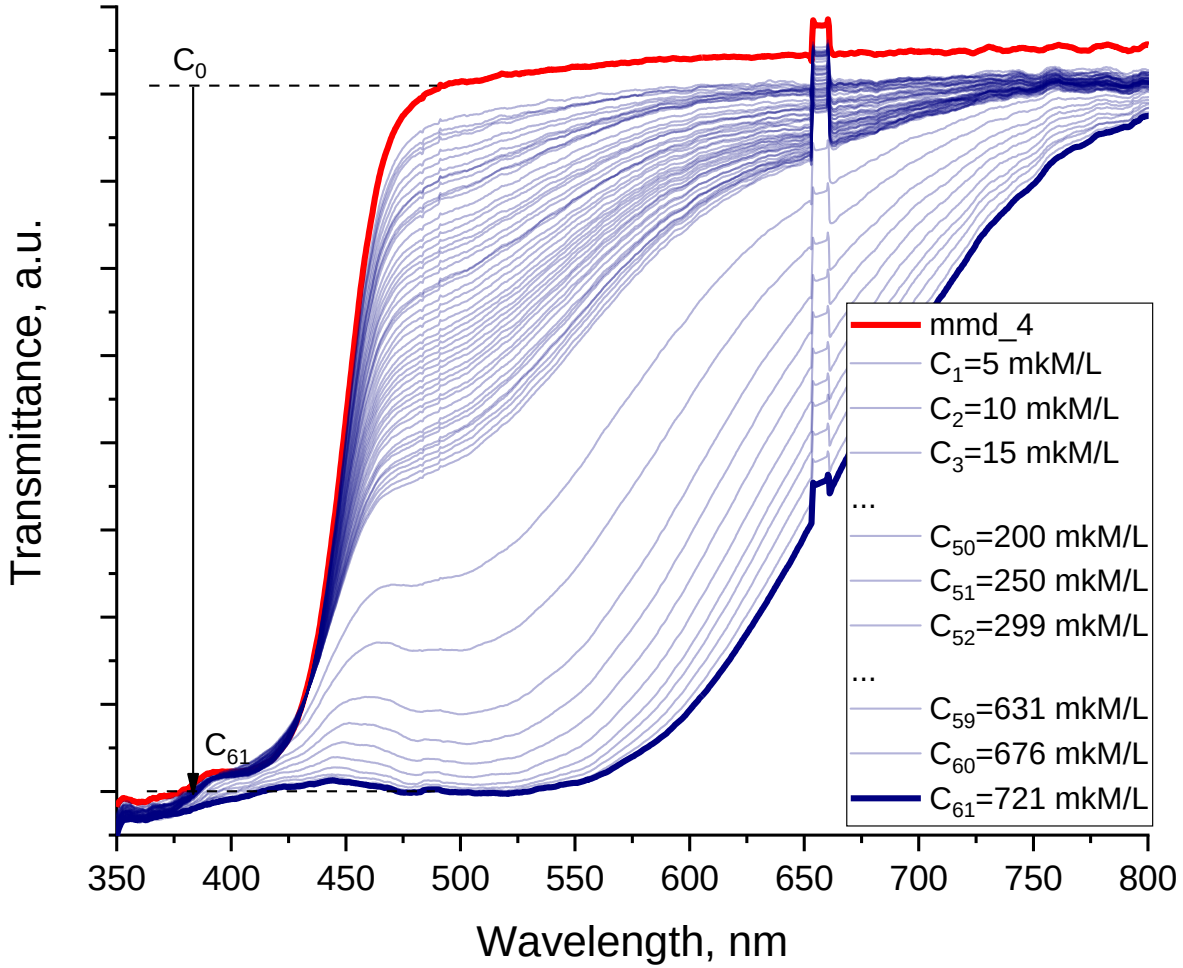
Sensor testing by transmittance

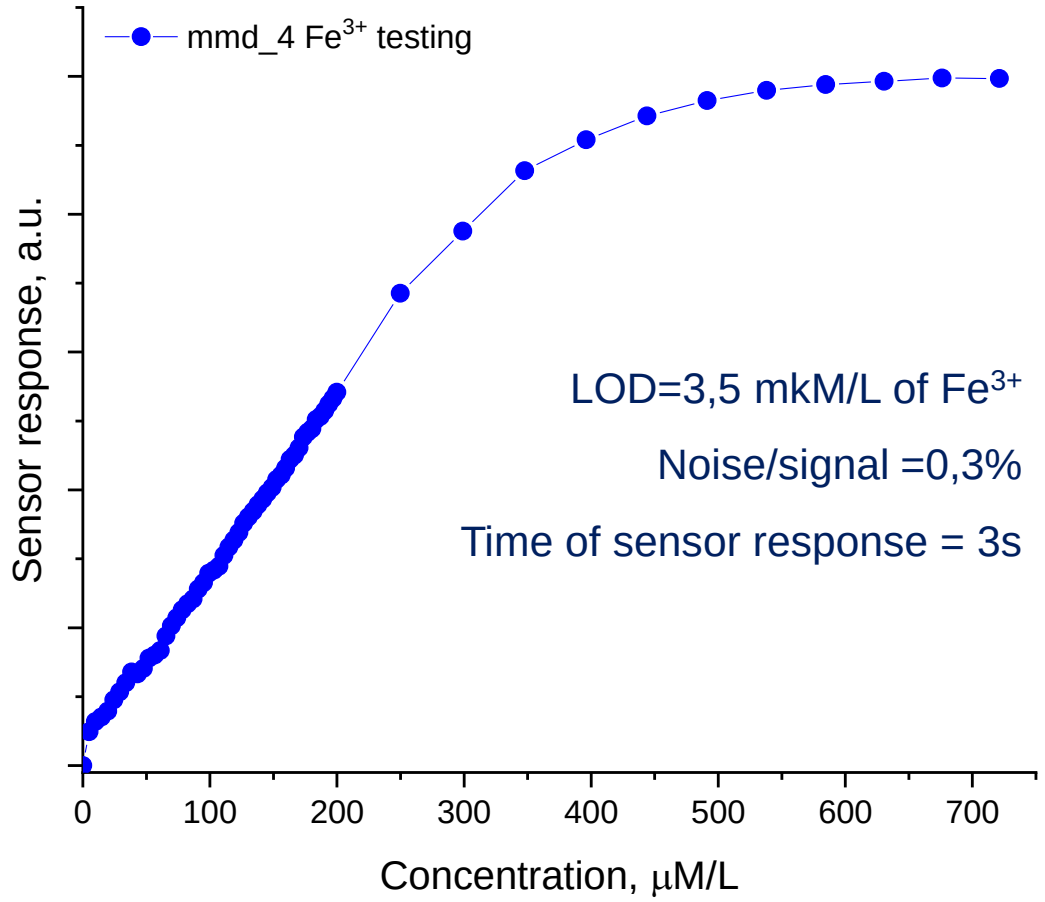


Ligand mmd_22, preliminary sensor testing to different ions. Kinetic of the transmittance on 470nm, 500nm, 600nm bands.

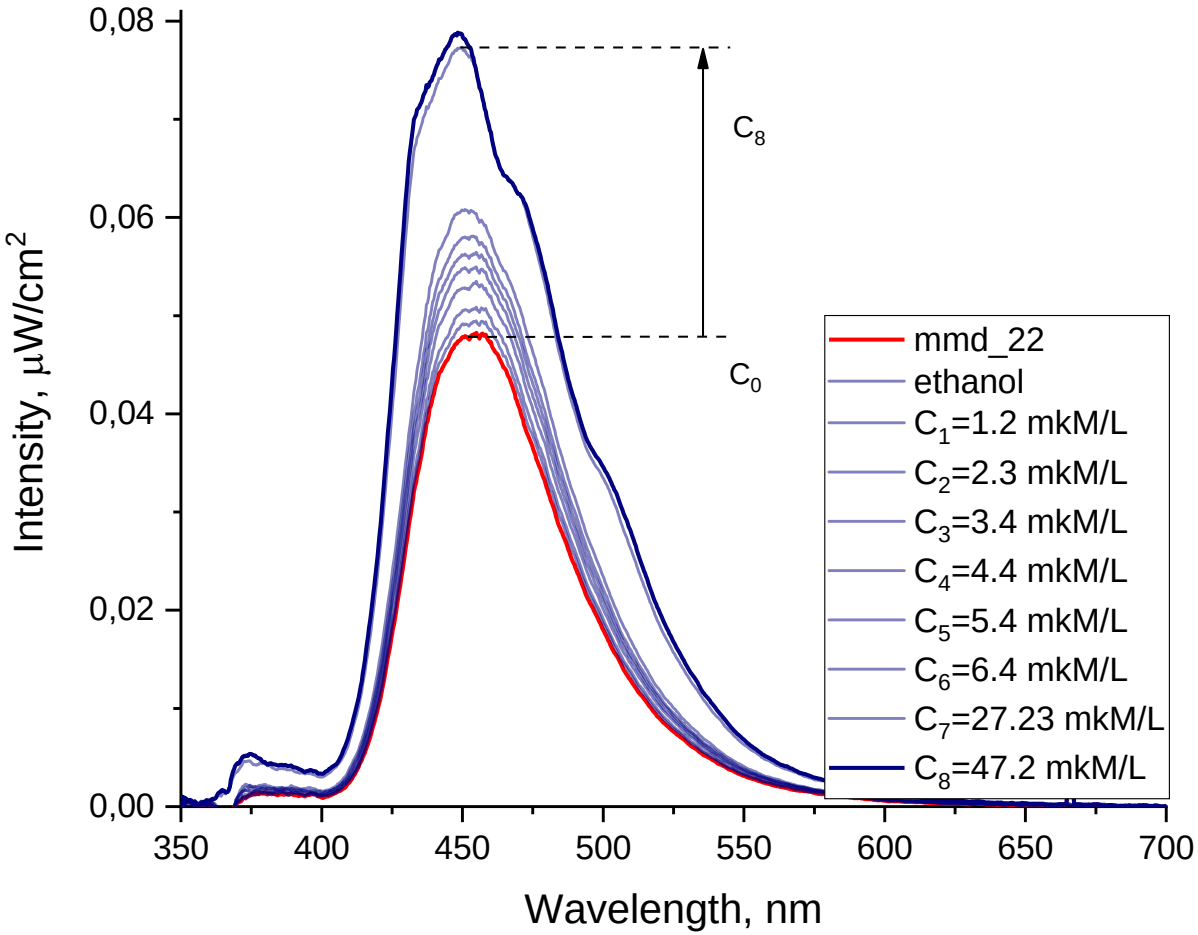
Target ions for mmd_22: Cu^{2+}, Fe^{3+}, Co^{2+}, Ni^{2+}.

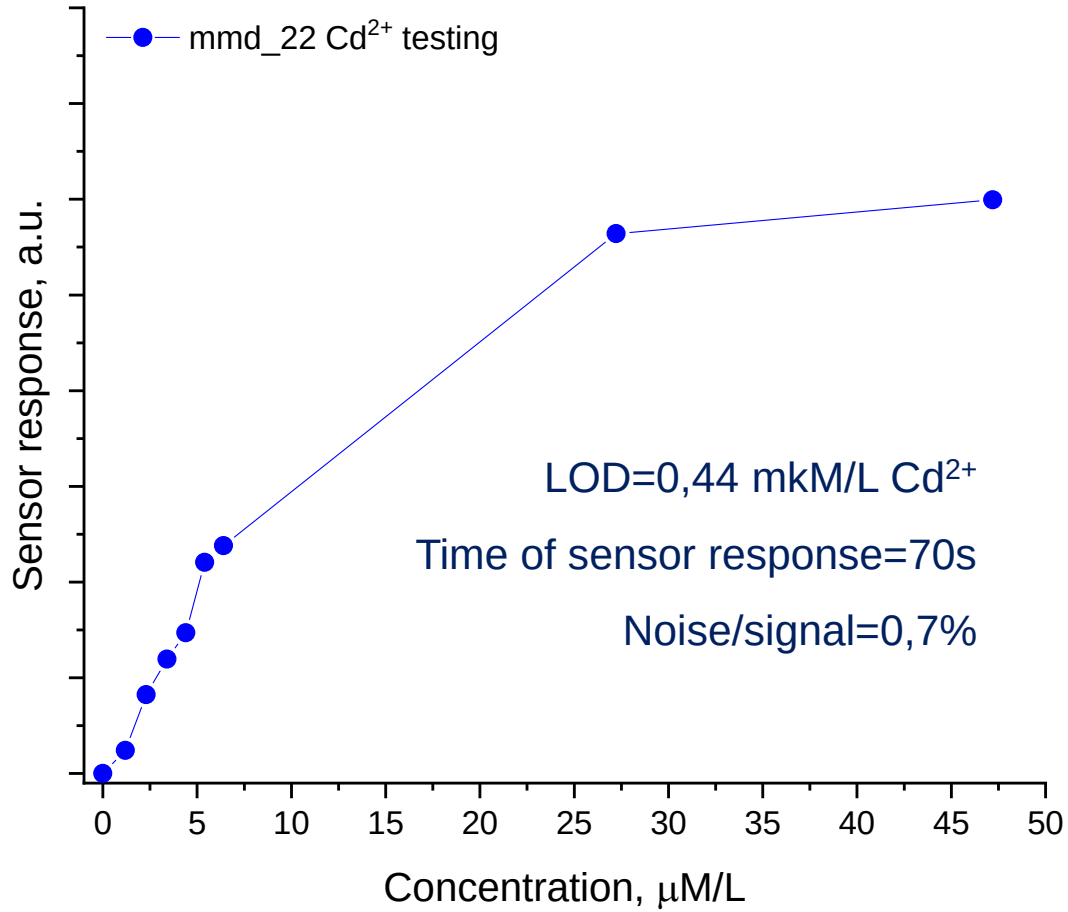
Sensor testing by transmittance



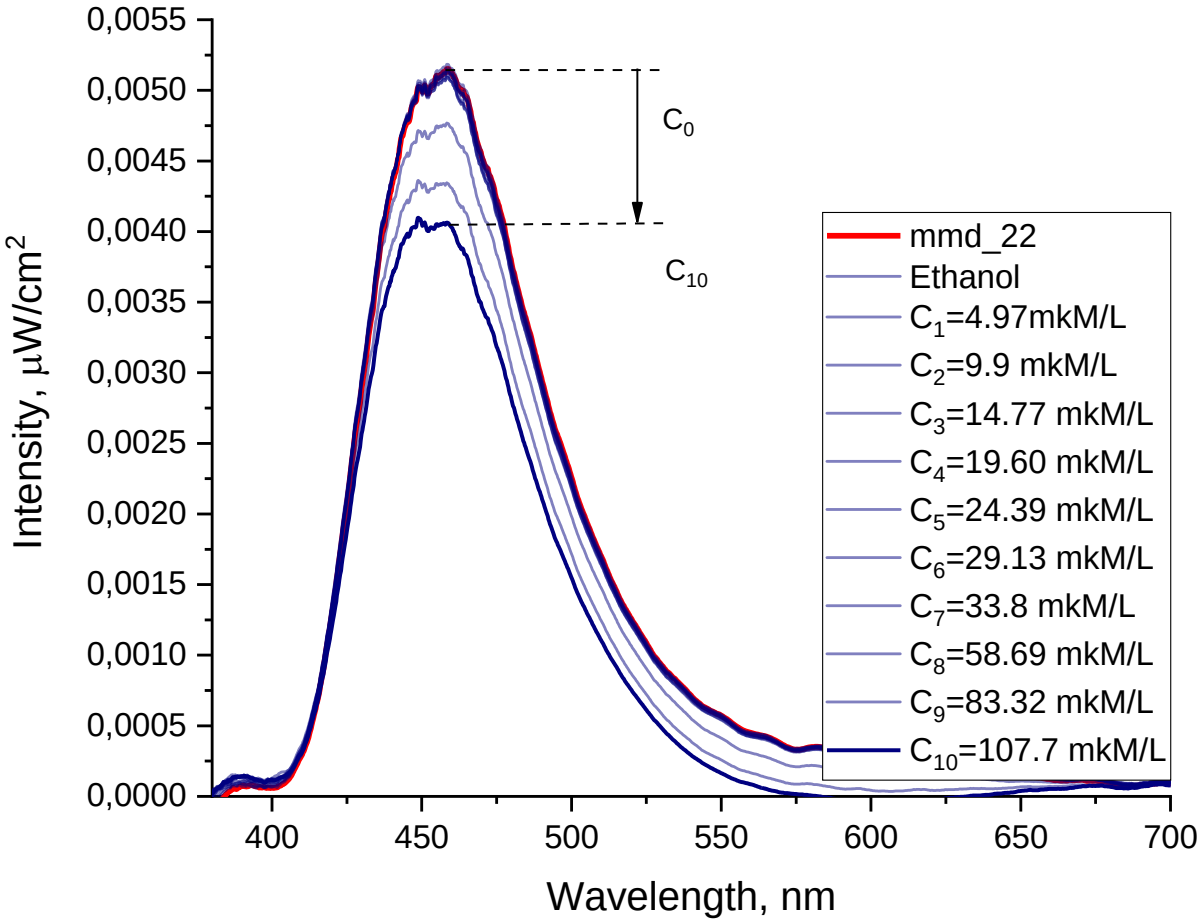


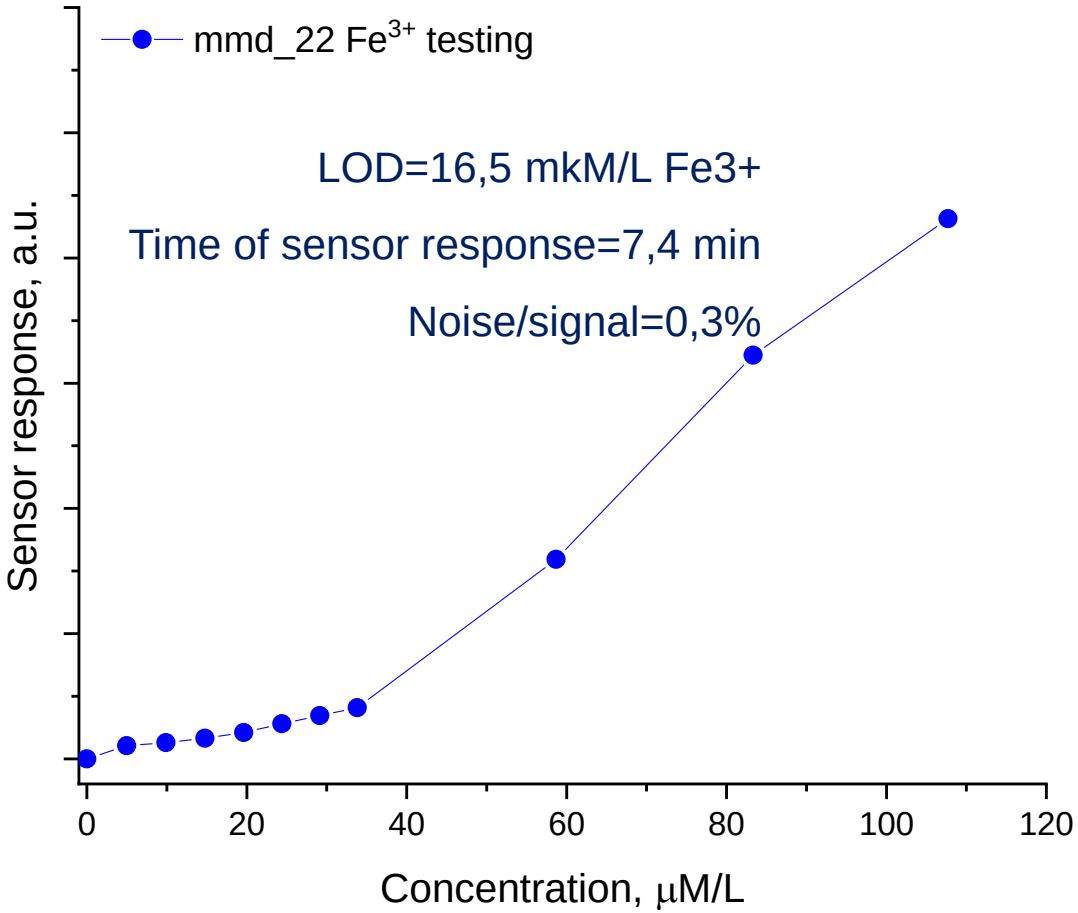
Sensor testing by photoluminescence





Sensor testing by photoluminescence





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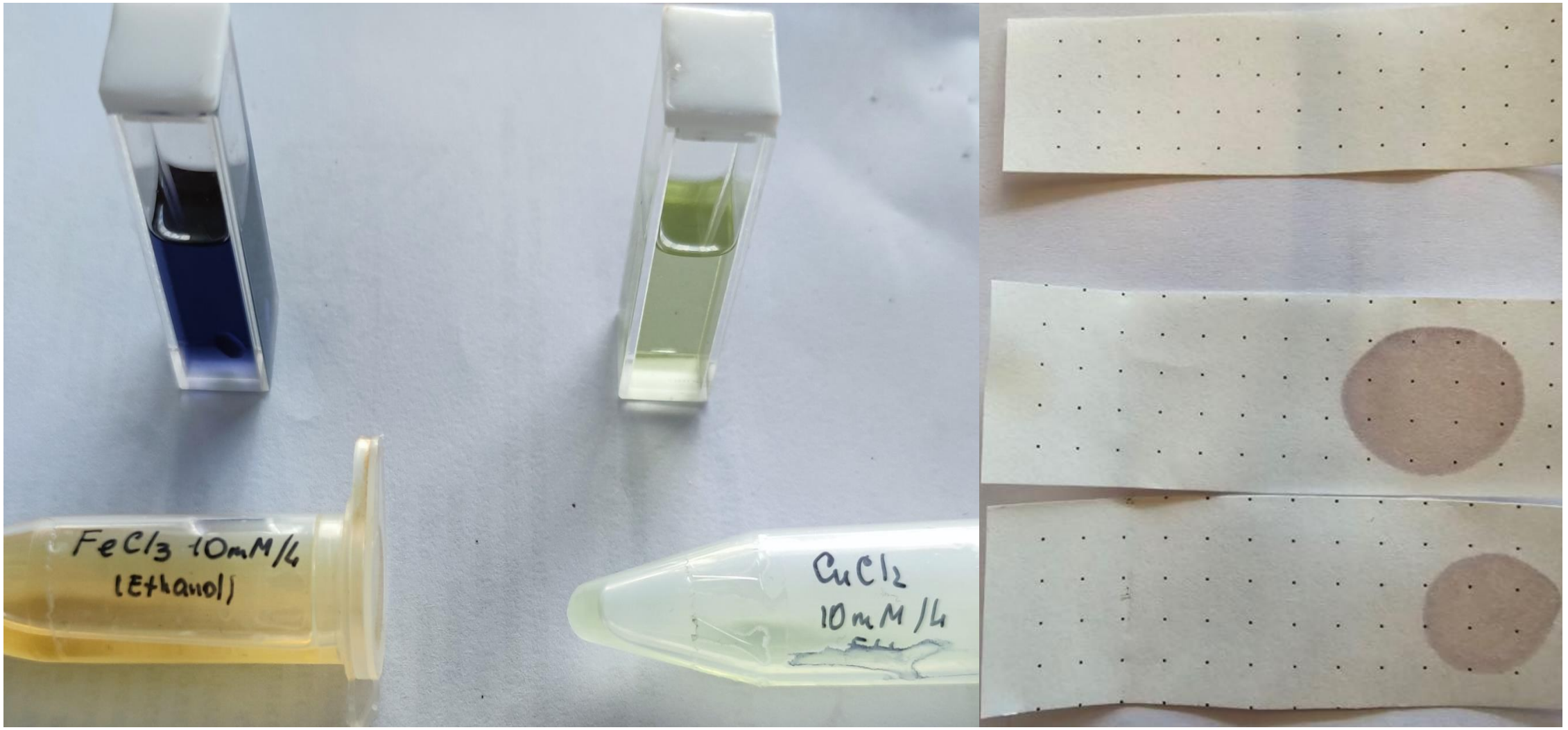
Colorimetric reaction of L2 in ethanol with Cu^{2+} and Fe^{3+}



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Salan type ligands for optical detection of Cu^{2+} and Fe^{3+} ions
14.02.2025

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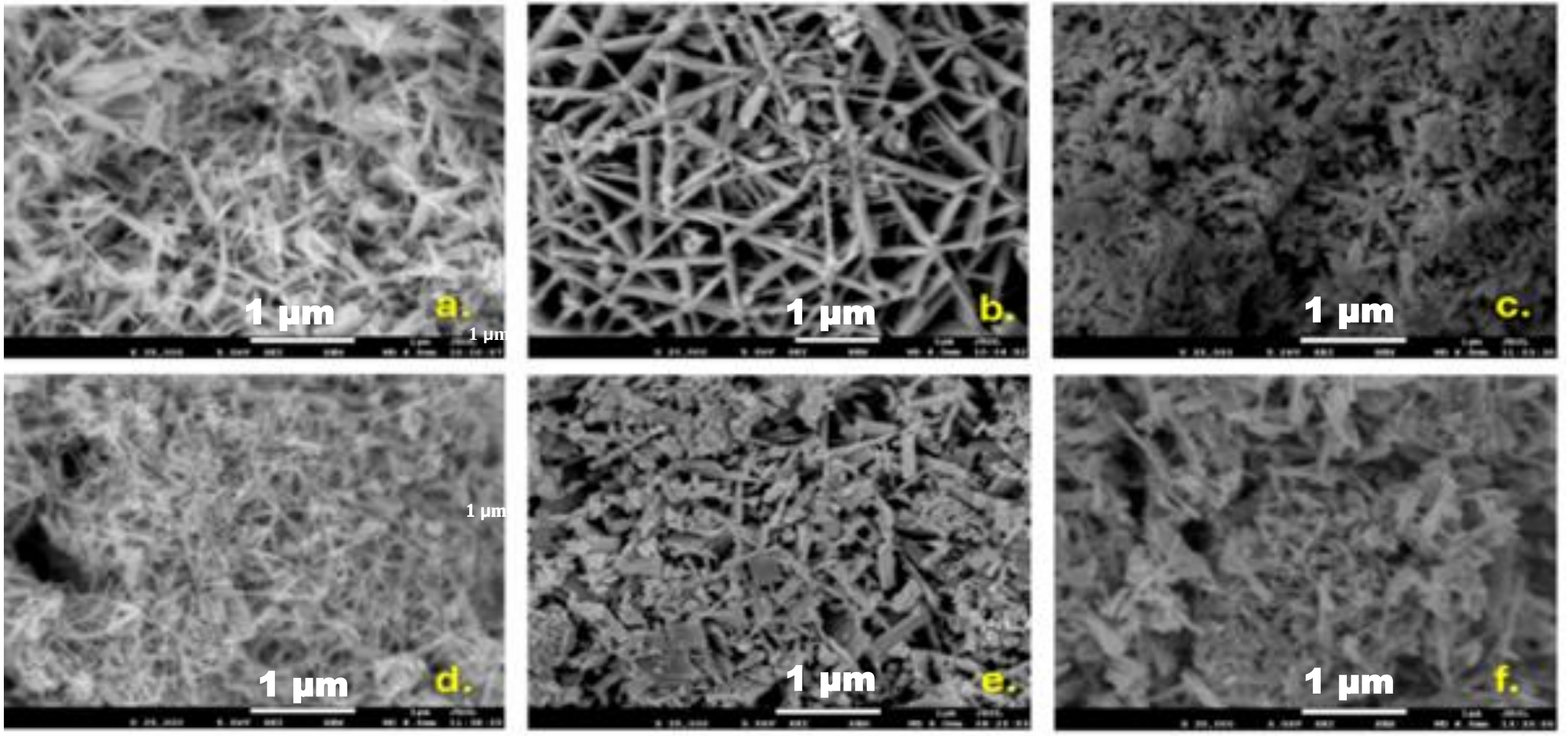
New metal doped h-WO_3 for catalytic and sensor applications

14.02.2025



HR-SEM images of pure and doped h-WO_3 nanostructures h-WO_3 (a), h-WO_3:Co (b), h-WO_3:Cr (c), h-WO_3:Mo (d) h-WO_3:Ni (e), h-WO_3:Ti (f)

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Applications

- Electrocatalysis
- Gas resistive sensors (University of Messina, prof. Neri)
- Photocatalysis
- More details in presentation 14.02.2025

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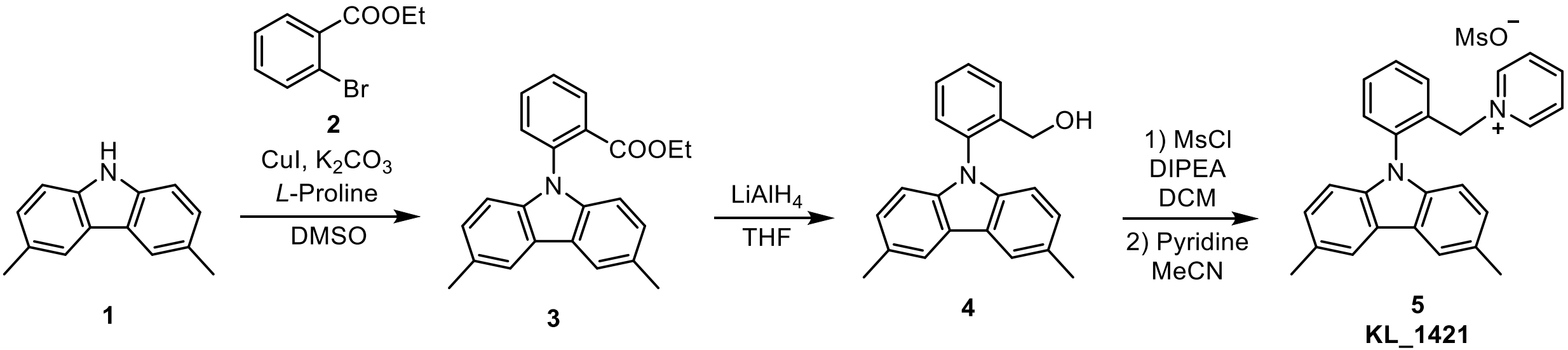
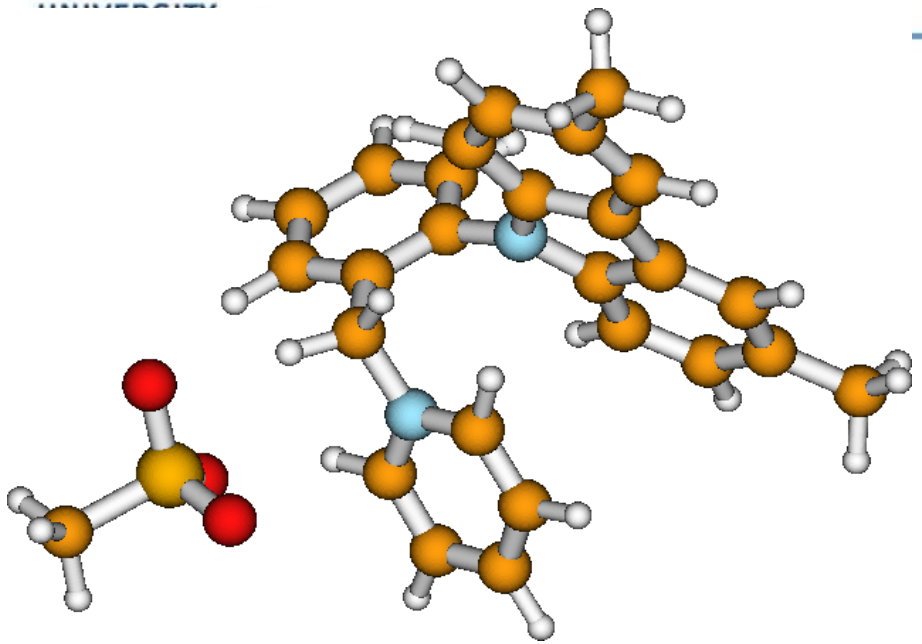
New organic luminophores: modelling and testing of the properties

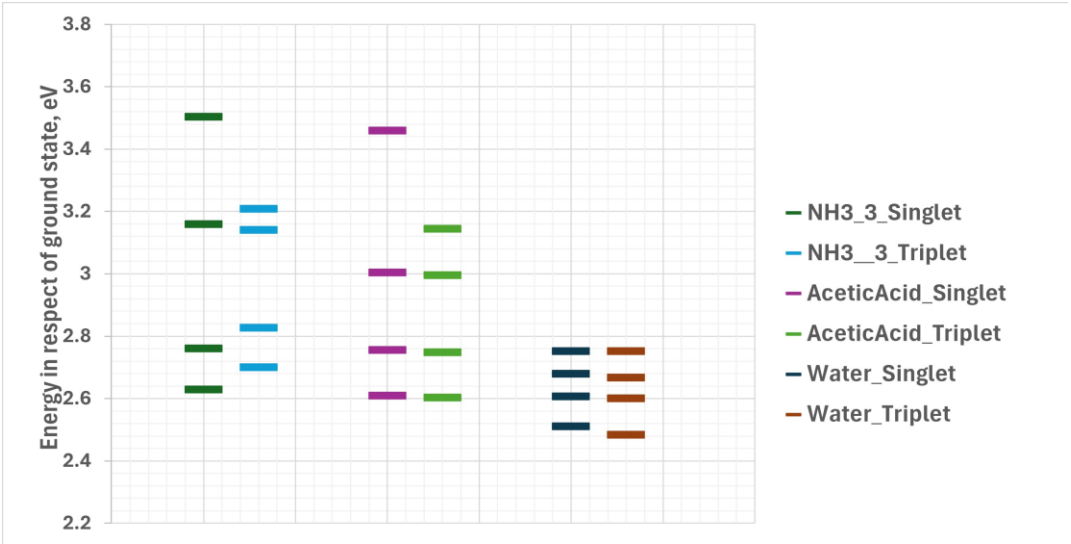
Pyridinium luminophores

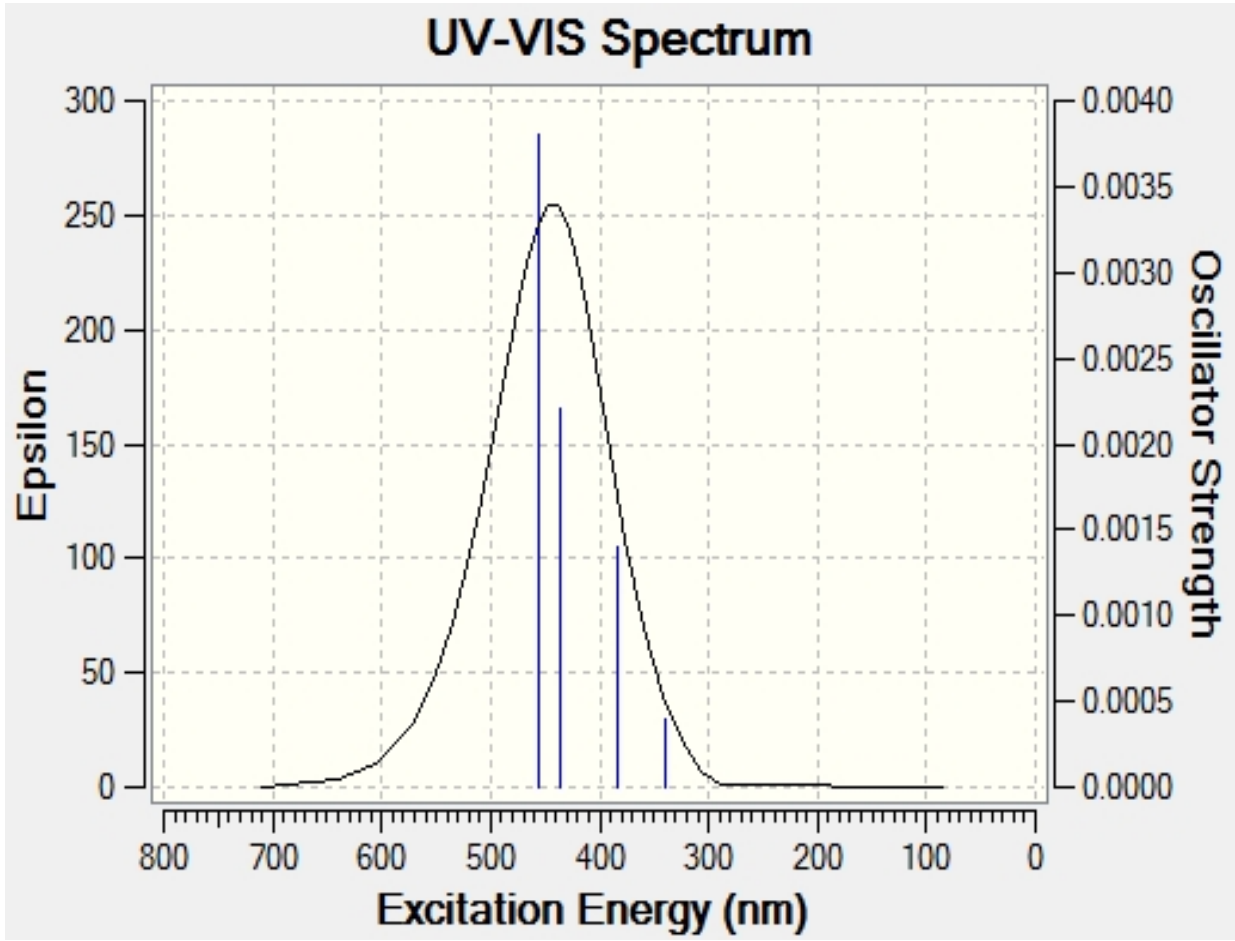


Synthesis of luminophores

Modelling of the properties







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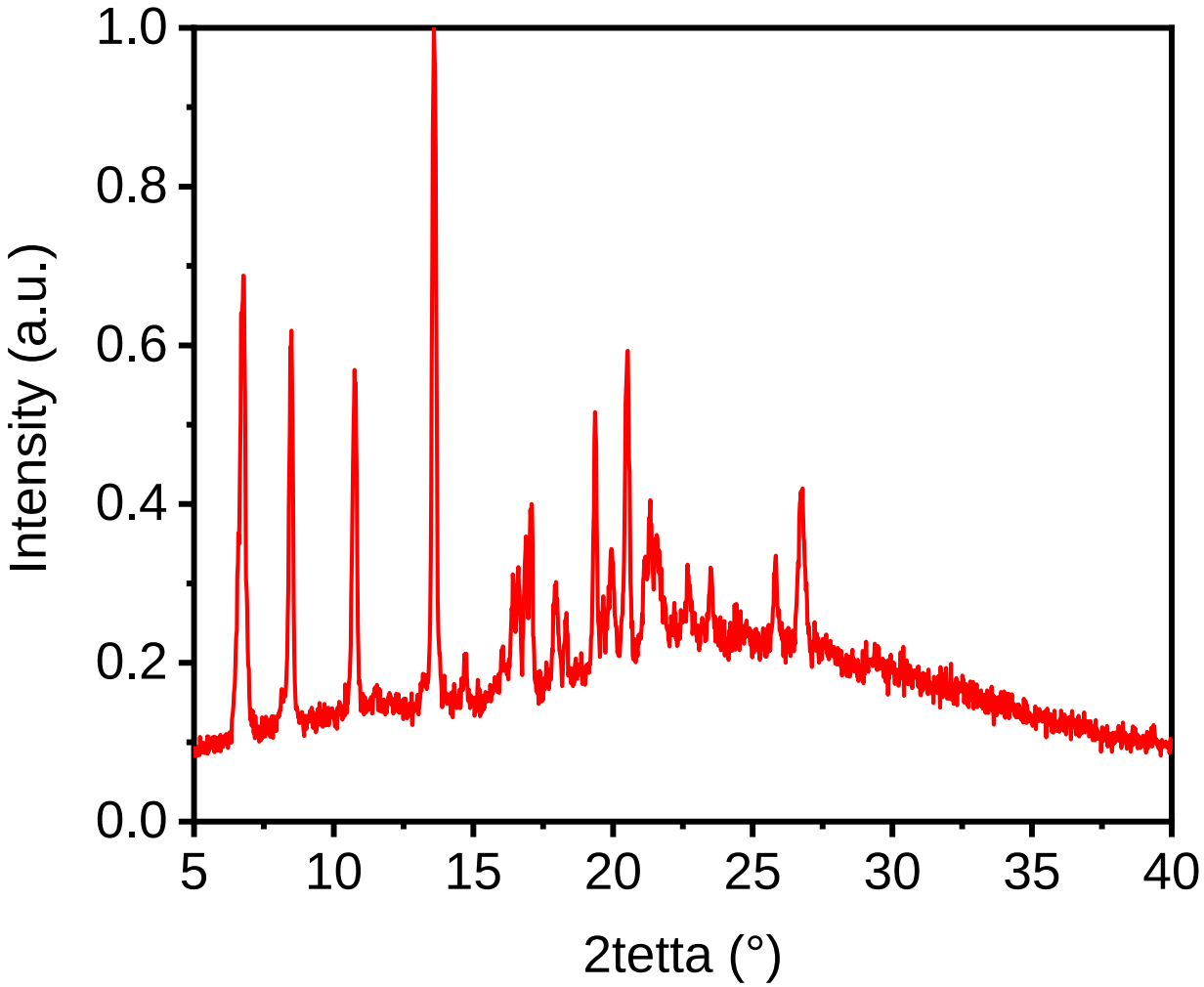
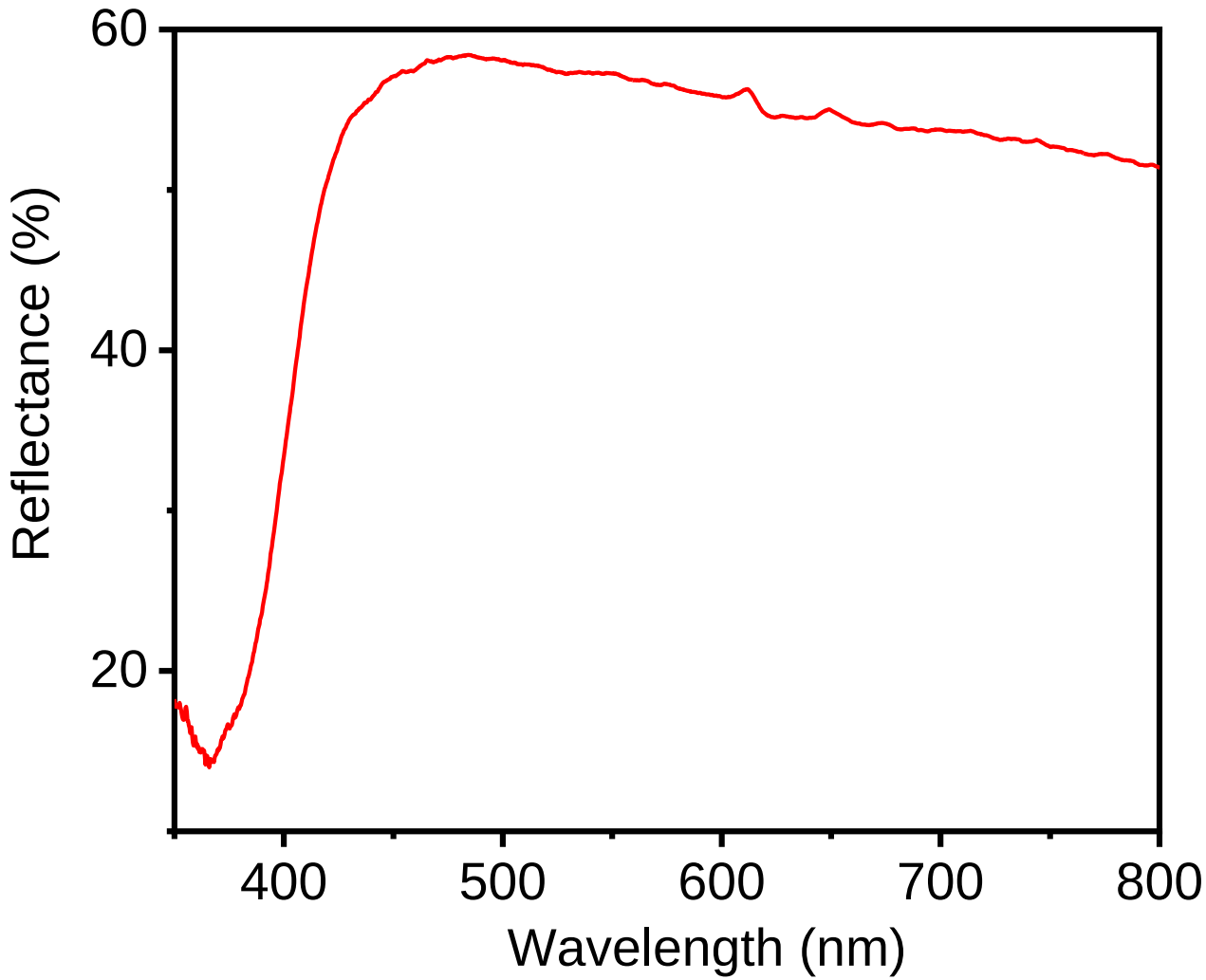
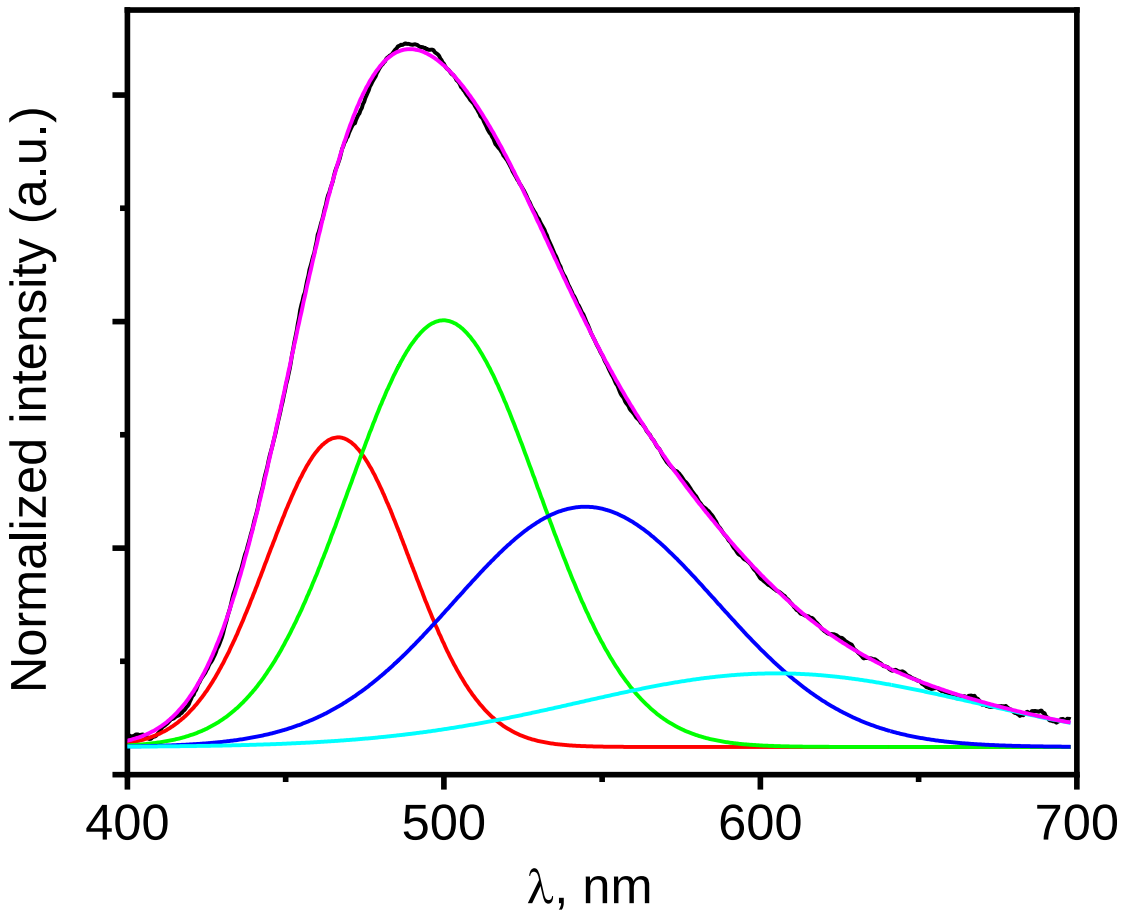
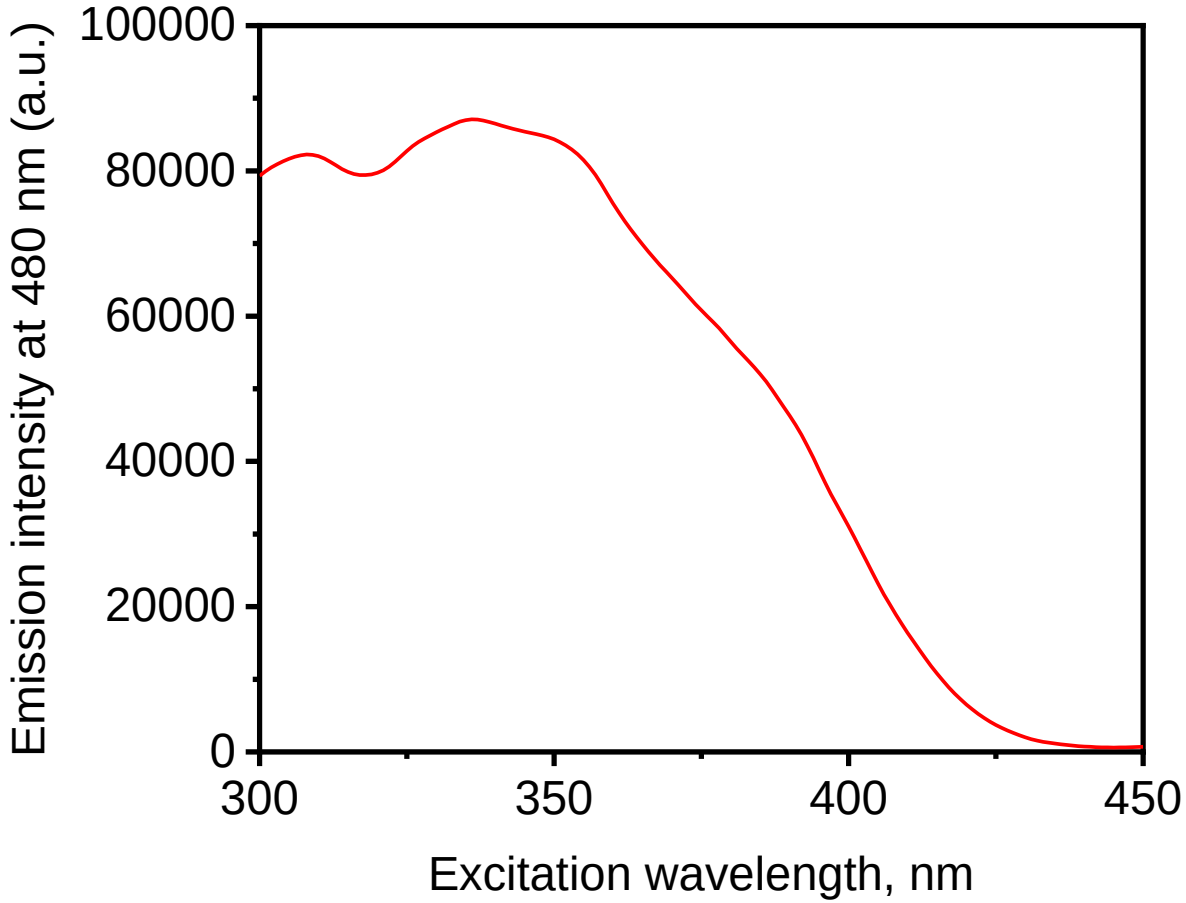
Structure and optical properties



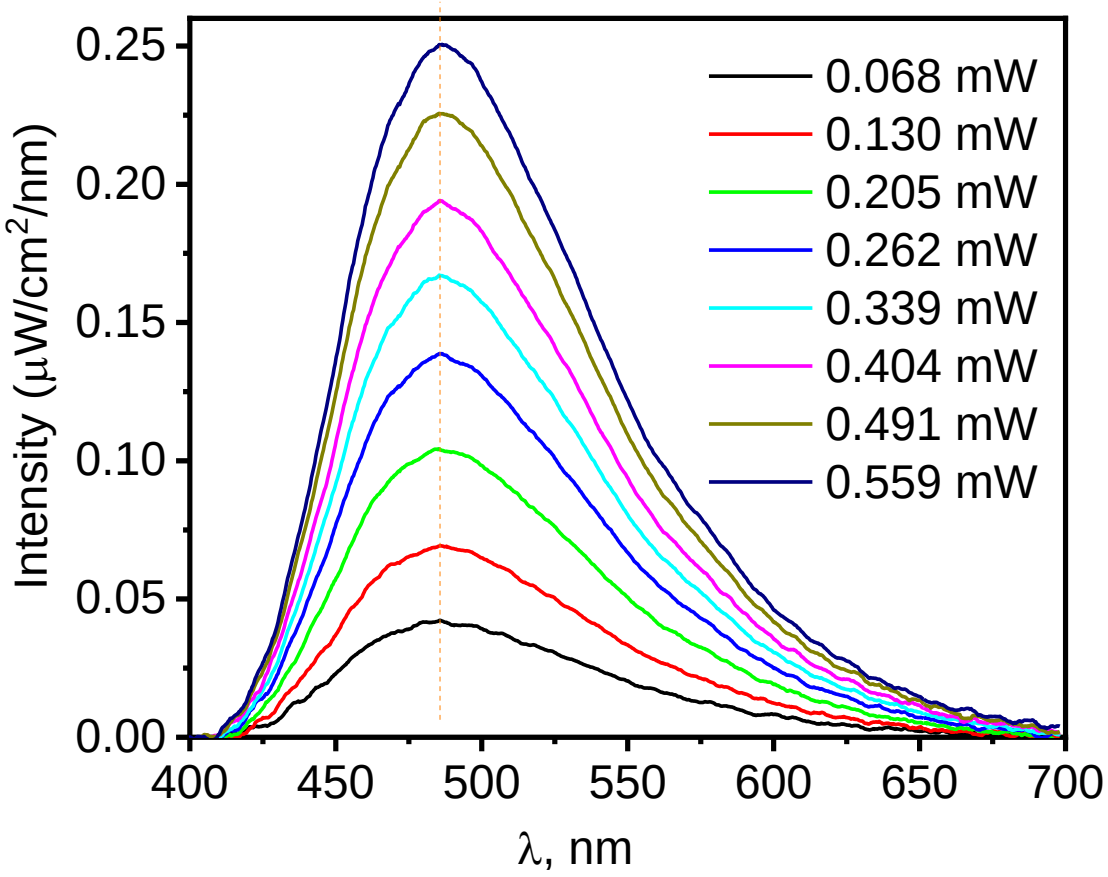


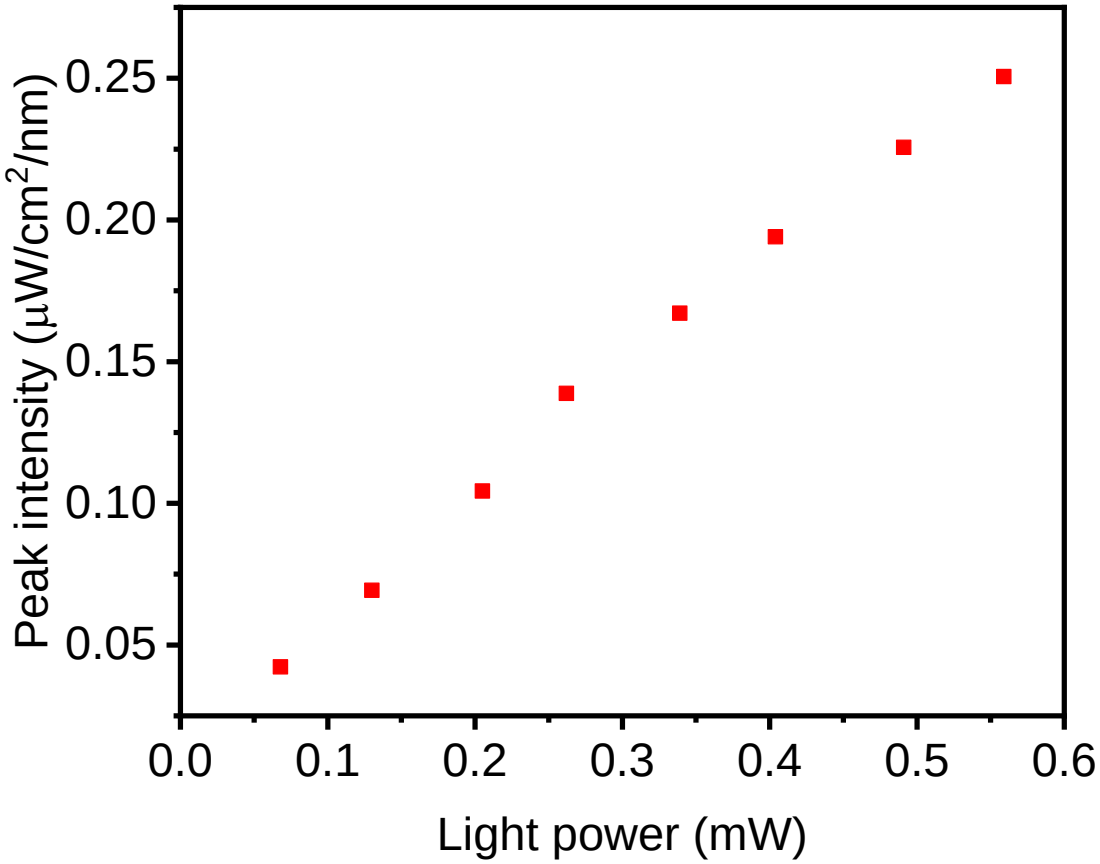
Optical properties



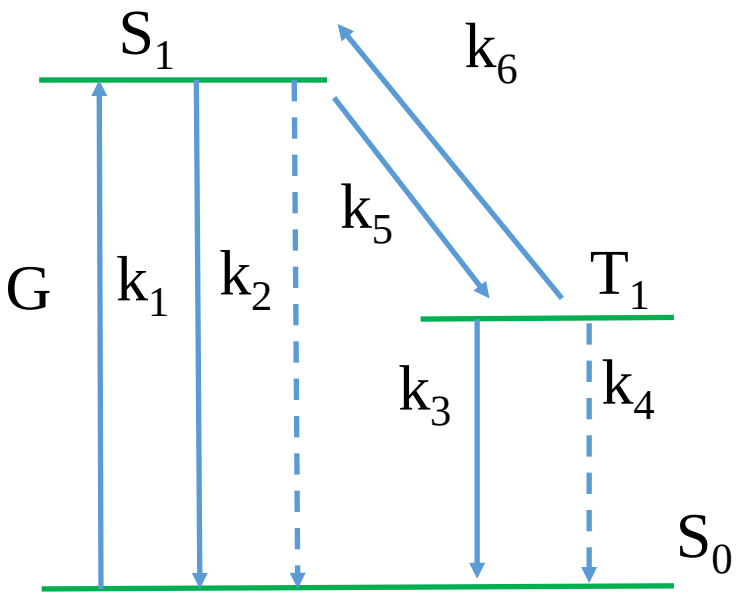


Optical properties





Modelling



- S_0 – ground state, S-singlet and T-triplet states
- transition 0 – photoexcitation with coefficient G ~ excitation power
- transition 1 – emission S→ S_0 with coefficient k_1
- transition 2 – non radiative emission S→ S_0 with coefficient k_2
- transition 3 –emission T→ S_0 with coefficient k_3
- transition 4 – non radiative emission T→ S_0 with coefficient k_4
- transition 5 – non radiative transition S→ T with coefficient k_5
- transition 6 – non radiative transition T→ S with coefficient k_6

$$I = \left(1 + \frac{k_2}{k_1} + \frac{k_5}{k_1} - \frac{k_6 \cdot k_5}{(k_3 + k_4 + k_6) \cdot k_1}\right)^{-1} \cdot G$$

$$k_3, k_4 \ll k_6, k_5 \ll k_1$$

$$I = \left(1 + \frac{k_2}{k_1}\right)^{-1} \cdot G$$

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Systems for drug delivery

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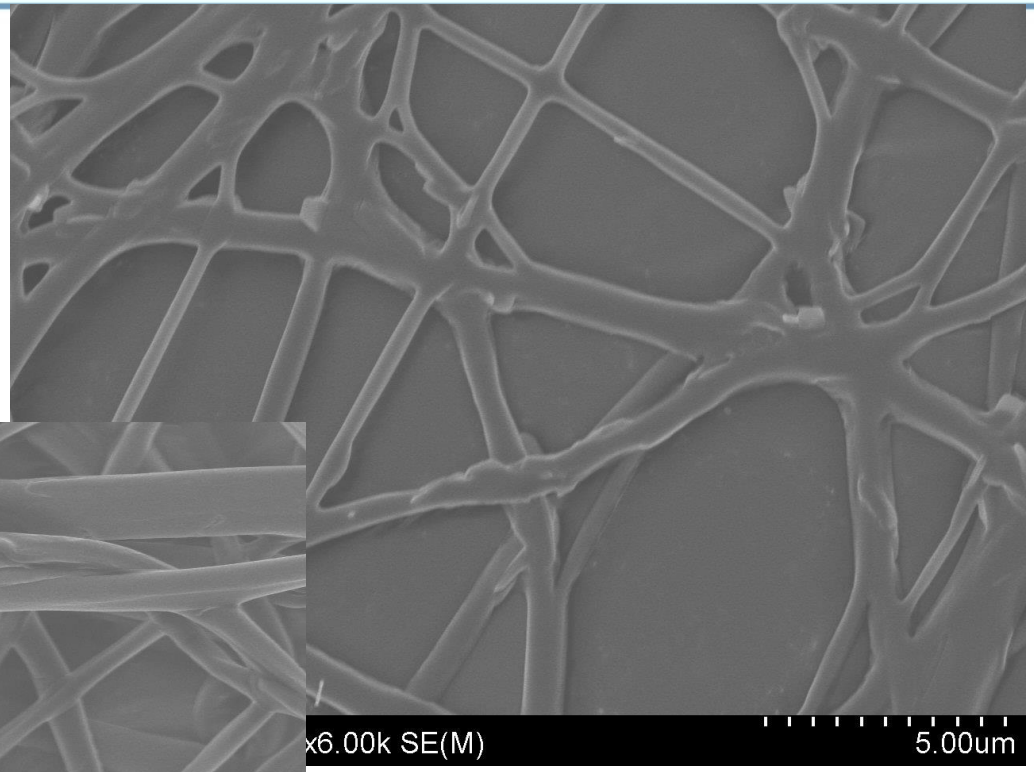
Polymer-drug formulation for nanofiber fabrication: model drug albendazole (ABD)

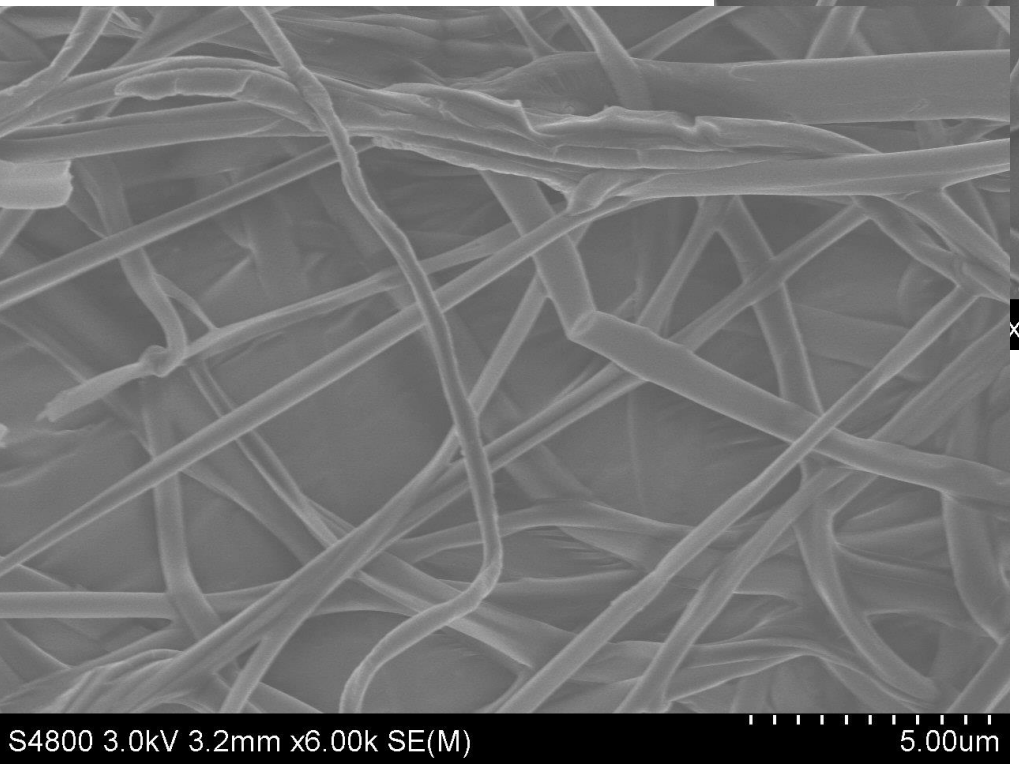
Electrospining formulation

Ethanol + HCl	PVP	ABD	Electrospinning characteristics
990 µl/10 µl	125 mg	25 mg	T = 22.9 °C, H = 10%, d = 12 cm, V = 16.69 kV, 1000 µl/h.
990 µl/10 µl	125 mg	12 mg	T = 23 °C, H = 10%, d = 12 cm, V = 16.73 kV, 1000 µl/h.
990 µl/10 µl	125 mg	5 mg	T = 22.9 °C, H = 10%, d = 12 cm, V = 11.19 kV, 1000 µl/h.

Ethanol + HCl	PVP	ABD	Electrospinning characteristics
980 µl/20 µl	125 mg	50 mg	T = 22.3 °C, H = 10%, d = 12 cm, V = 17.00 kV – 18.00 kV, 1000 µl/h, 800 µl/h.
970 µl/30 µl	125 mg	75 mg	T = 22.6 °C, H = 10%, distance = 12 cm, V = 18.26 kV, 800 µl/h.
960 µl/40 µl	125 mg	100 mg	T = 22.9 °C, H = 10%, distance = 12 cm, V = 18 kV, 800 µl/h.

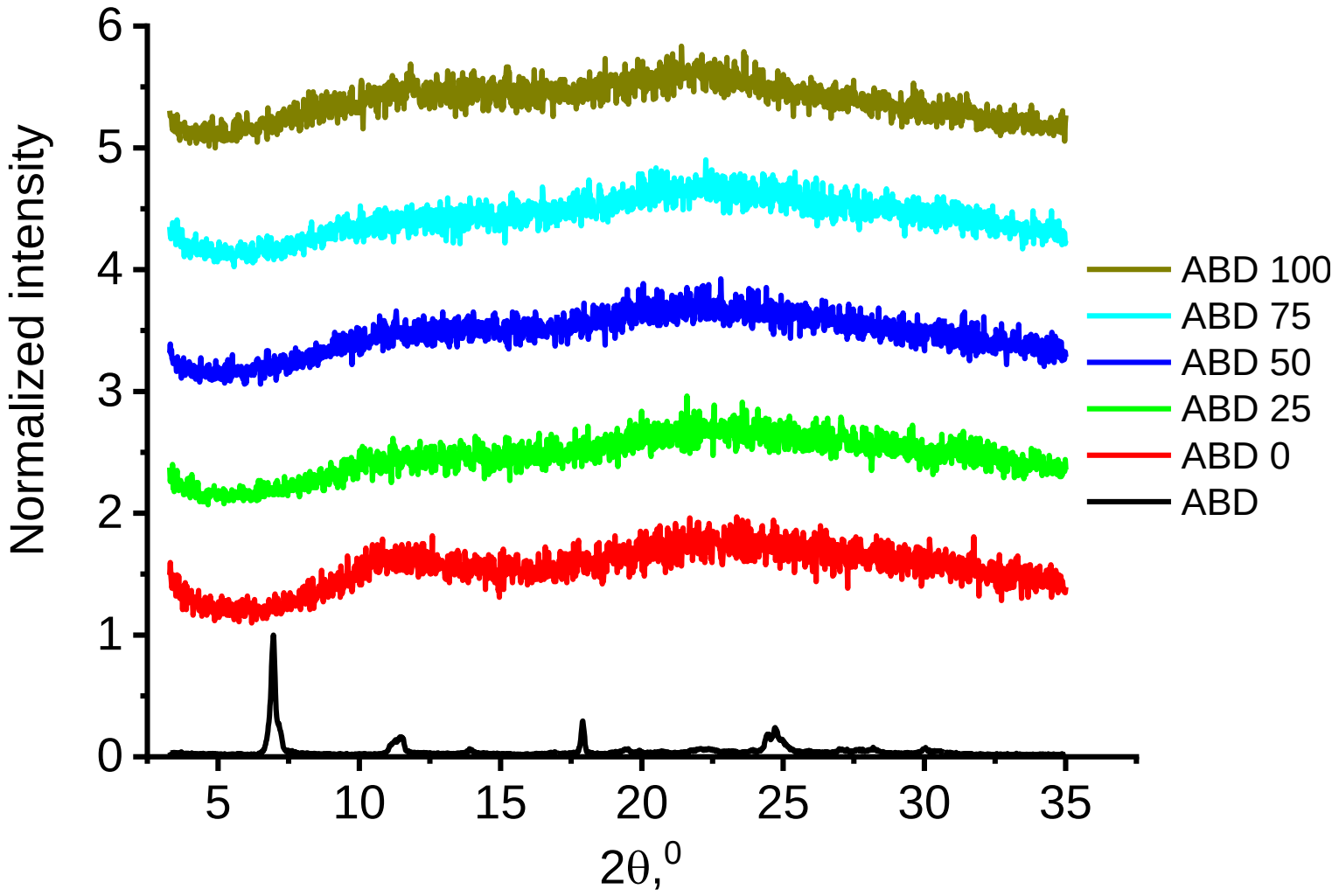
SEM characterization





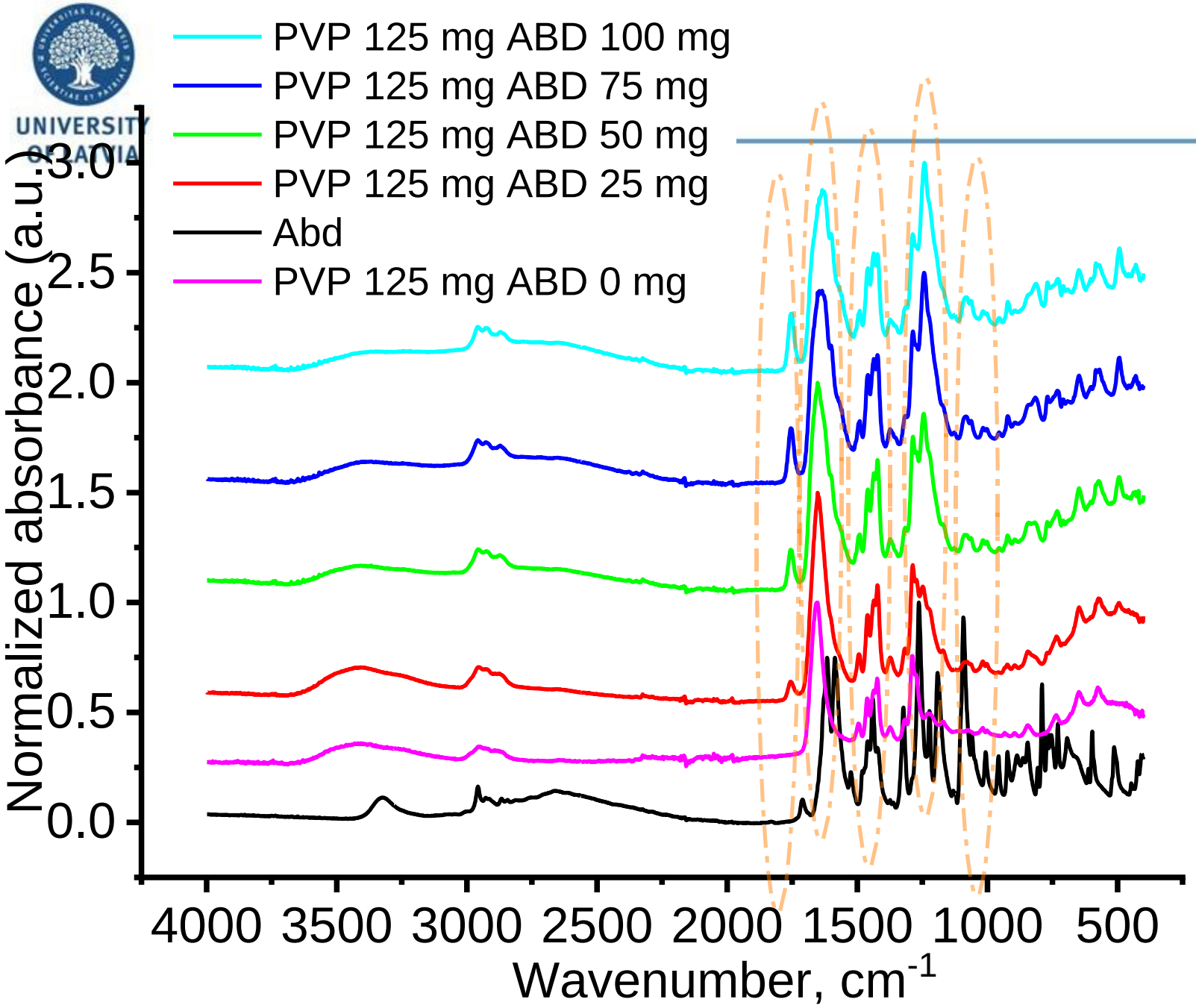
- Au/Cr 5/5 nm deposited on fiber
- Fiber diameter 540±110 nm, Fiber length 20±2 mkm
- No significant difference in fiber properties on abd concentration

XRD characterization



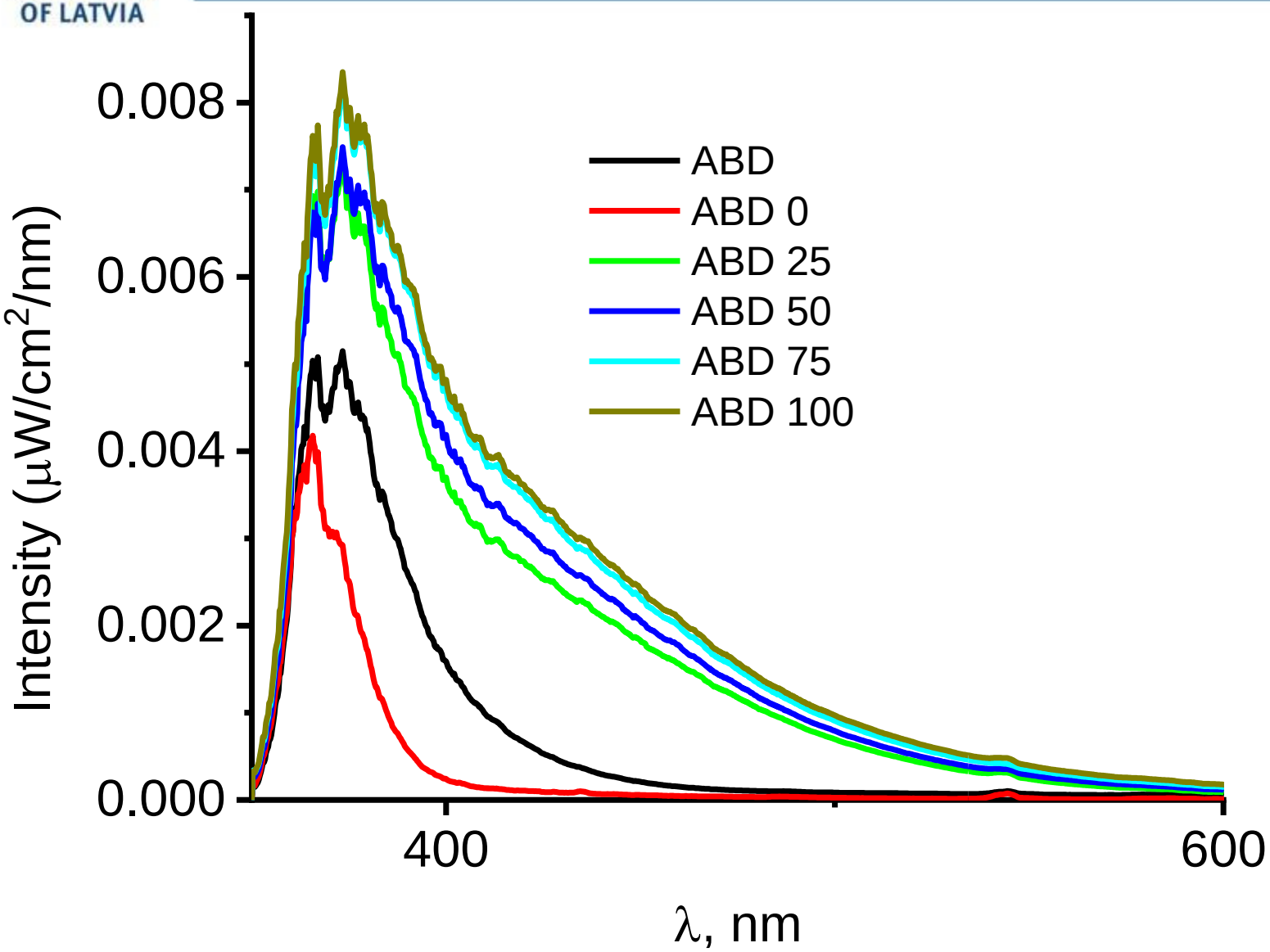
- Crystalline phase of pure ABD
- Amorphous solid dispersion formed
- Stabilization of ASD at high drug load

FTIR



- C=O peak in ABD
- Peak shift from 1714 to 1760 cm^{-1}; Peak shift from 1193 to 1156 cm^{-1}
- New peaks at 1082, 1428, 1608 cm^{-1};
- PVP-ABD interaction

Photoluminescence



- Express method to measure drug load
- Low emission of crystalline ABD
- Enhancement of emission by polymer-drug interaction

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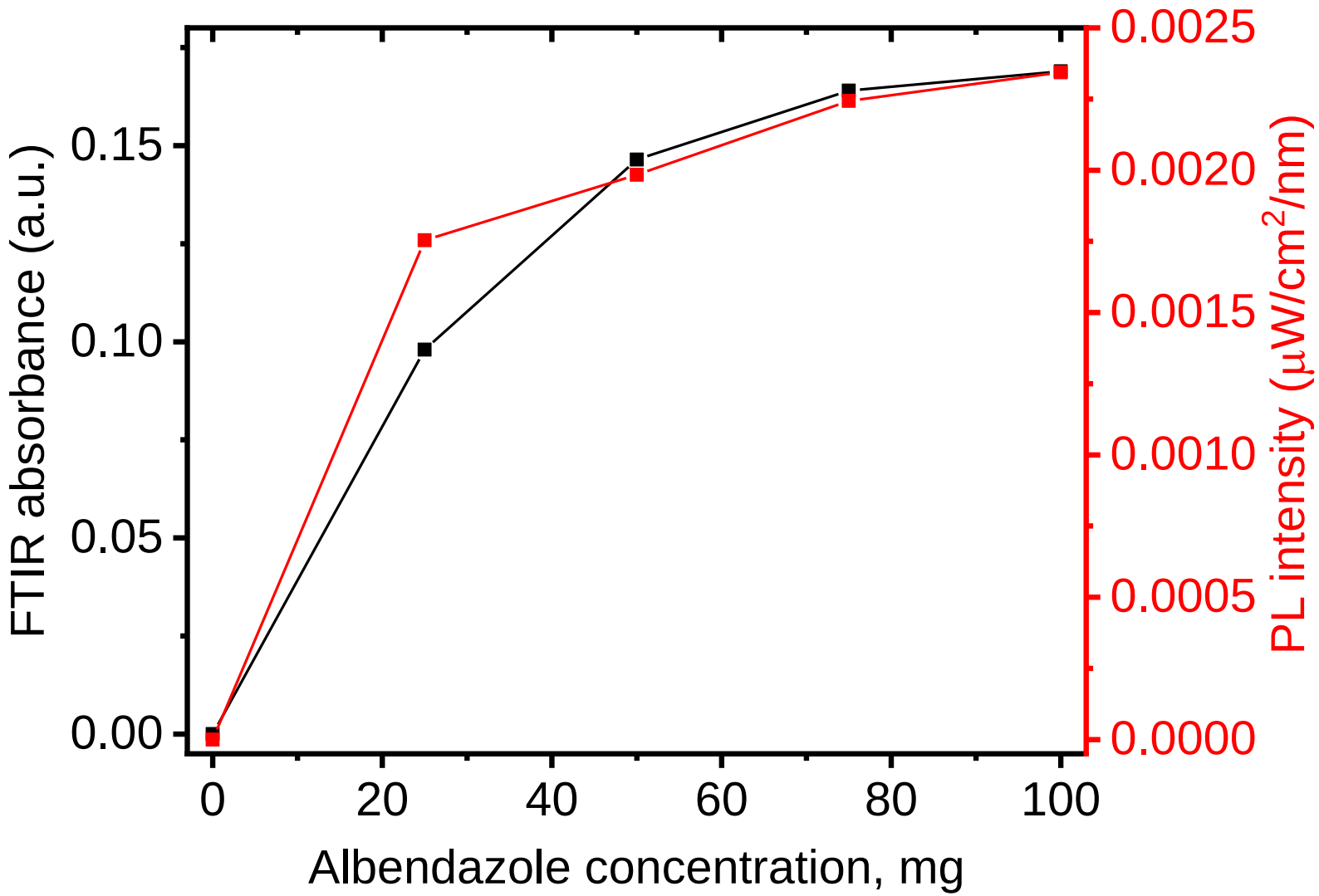
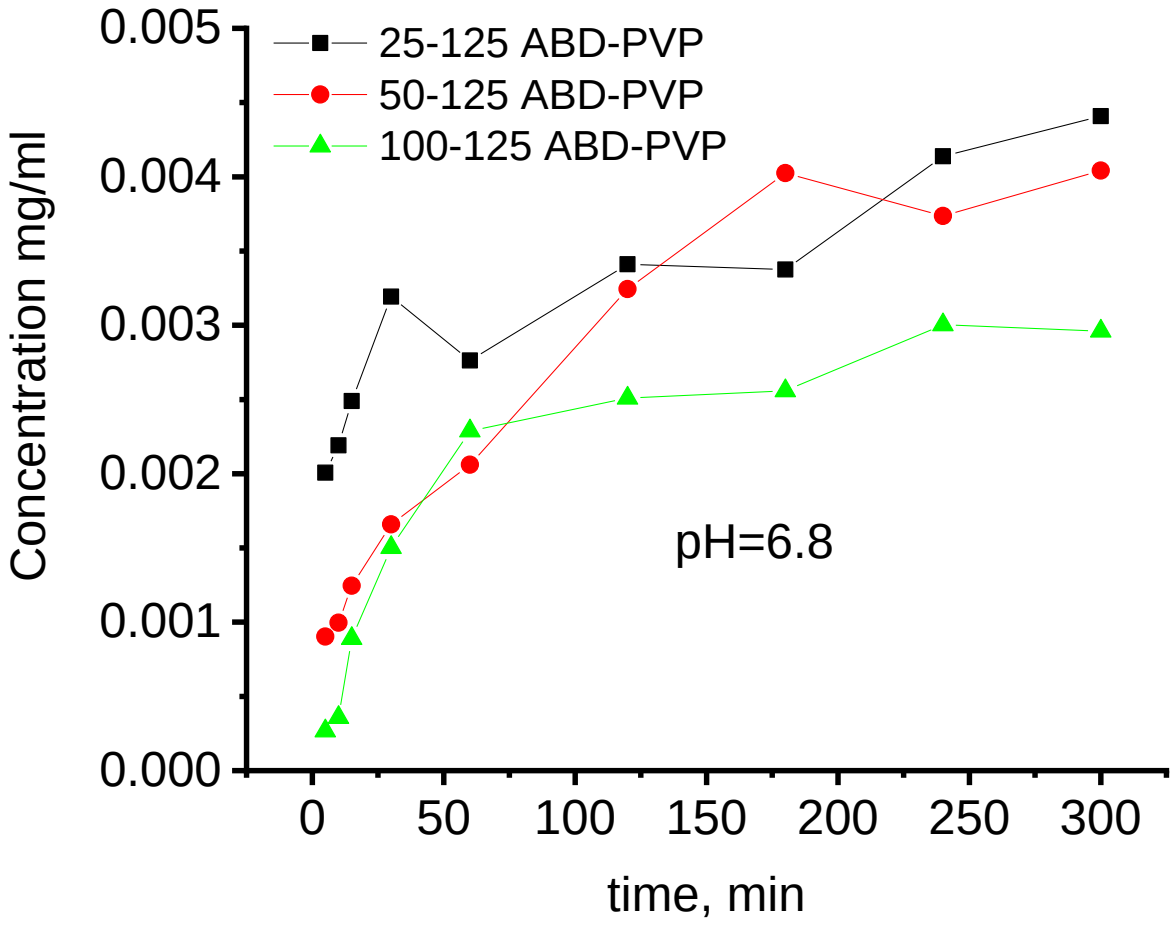
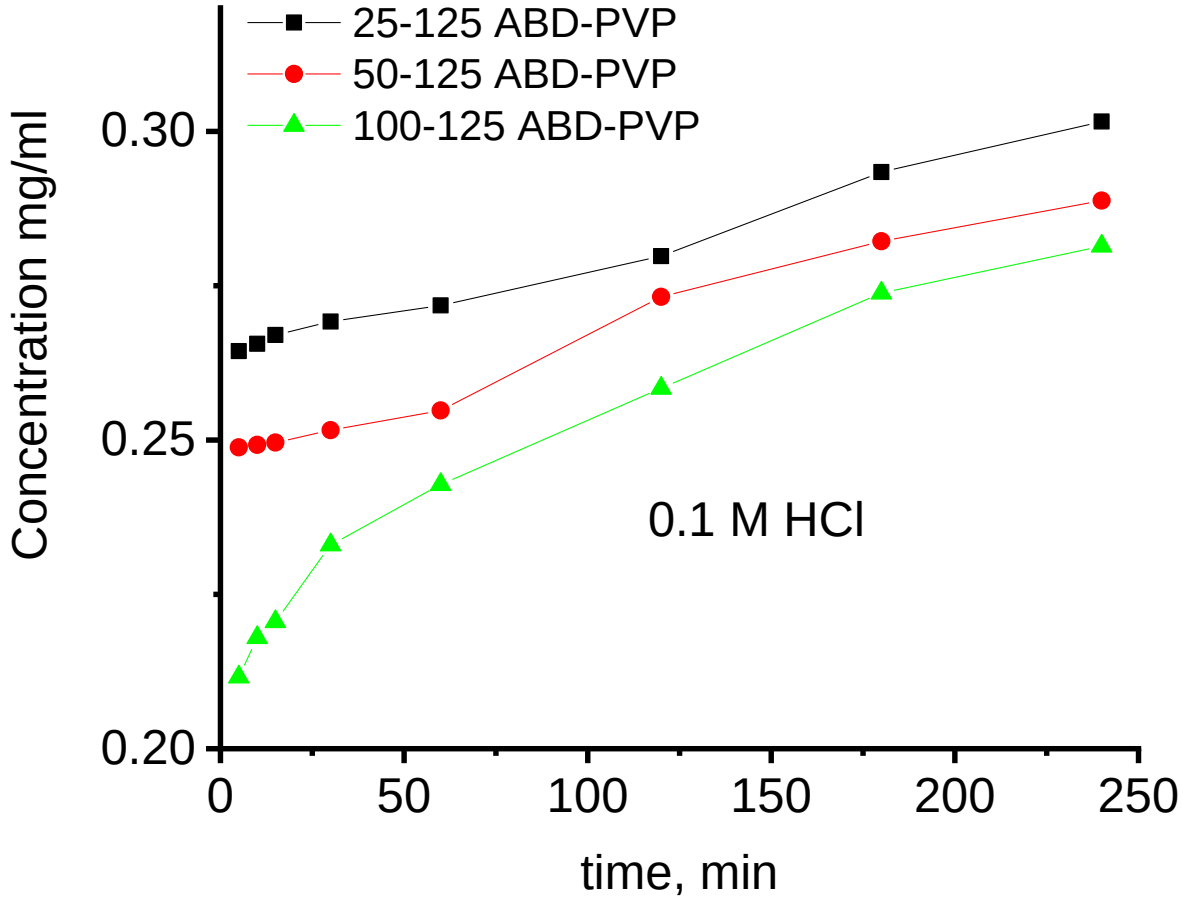
Process control FTIR and PL

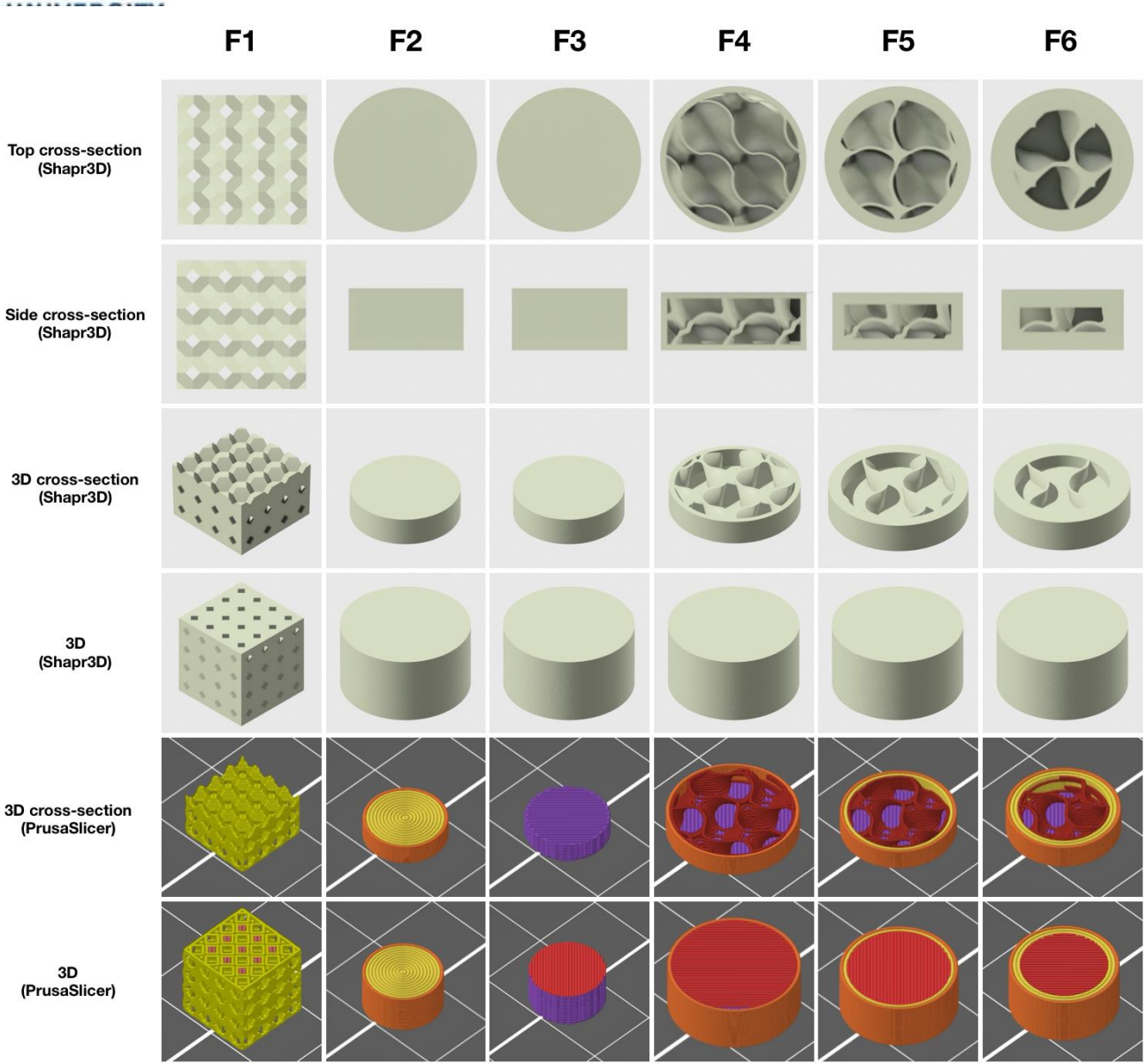


Dissolution





3D printed tablets



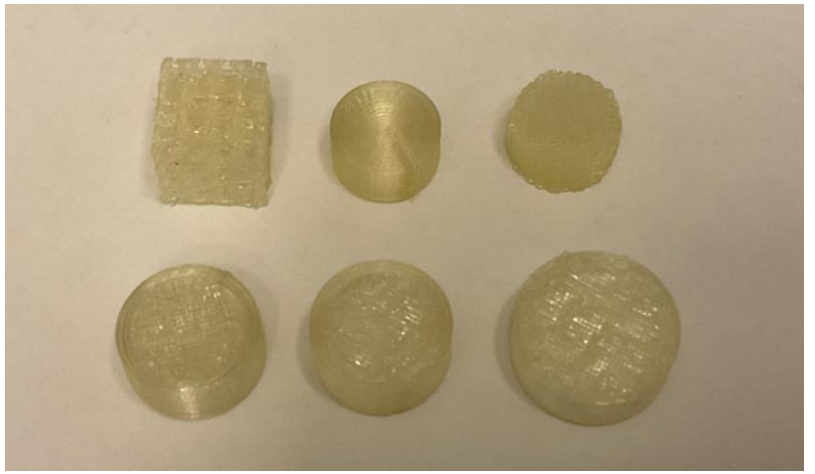
better control of release profile

personalized doses

Scaffold/carrier

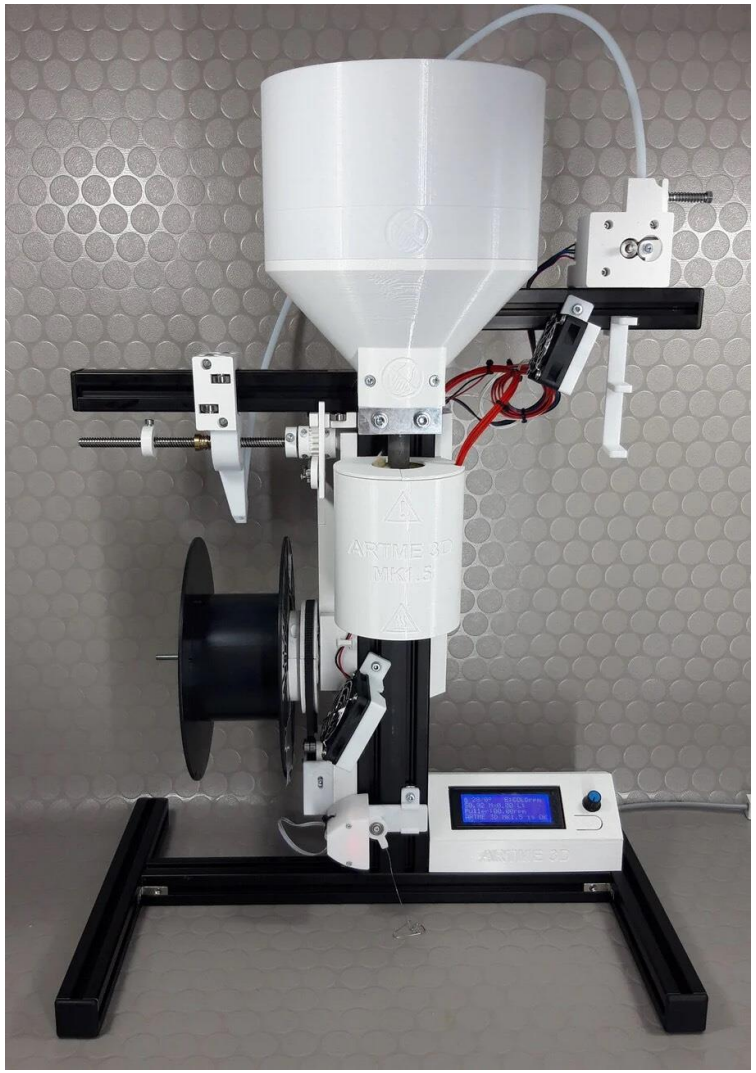
Drug

Polymer matrix



Customized filament making

Filament extruder



hydrophilic

Twin screw extruder

For polymer/drug mixing

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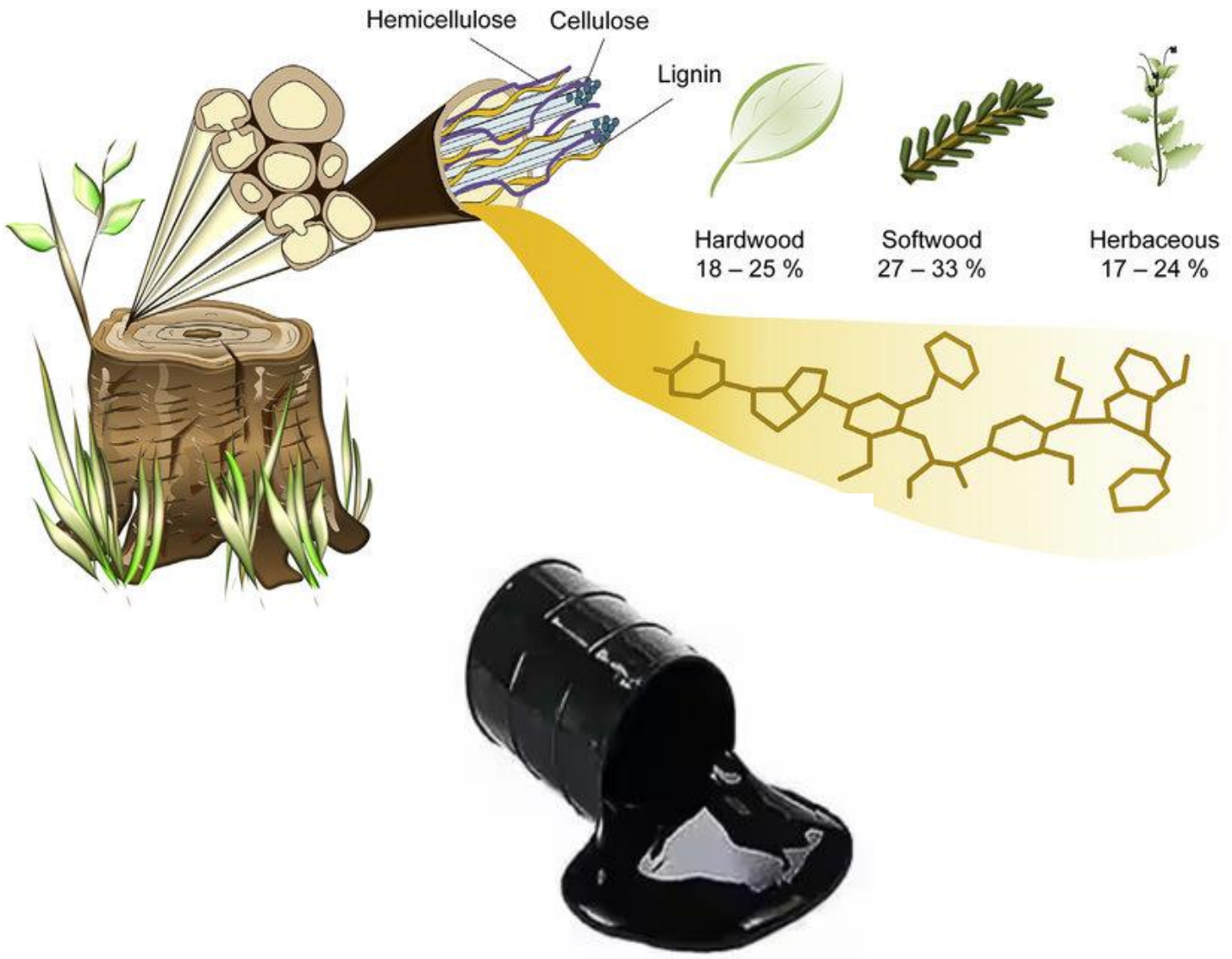
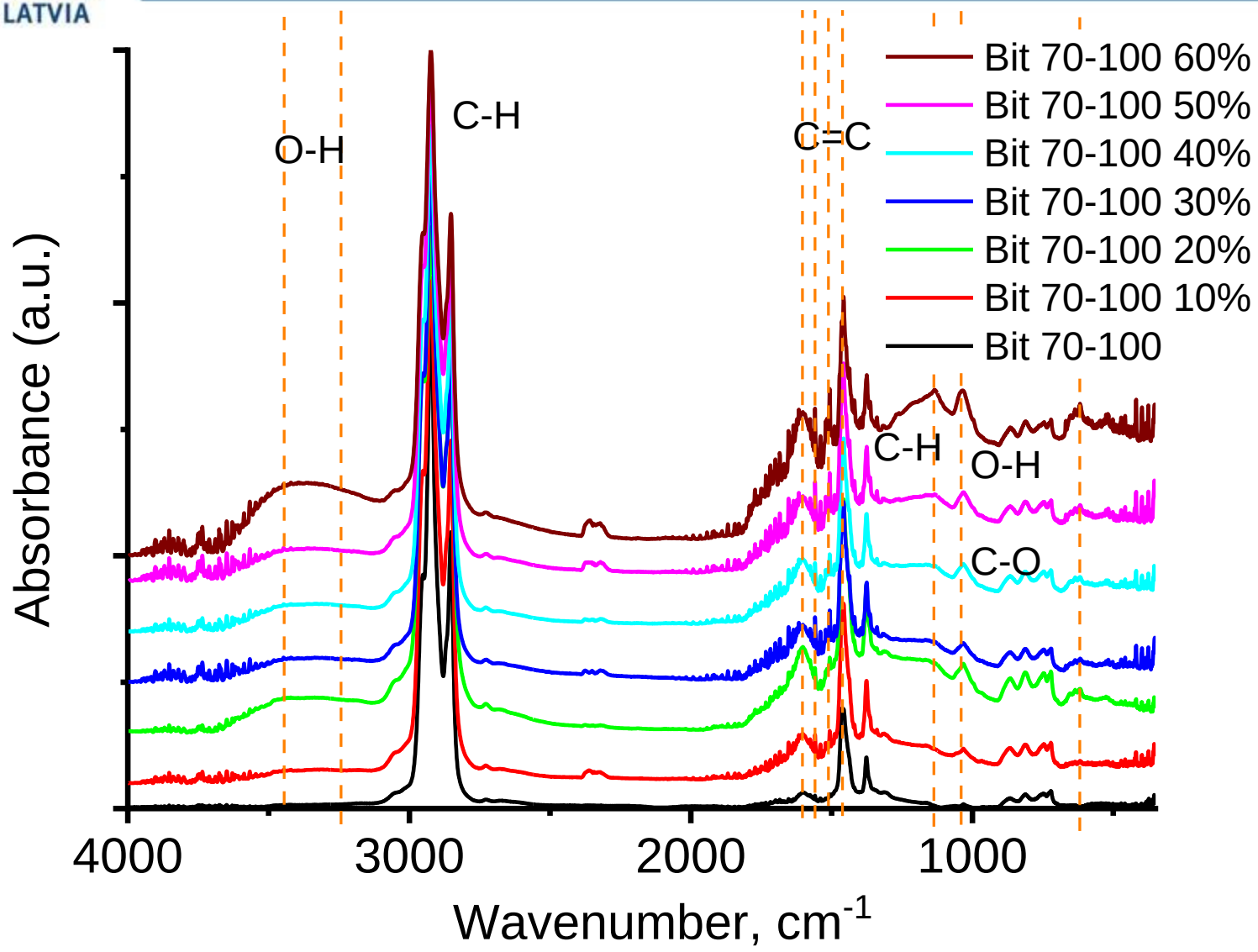
Smart asphalt coating: lignin modified bitumen with advance antioxidative properties

Lignin



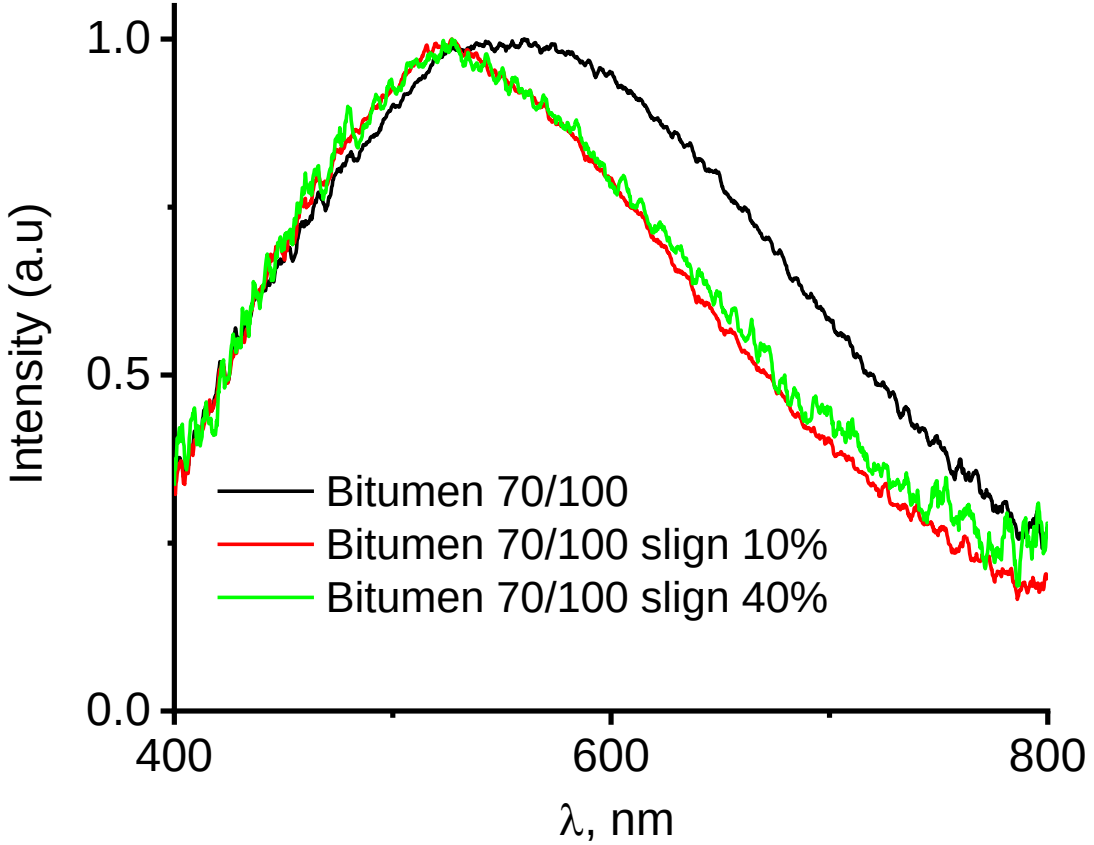
- Wood by product
- Polyphenolic compound
- Anti-oxidative properties

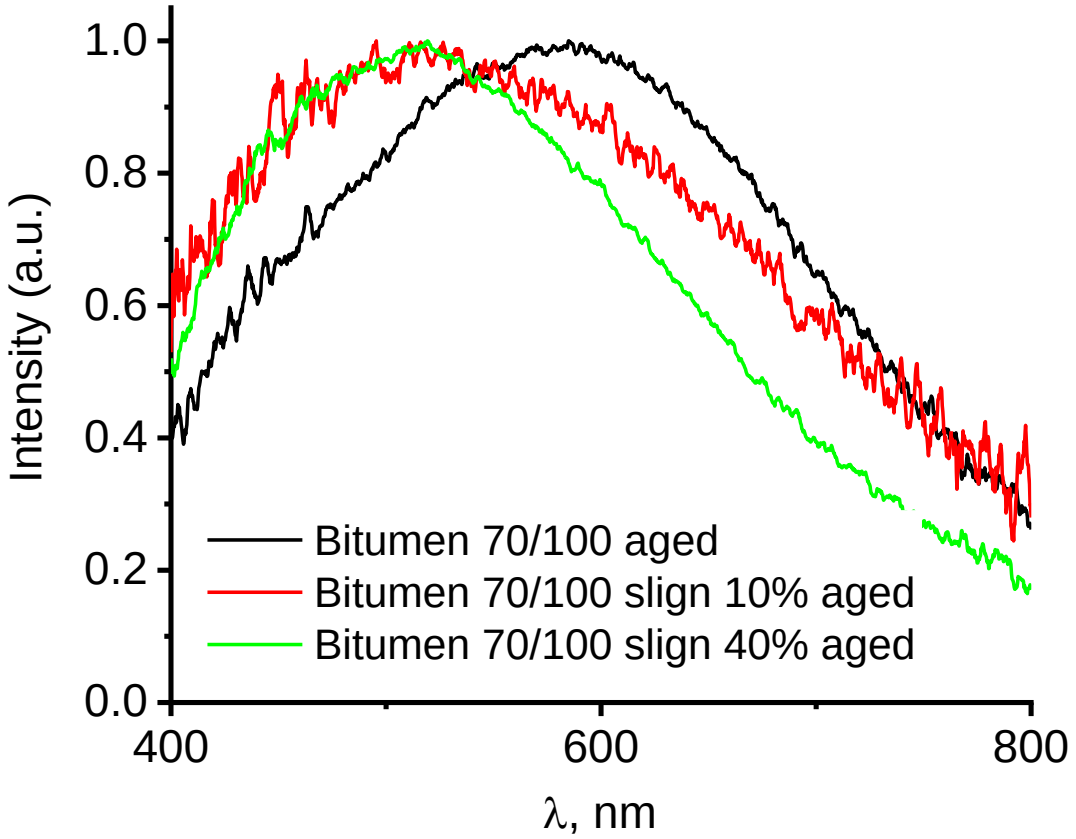
Bitumen-FTIR



- Big changes
- New peaks
- Enhancement of other peaks

Comparison of as prepared and aged samples: photoluminescence





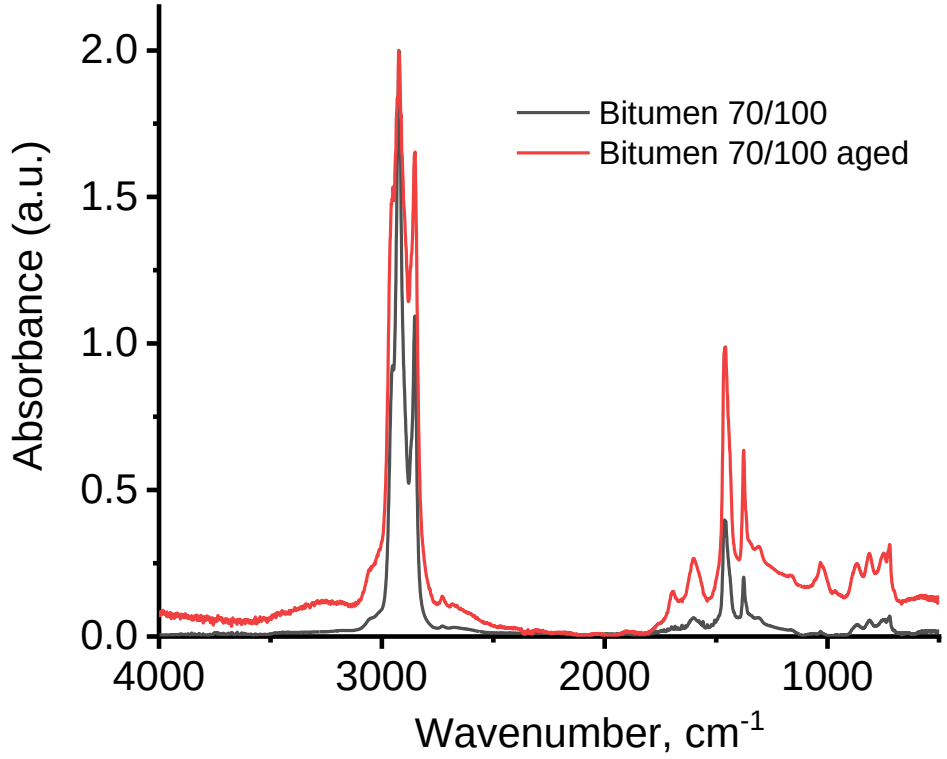
Bitumen was modified with sulfolignin 10 and 40%

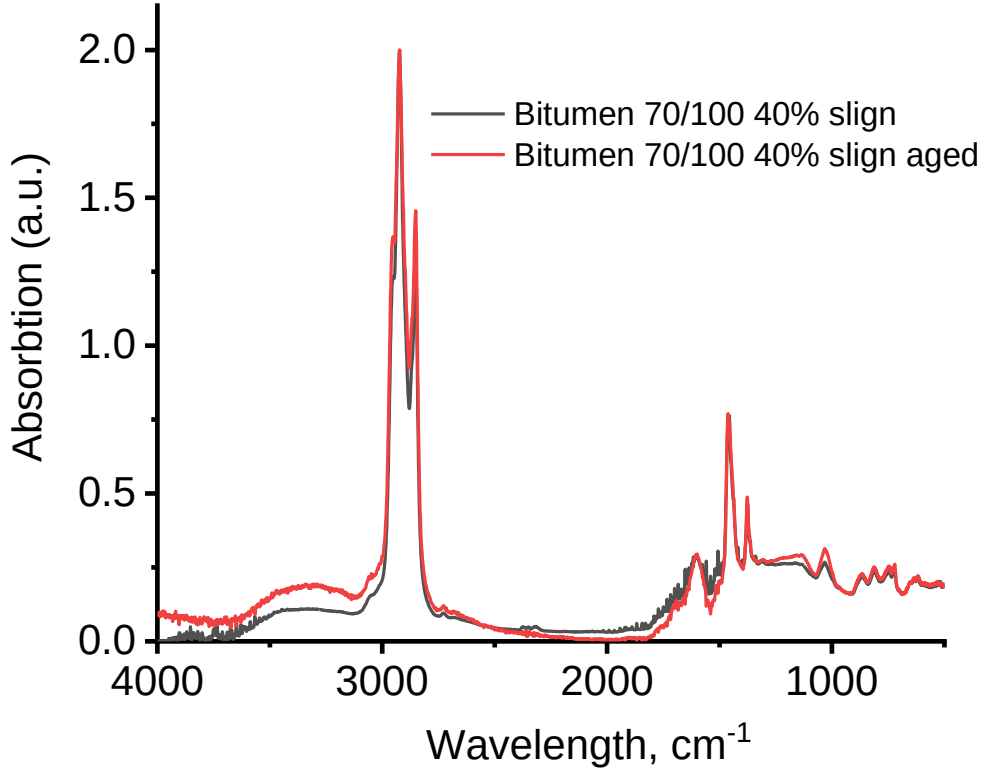
Due to interaction with bitumen absorption in 500-800 nm

Aging of bitumen red shifted PL (25-30 nm)

Higher lignin % - better stability

Comparison of as prepared and aged samples: FTIR





All samples showed increased –OH mode at 3300 cm-1

Pure bitumen spectrum had intense peaks 1700 cm-1, 1600 cm-1 and 1100 cm-1 as products of aging reaction

Peak shift 1430 and 1350 cm-1

Redistribution of peak intensity sp3/sp2 peaks at 2900/2850 cm-1

No drastic changes for Bitumen-lignin

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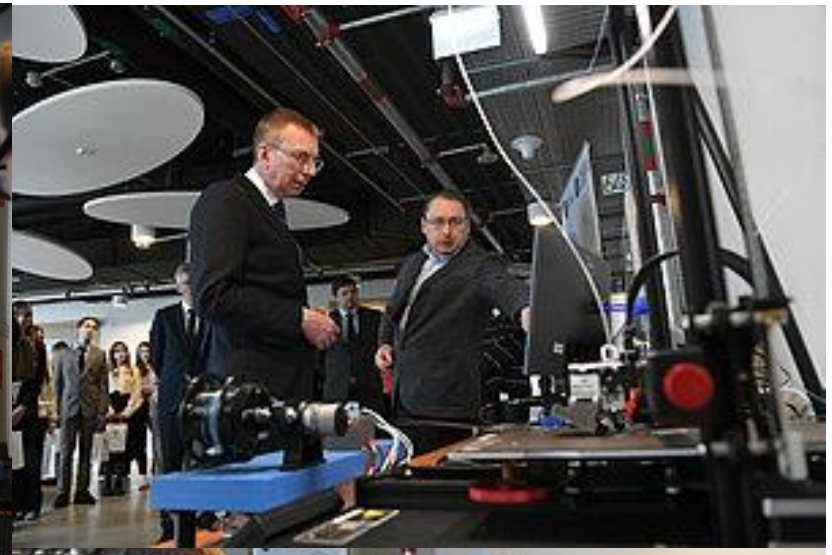
Dissemination and outreach activities

Dissemination



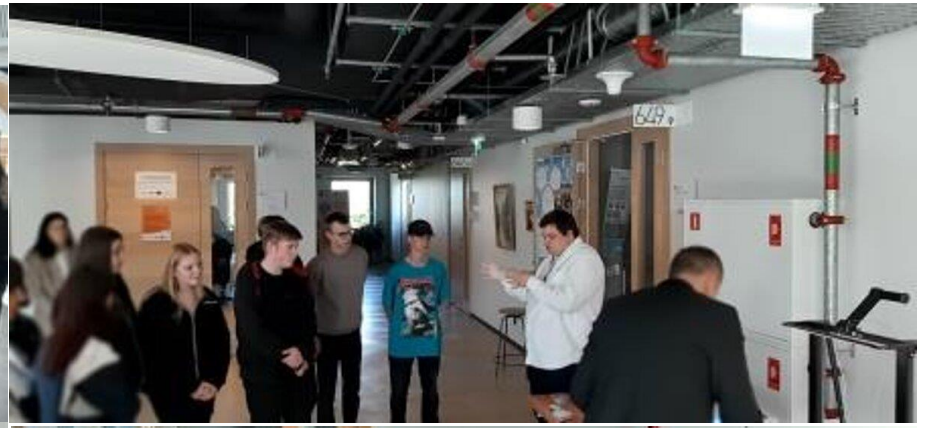
Official visit of President of Latvia
Edgars Rinkēvičs
4 April 2024

Institute of Atomic Physics and Spectroscopy, Riga, Latvia

Composite materials for sensors (LU&NCU) were demonstrated

3D printing for plastic recycling and prototype printing was shown

Dissemination



Visit of Schoolchildren 16 May 2024,

Institute of Atomic Physics and Spectroscopy, Riga, Latvia

Demonstration of optical sensor measurements, 3D printing for prototyping

Dissemination



Researchers night 2024: Dissemination to general public:

27 September 2024 Institute of Atomic Physics and Spectroscopy, Riga, Latvia

-Photochemical sensors, dual-mode of metal ions detection

-Photochemical sensor for detection of gases

- 4D printing and sensor prototyping

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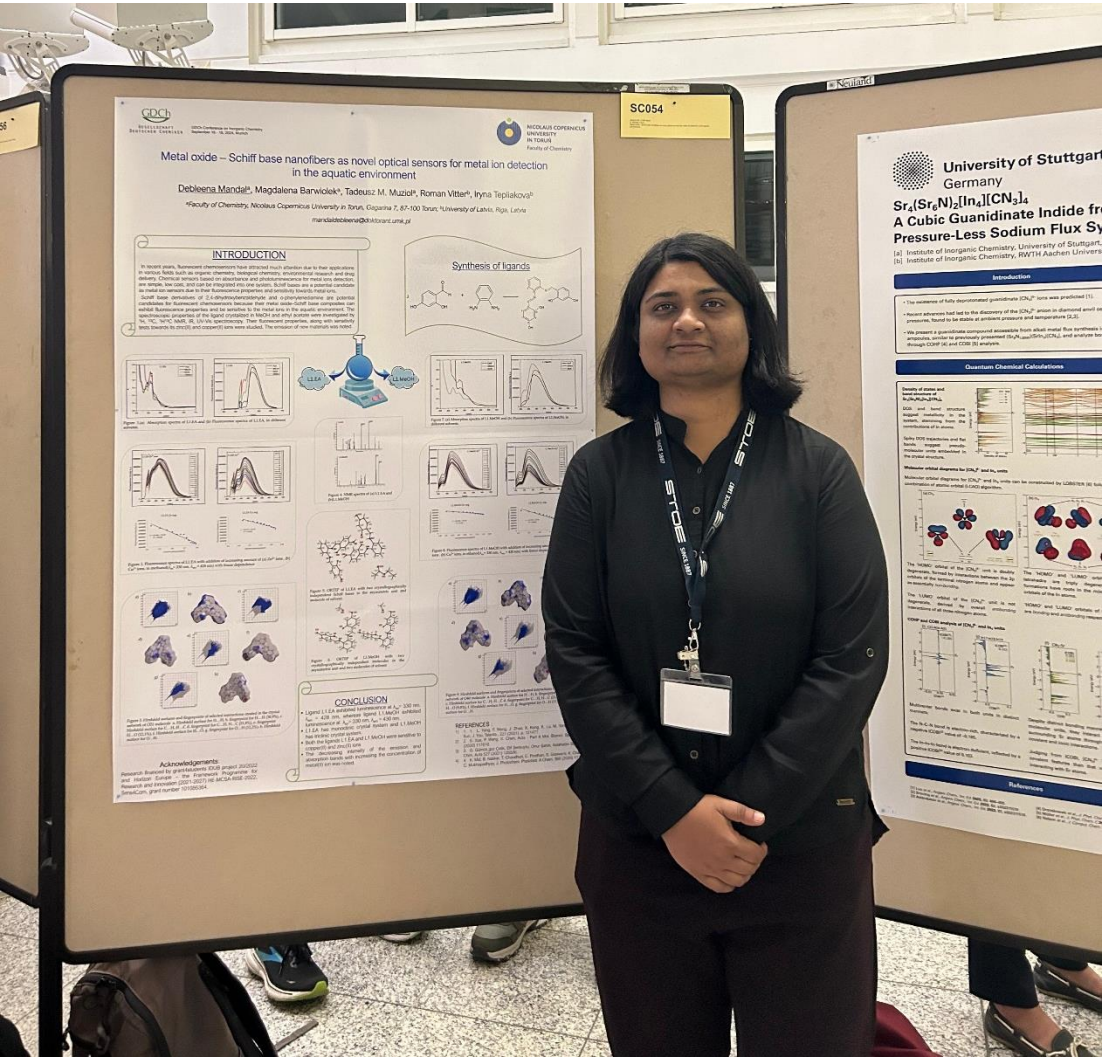
Dissemination



GDCh Conference on Inorganic Chemistry

16-18 August 2024, Munich,Germany

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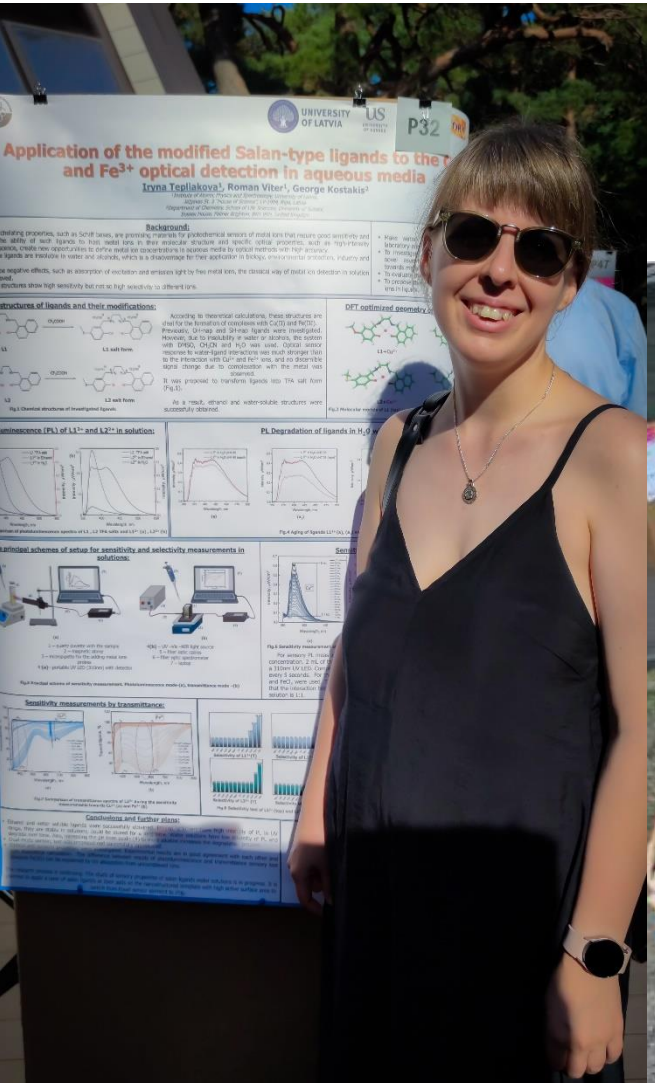
Dissemination

Advanced materials and technology conference (AMT) 2024
26-30 August, 2024, Palanga, Lithuania



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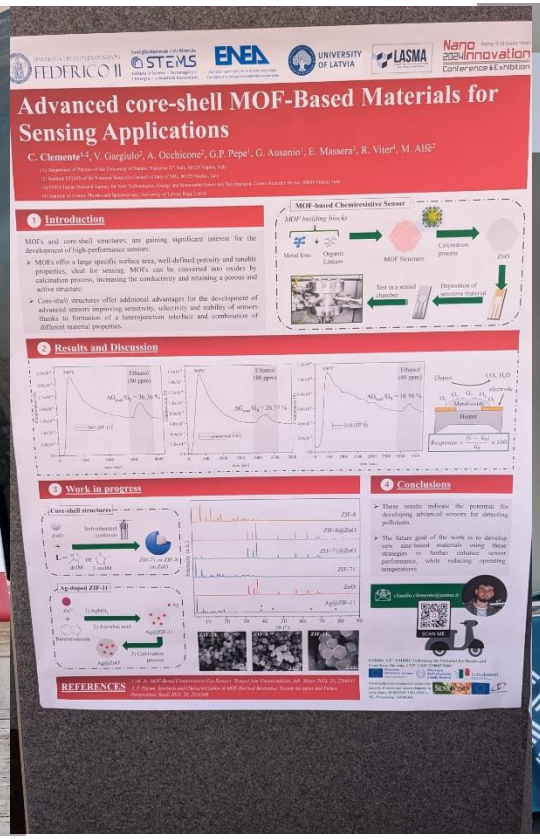
Dissemination

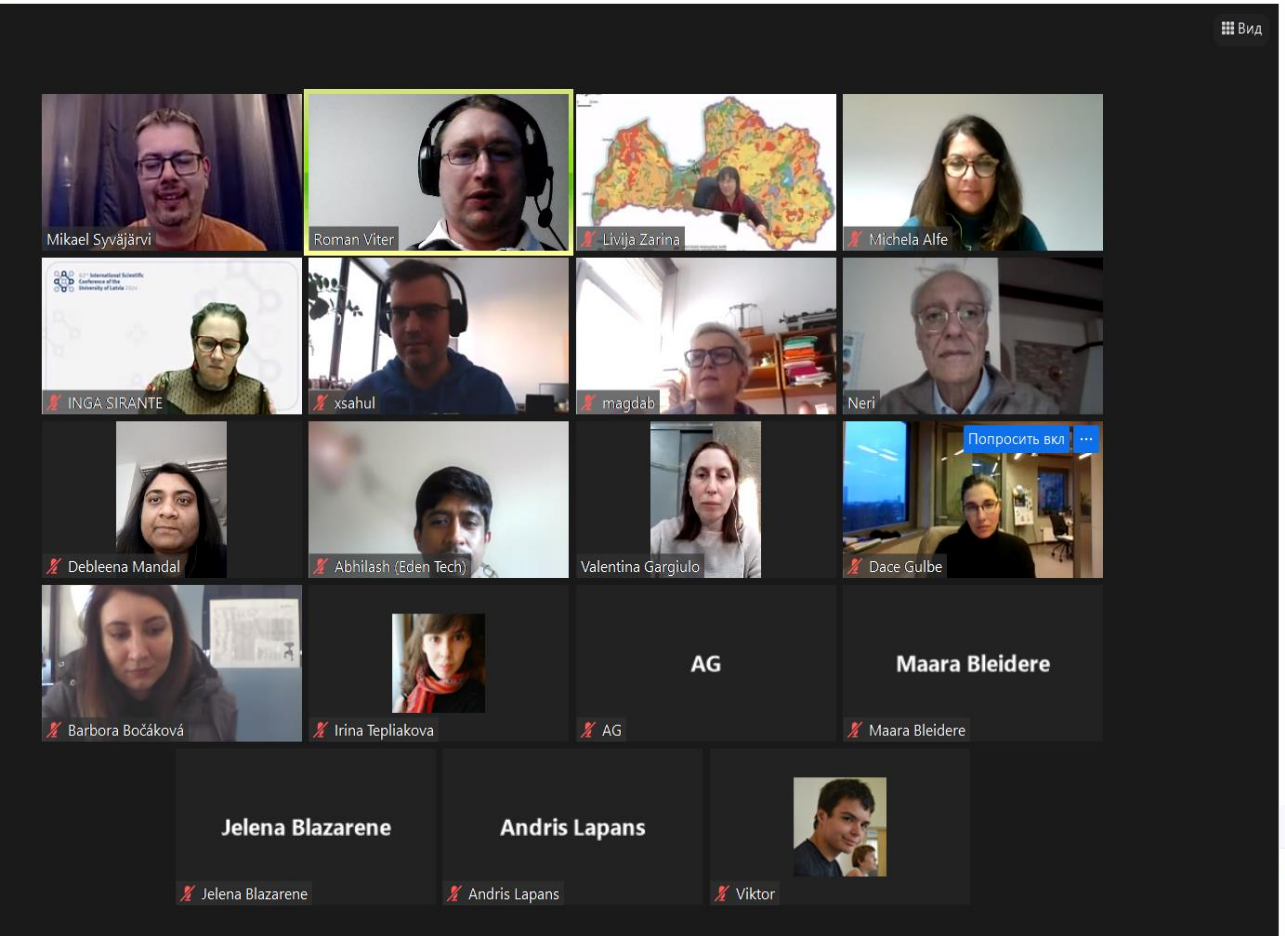
(Nanoinnovation 2024, Rome 9-13 September 2024)



Dissemination

(Nanoinnovation 2024, Rome 9-13 September 2024)

Workshop in Riga 12.02.2024



- Dr. Roman Viter, University of Latvia
- Ms. Iryna Yakymenko, UkraVit, Ukraine
- Prof. George Kostakis, University of Sussex
- Mr. Viktor Zabolotnii (PhD) University of Latvia
- Dr. Michela Alfe CNR, Naples, Italy
- Rayane Zribi, University of Messina, Italy
- Ms. Iryna Tepliakova (PhD) University of Latvia
- Prof. Vincent Noel University Paris Cite, France,
- Dr. Mikael Syväjärvi, Alminica AB, Sweden

International collaboration

- Outgoing secondments: 11
- Hosting of secondments: 20
- Grants: Dr. Roman Viter, visiting accosiate professor at University of Paris Cite, 2-17 May 2024
- PhD thesis evaluation: Dr. Roman Viter, 1 thesis in chemistry (Tallinn Technical University, Estonia) and 1 thesis in chemical engineering (University of Messina, Italy)

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Paldies/
Thank you