BiOrgaMCT

Bioactive Organic and inorganic advanced Materials and Clean Technologies

Funded by the European Union

NextGenerationEU

MINISTRY OF EDUCATION AND SCIENCE

Organic Functional Materials

Part of the project №BG-RRP-2.004-0002, "BiOrgaMCT"

9 October 2025, Sofia

Laboratory of Organic Functional Materials

WP 1 Synthesis of Organic Materials

- *Design of new molecules*
- *Synthesis and purification*
- *Structure elucidation*

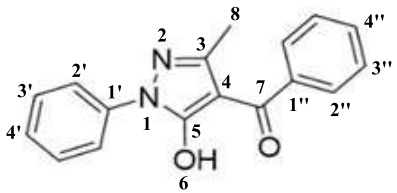
WP 2 Investigation of the Photophysical Properties

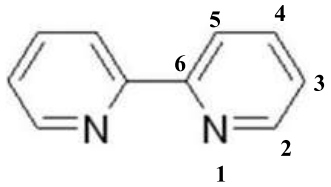
- *Steady-state and transient spectroscopy measurements*
- *Dynamic spectral measurements upon external stimuli*
- *Preparation of 1D and 2D solid-state materials*

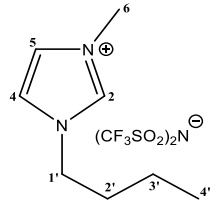
WP 3 Study and Evaluation their Working Functions as Molecular Devices

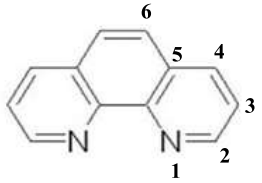
- *Solid-state performance of organic materials (thin films, bulk material, deposition of various substrates)*
- *Investigation microscopic characteristics by TEM, SEM, XRD*
- *Structure-properties relationship evaluation*

SOLVENT EXTRACTION OF METALS WITH FANCY LIGANDS









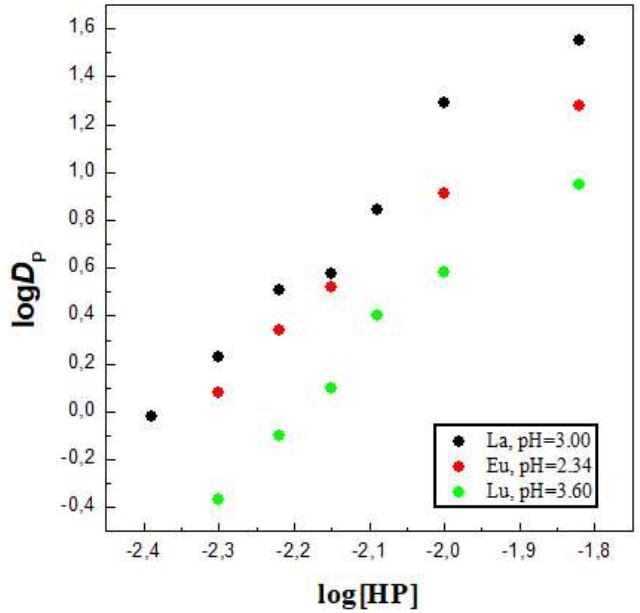
2 > 1 → synergism

$La^{3+}_{(aq)} + 3HL_{IL} + 2S1_{IL} \leftrightarrow La(L)_3(S1)_{2IL} + 3H^+_{(aq)}$,

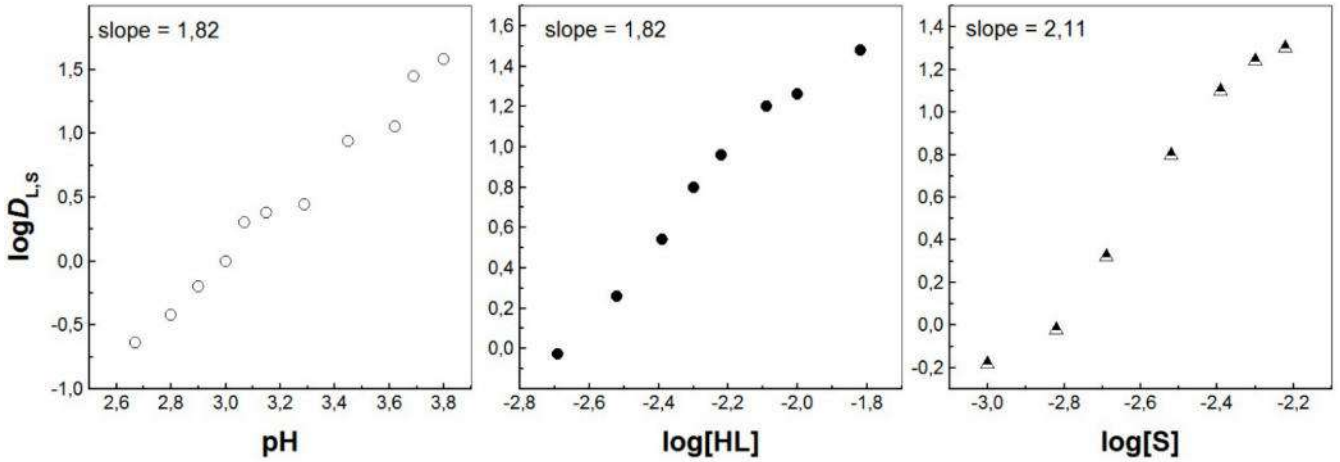
$Eu^{3+}_{(aq)} + 2HL_{IL} + S1_{IL} \leftrightarrow Eu(L)_2(S1)_{IL} + 2H^+_{(aq)}$,

$Lu^{3+}_{(aq)} + 3HL_{IL} + nS1_{IL} \leftrightarrow Lu(L)_3(S1)_{nIL} + 3H^+_{(aq)}$,

Мултифункционално химично моделиране на екстракция с йонна течност на различни метали с различни леганди с цел подобряване на ефективността на процеса и неговата екологичност. Приложен е и нетрадиционен синергентен подход с изследване ефекта на комбинация от два лиганда.



Log D *vs*. log $[HP]_{IL}$ plots at constant pH for La^{3+}, Eu^{3+} and Lu^{3+}) in $[C_1C_4im^+][Tf_2N^-]$.



Log $D_{L,S}$ *vs*. log pH ($[HL]=5\times10^{-3}$ mol/dm^3 and $[S]=3\times10^{-3}$ mol/dm^3), log $D_{L,S}$ *vs*. log$[HL]_{IL}$ ($[S]=3\times10^{-3}$ mol/dm^3 at pH=3) and log $D_{L,S}$ *vs*. log[S] ($[HL]=5\times10^{-3}$ mol/dm^3 at pH=2.78) plots for solvent extraction of La^{3+} with HL–bipy mixture in $[C_1C_4im^+][Tf_2N^-]$.

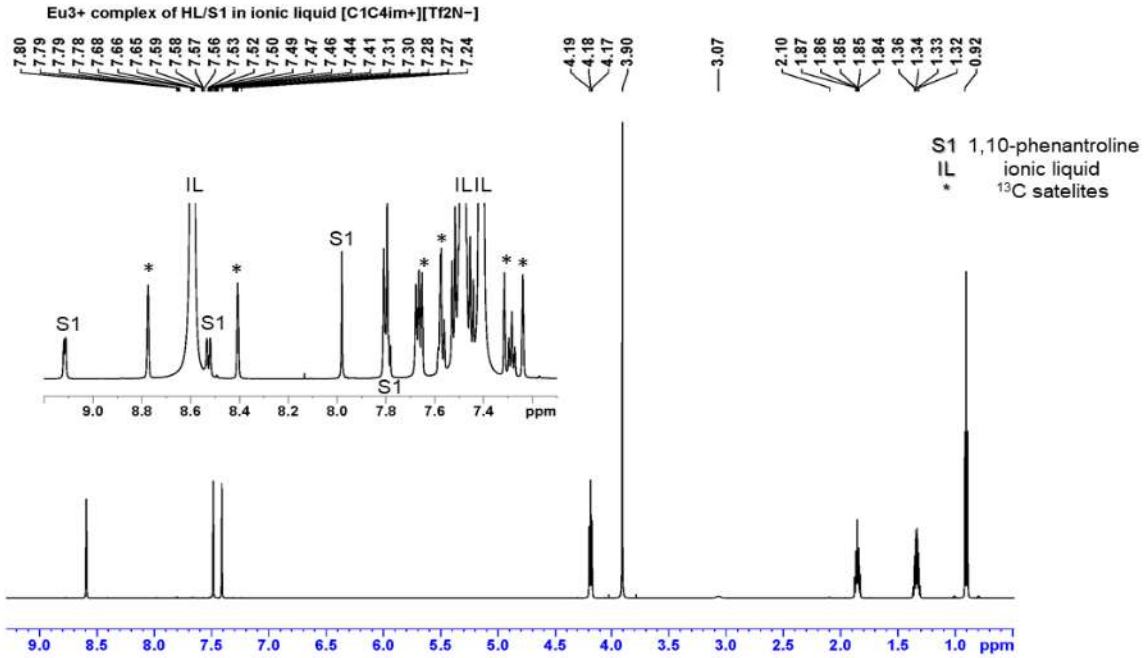
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Li(I)									pH_{eq}= 1.65	IL HP S1 S2 HP−S1 HP−S2				
Na(I)	Mg(II)											Al(III) 3.2% 68.8% 4.5%		
K(I) 6.2% 8.2% 1.6%	Ca(II)	Sc(III)	Ti(IV)	V(V)	Cr(III)	Mn(II)	Fe(III) 15.5% 99.3% 16.9% 16.6% 98.4% 98.2%	Co(II) 100% 100% 100% 99.05%	Ni(II) 89.3% 99.7% 57.4% 99.7%	Cu(II) 1.9% 87.5% 99.8% 99.8% 100% 100%	Zn(II)	Ga(III)		
Rb(I)	Sr(II)	Y(III)	Zr(IV)	Nb(V)	Mo		Ru(III)	Rh(III)	Pd(II)	Ag(I) 99.7% 99.7% 99.7% 99.7% 100% 100%	Cd(II)	In(III)		
Cs(I)	Ba(II)	Ln(III)	Hf(IV)	Ta(V)	W(VI)	Re(VII)	Os(IV)	Ir(III)	Pt(IV)	Au(III)	Hg(II) 17.2% 11.2% 86.6% 28.9% 70.5% 35.9%	Tl(I)	Pb(II) 21.09% 4.2% 4.0% 3.09% 3.9% 1.5%	Bi(III) 99.8% 99.8% 99.8% 99.8% 100% 100%

Ln(III)													
La(III) 4.3% 1.05% 4.07% 6.0%	Ce(III) 8.3% 1.9% 7.04% 8.3%	Pr(III)	Nd(III)	Sm(III)	Eu(III) 39.07% 1.5% 44.6% 44.3%	Gd(III)	Tb(III)	Dy(III)	Ho(III)	Er(III)	Tm(III)	Yb(III)	Lu(III) 42.6% 1.9% 49.7% 48.4%

Solvent extraction performance of IL, HL ($1 \acute{I} 10^{-2}$ mol/dm^3), S1 and S2 ($8 \acute{I} 10^{-3}$ mol/dm^3) ligands diluted in $[C_1C_4im^+][Tf_2N^-]$ and as well as the two mixtures (HL−S1 and HL−S2: $1 \acute{I} 10^{-2}$ mol/dm^3 – $5 \acute{I} 10^{-3}$ mol/dm^3) for 22 metal ions

J. Mol. Liq. 415 (2024) 126332. Q1
Molecules 30 (2025) 786. Q2

Понастоящем ролята на лигандите е научно изследвана поотделно и в контекста на един метал или една група метали, но без постигане на глобална картина и универсалност. Предложен е подход за екстракция „моментна снимка“, който е в рамките на екологична и устойчива химия, а и също ефективен прийом в контекста на зелена индустрия с нулев отпадък.



^{1}H NMR spectrum of Eu^{3+} complex of **HL/S1** in $[C_1C_4im^+][Tf_2N^-]$ obtained during solvent extraction process, **without any dilution of the organic phase with an organic (deuterated) diluent**.

Light-driven self-sterilizing cotton fabric and drug delivery

Photochemical & Photobiological Sciences
https://doi.org/10.1007/s43630-025-00710-1

ORIGINAL PAPERS

Light-driven self-sterilizing cotton fabric and drug delivery: improvement of the antimicrobial activity of 4-sulfo-1,8-naphthalimide via its dendrimer and metallic dendrimer formation

Desislava Staneva[1] · Awad I. Said[2,3] · Petar Grozdanov[4] · Ivanka Nikolova[4] · Radostina Stoyanova[5] · Albena Jordanova[2] · Ivo Grabchev[2]

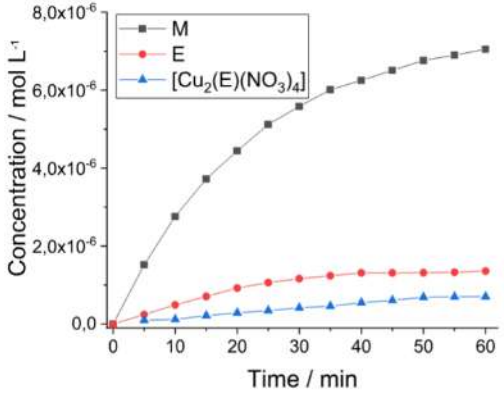


Figure. The release of monomer M, dendrimer E, and metallodendrimer $[Cu_2(E)(NO_3)_4]$ from the cotton fabric in a phosphate buffer with pH=7.4 at 37 °C

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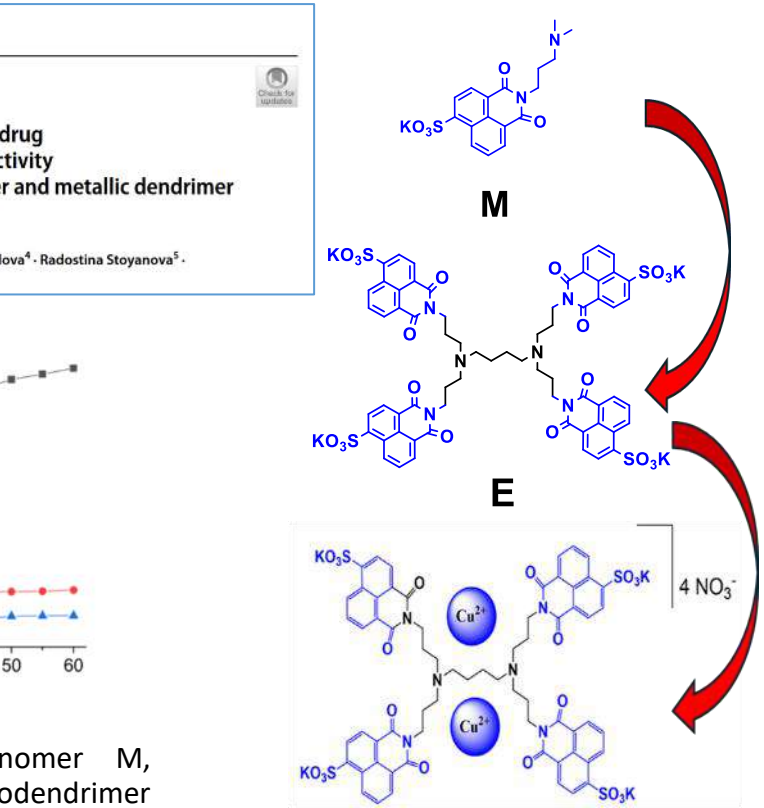
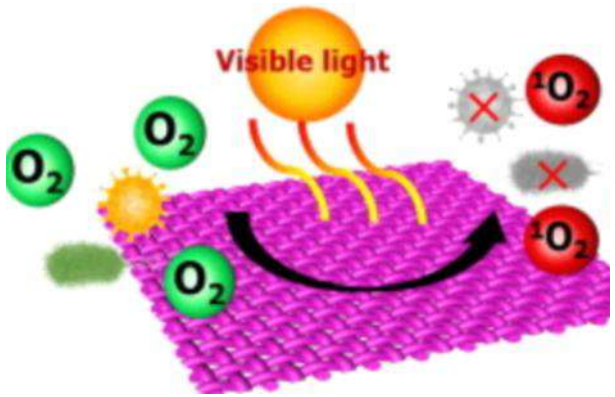
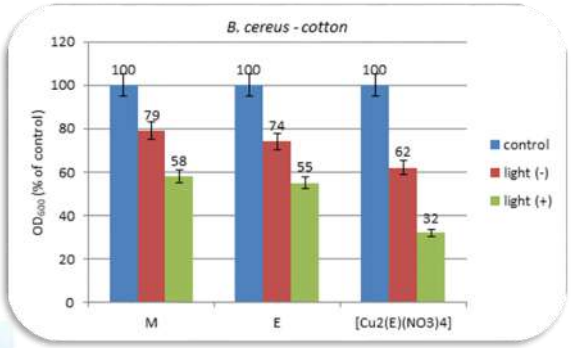
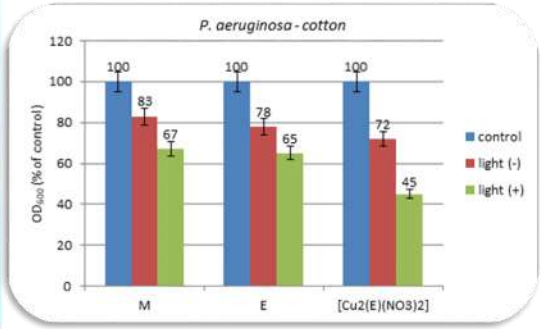
A new photoactive water-soluble polypropylene imine dendrimer modified with 1,8-naphthalimide and N-glucosamine for light-driven self-sterilizing cotton fabrics

Awad I. Said[a,b], Desislava Staneva[c,*], Daniela Atanasova[c], Albena Jordanova[a], Ivo Grabchev[a,*]









Textile with antimicrobial and cleaning properties

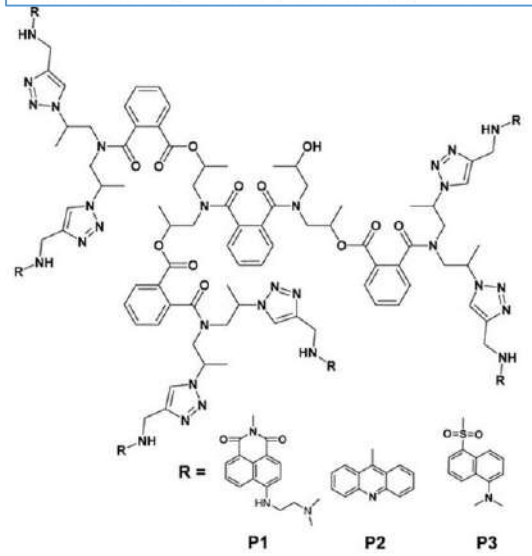
macromol

MDPI

Article

Fluorescent Hyperbranched Polymers and Cotton Fabrics Treated with Them as Innovative Agents for Antimicrobial Photodynamic Therapy and Self-Disinfecting Textiles

Desislava Staneva [1,*], Paula Bosch [2], Petar Grozdanov [3], Ivanka Nikolova [3] and Ivo Grabchev [4,*]



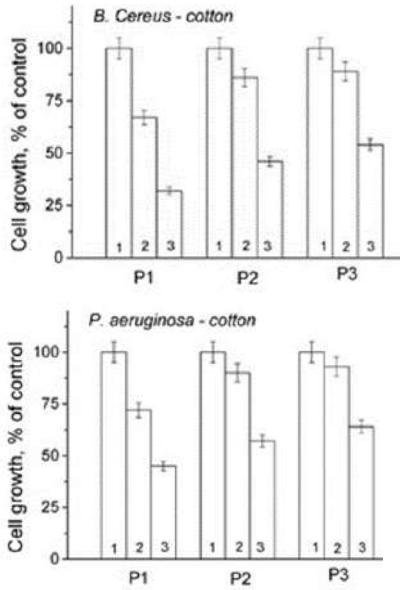


Figure. The growth of the model strains *P. aeruginosa* and *B. cereus* in the presence of cotton fabrics treated with polymers P1, P2, and P3, (1—control, 2—in the dark, and 3—after illumination).

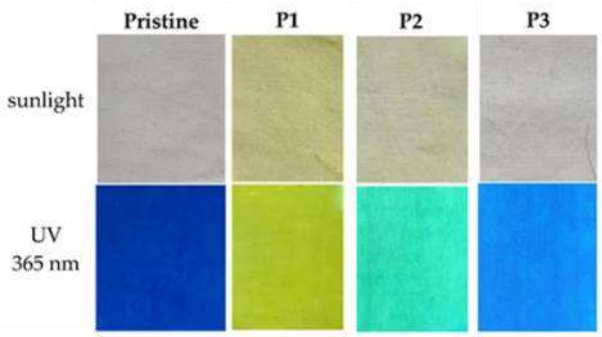


Table. Virucidal effect of cotton fabric treated with the polymers against HRSV-2 and HAdV-5 (irradiated with light for 1 h and non-irradiated).

	HRSV-2				HAdV-5			
	Irradiated		Non-Irradiated		Irradiated		Non-Irradiated	
	Δlog 30 min	Δlog 60 min	Δlog 30 min	Δlog 60 min	Δlog 30 min	Δlog 60 min	Δlog 30 min	Δlog 60 min
P1	0	0.1	0	0	0	0.2	0	0
P2	0	0.1	0	0	0	0.1	0	0
P3	0	0.3	0	0	0	0.4	0	0

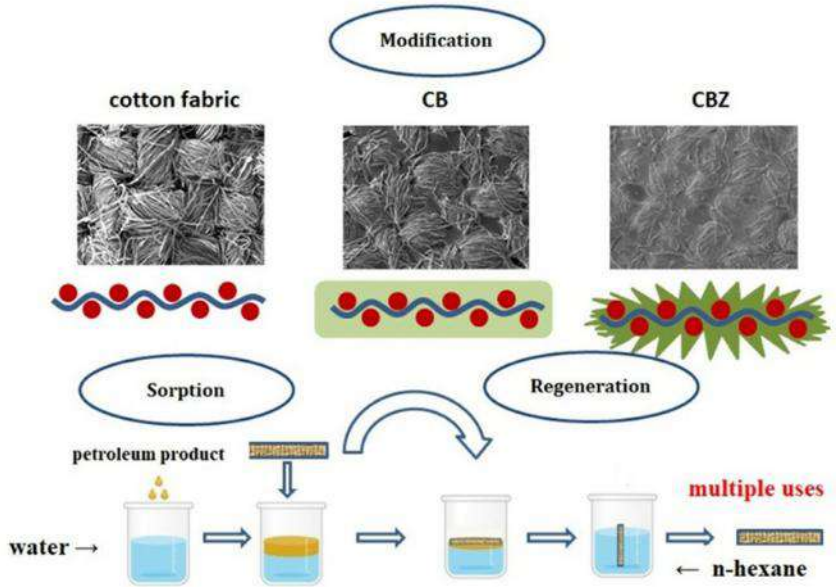
materials

MDPI

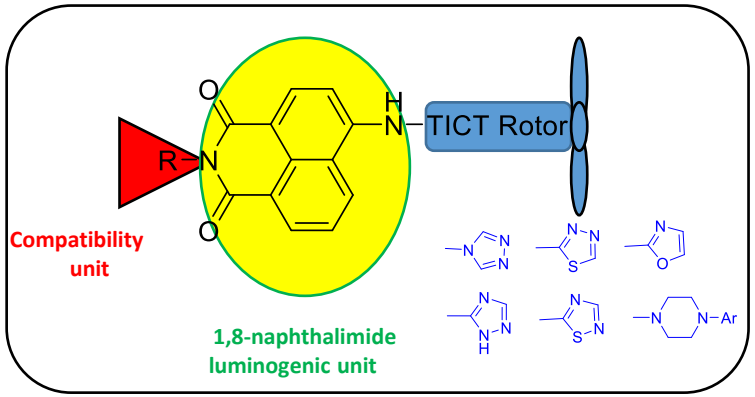
Article

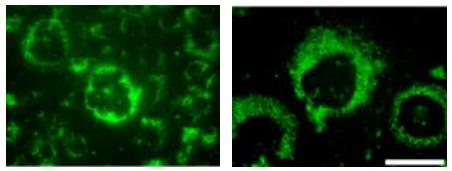
Application of Textile Composite Materials as a Sorbent for Cleaning Up Oil Spills

Daniela Angelova *, Desislava Staneva *, Daniela Atanasova and Vesislava Toteva

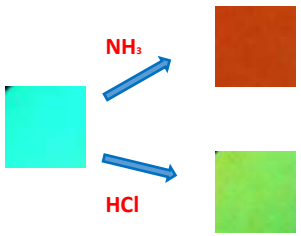


Fluorescent sensing 1,8-naphthalimide based TICT rotors

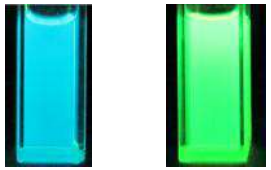




Logic gates for medical diagnostic

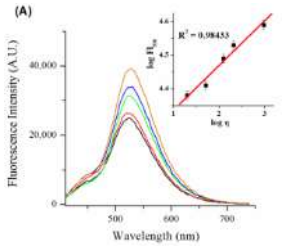


Solid state emissive probes for acid/base vapors

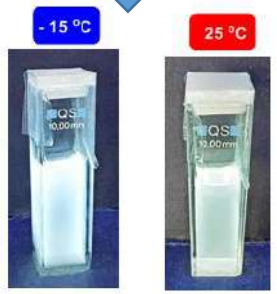


Acid Alkaline

Water-soluble pH sensing probes

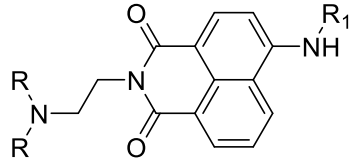


Viscosity sensing probes

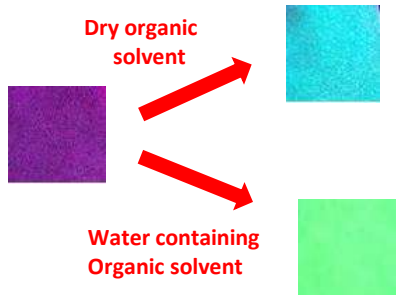


Fluorescent thermometers

Fluorescent probes for humidity



R_1 = —$COCF_3$ —$NHCOCF_3$
—$COCCl_3$ —$NHCOCCl_3$
—$COCHCl_2$ —$NHCOCHCl_2$
—$COCH_2Cl$ —$NHCOCH_2Cl$
—$COCH_2Ar$ —$NHCOCH_2Ar$



Molecular switches

Chiral and non-conjugated C2-spirooxindole substituted at the C3 position by a phenyl ring has been studied for its unusual photoluminescence behaviour.

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Intramolecular through-space conjugation of chiral C2-spirooxindole

Kosuke Nakashima [a,*], Aoi Imamura [a], Yasuyuki Matsushima [a], Shin-ichi Hirashima [a], Dancho Yordanov [b,c], Tsuyoshi Miura [a], Anton Georgiev [b,*]

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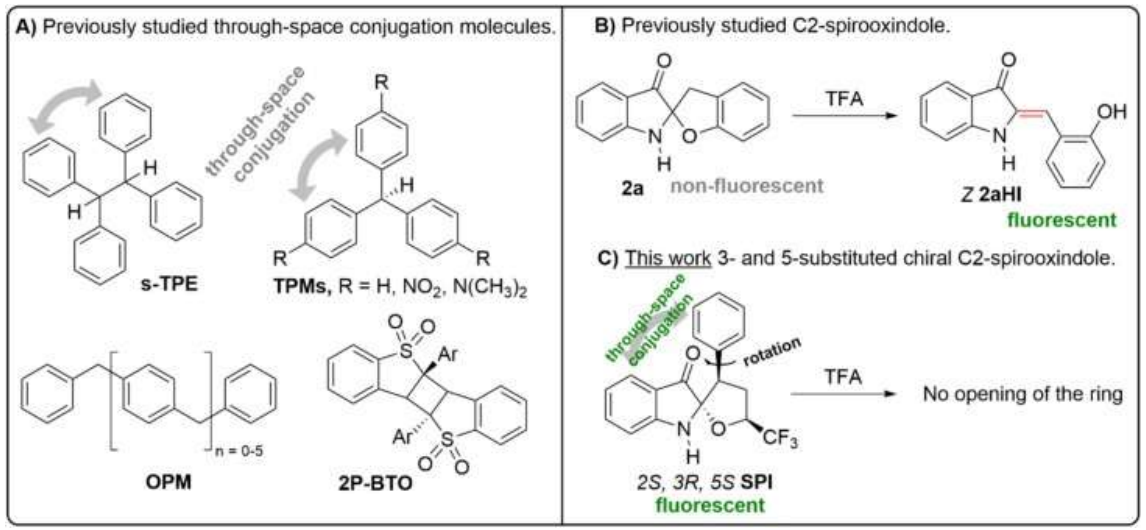
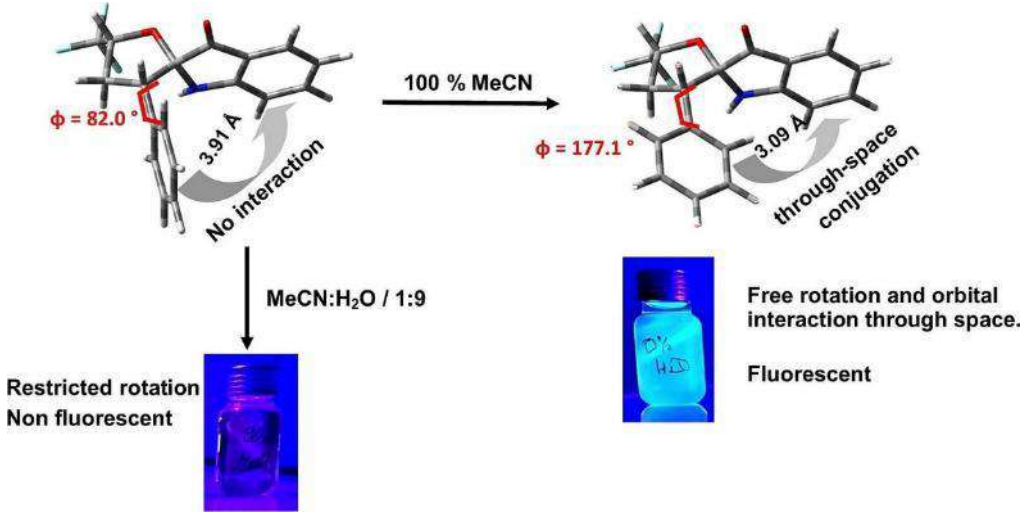
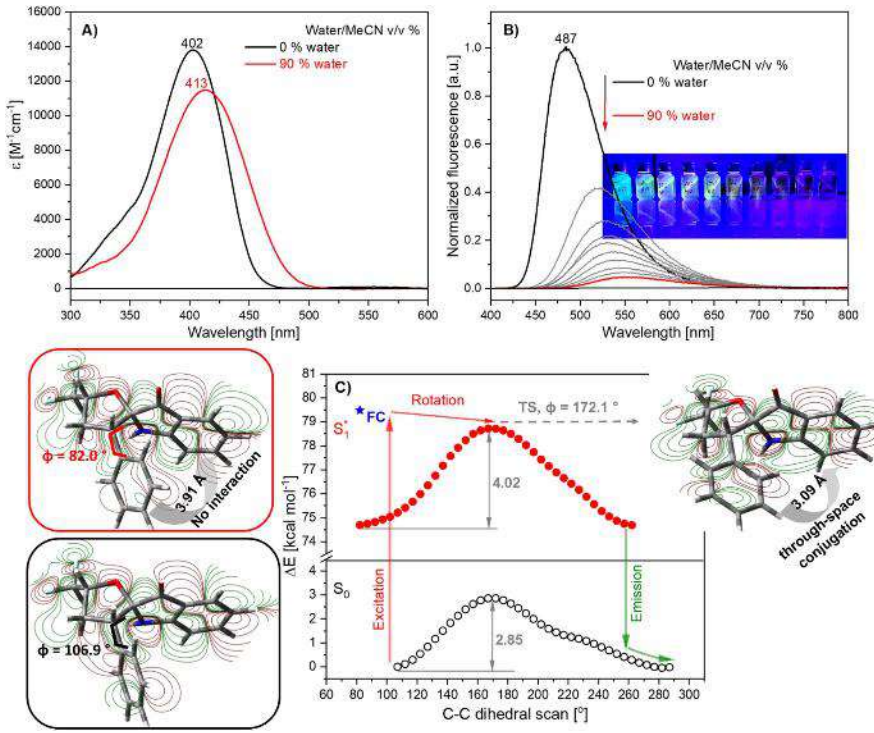
[b] Department of Organic Chemistry, University of Chemical Technology and Metallurgy, 8 St. Kliment Ohridski blvd, 1756 Sofia, Bulgaria
[c] Institute of Organic Chemistry with Centre of Phytochemistry, Bulgarian Academy of Sciences, Acad. G. Bonchev avenue, bldg. 9, Sofia 1113, Bulgaria







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Visible Light Switching of *Ortho*-Functionalized Azo Phthalimides with Tunable *Z*-Isomer Stability

Dancho Yordanov, Kosuke Nakashima, Rastislav Smolka, Yasuyuki Matsushima, Shin-ichi Hirashima, Martin Vala, Tsuyoshi Miura, and Anton Georgiev*

Cite This: https://doi.org/10.1021/acs.joc.5c01018 Read Online

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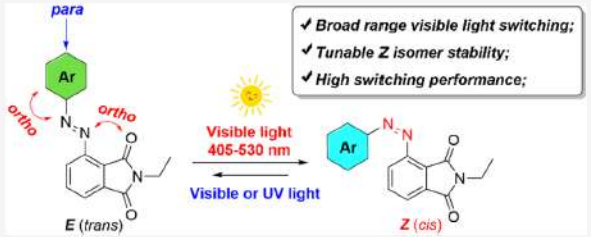
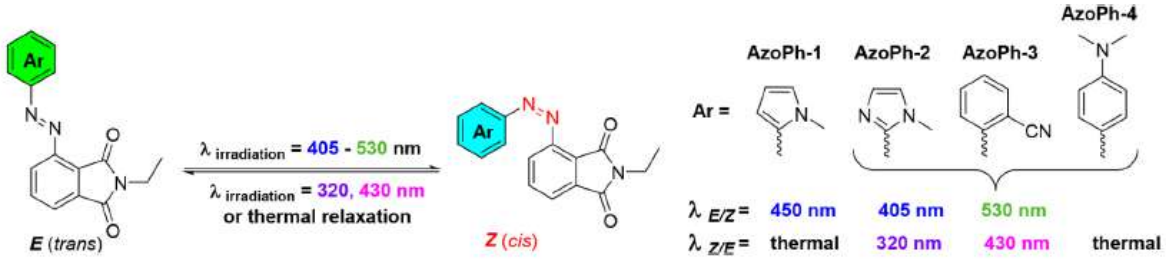
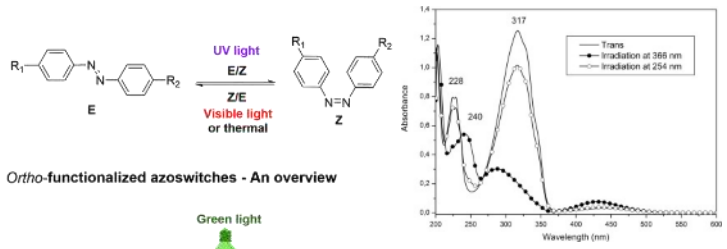
ABSTRACT: Herein, a novel class of azo photoswitches based on a phthalimide with an *ortho* azo bond to the imide ring is presented, exhibiting reversible isomerization under a broad range of visible light irradiation from 405 to 530 nm. Structural variations with heteroaryl or aryl segments attached to the 3-phthalylazo unit exhibit distinct spectral features, such as red-shifted absorption, well-separated absorption bands, and tunable stability of the metastable *Z* isomer, ranging from seconds to days. They differ drastically in the half-life of *Z*-isomer stability, ranging from several seconds (*N*-methylpyrrole) to days (*N*-methylimidazole). The *ortho*-cyanophenyl azo dye shows an n−π^* band separation of 22 nm between the *E* and *Z* isomers, enabling on−off switching by green (530 nm) and blue (430 nm) light. X-ray structural analysis reveals that the *E* isomer adopts a planar geometry. The *Z* isomers exhibit a T-shaped configuration for dyes with heteroaryl segments, while aryl *Z* isomers adopt a twisted conformation. Ground-state density functional theory calculations suggest a different mechanism for *Z*/*E* thermal relaxation depending on the heteroaryl or aryl substituents, explaining the varying stability of the *Z* isomers. Van't Hoff analysis of the thermal *Z*/*E* isomerization provided enthalpic and Gibbs free energy changes, supporting the substituent-dependent trends in *Z*-isomer stability.

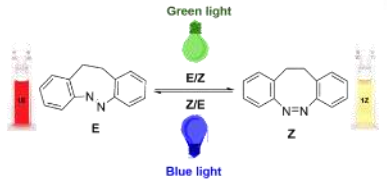


A novel class of azo photoswitches based on a phthalimide with an *ortho* substitution with improved characteristics has been synthesized and studied.



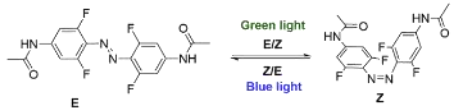


Poor n-π band separation.*
Impossible E/Z isomerization by visible light.

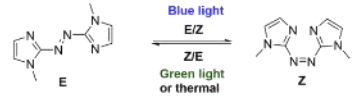


Herges, J. Am. Chem. Soc. 2009, 131, 15594–15595

Woolley, J. Am. Chem. Soc. 2011, 133, 19684–19687

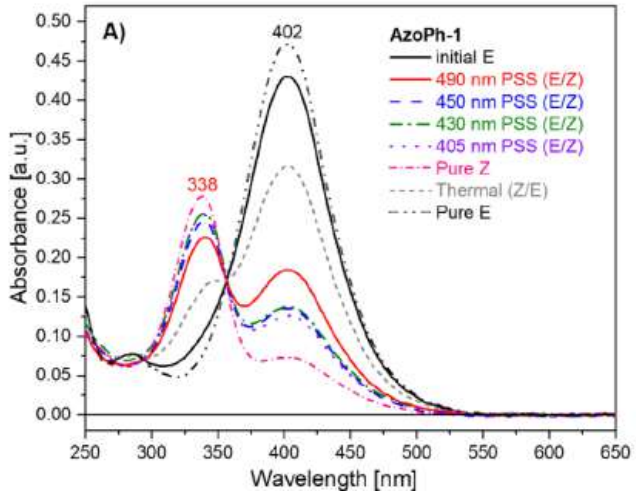


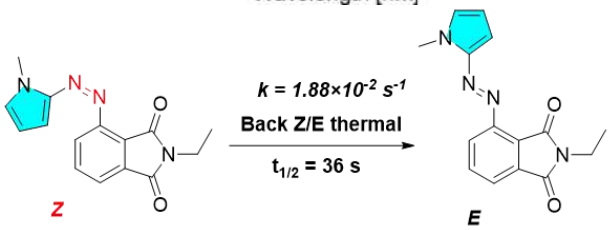
Hecht, J. Am. Chem. Soc. 2012, 134, 20597−20600



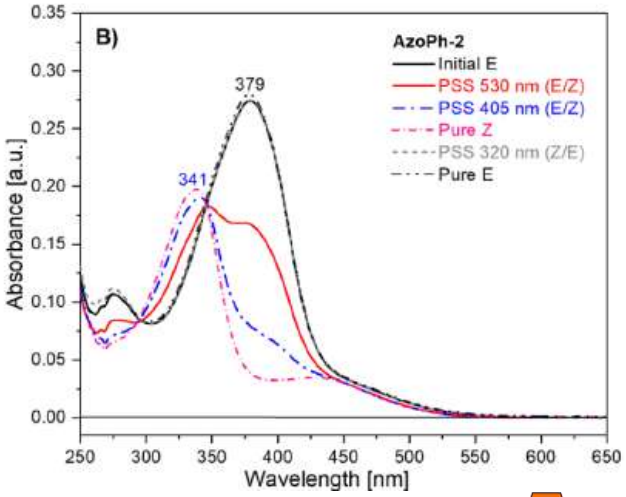
Fuchter, Chem. Commun., 2016,52, 4521-4524

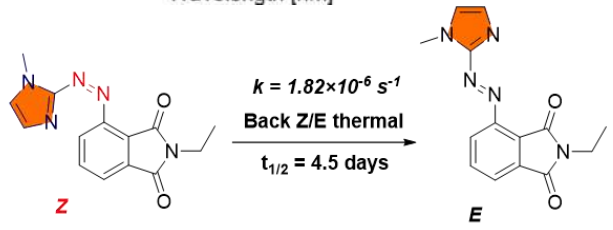
Molecular switches





AzoPh-1





AzoPh-2

The kinetics and thermodynamic comparative analysis reveals that AzoPh-1 and AzoPh-2 exhibit the highest ΔH°, indicating strong enthalpic stabilization of their Z isomers. However, only AzoPh-2 shows a positive ΔG°, confirming that the Z isomer is thermodynamically stable at ambient temperature and kinetically persistent, with the slowest thermal reversion ($t_{1/2}$ = 4.9 days).

Van't Hoff analysis

$$\ln K = -\frac{\Delta H^0}{R} \times \frac{1}{T} + \frac{\Delta S^0}{R}$$

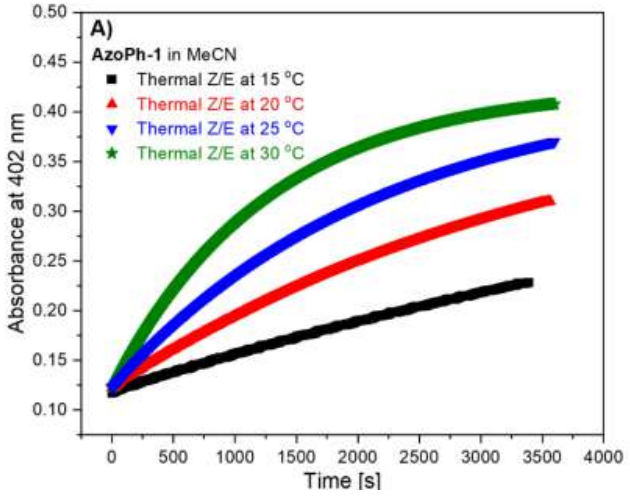
Plotting ***lnK*** vs ***1/T***, yields:

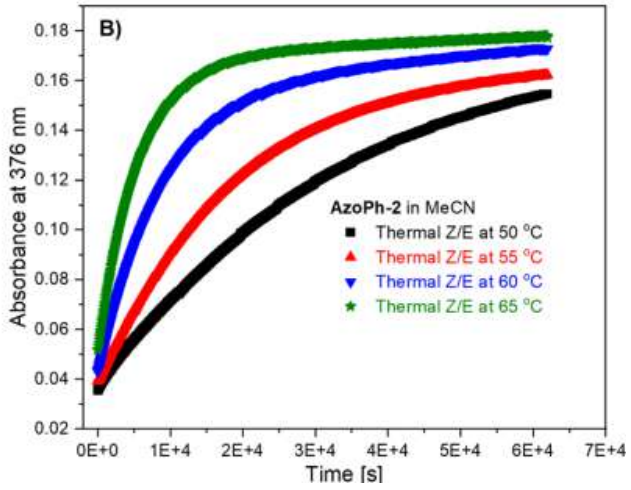
Slope: $-\frac{\Delta H^0}{R} \Rightarrow \Delta H^0 = -Slope \times R$

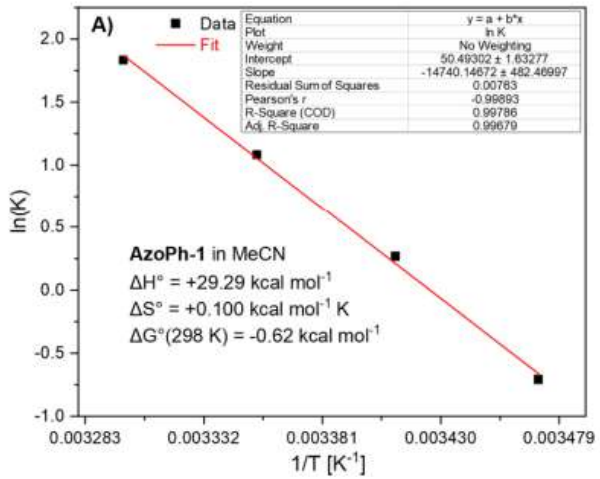
Intercept: $+\frac{\Delta S^0}{R} \Rightarrow \Delta S^0 = Intercept \times R$

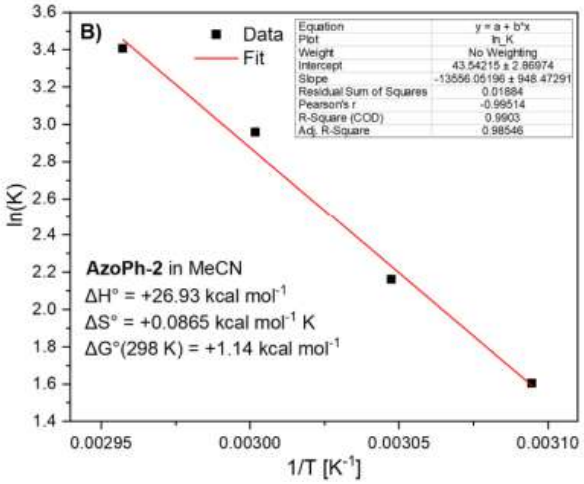
Then,

$$\Delta G^0 = \Delta H^0 - T\Delta S^0$$



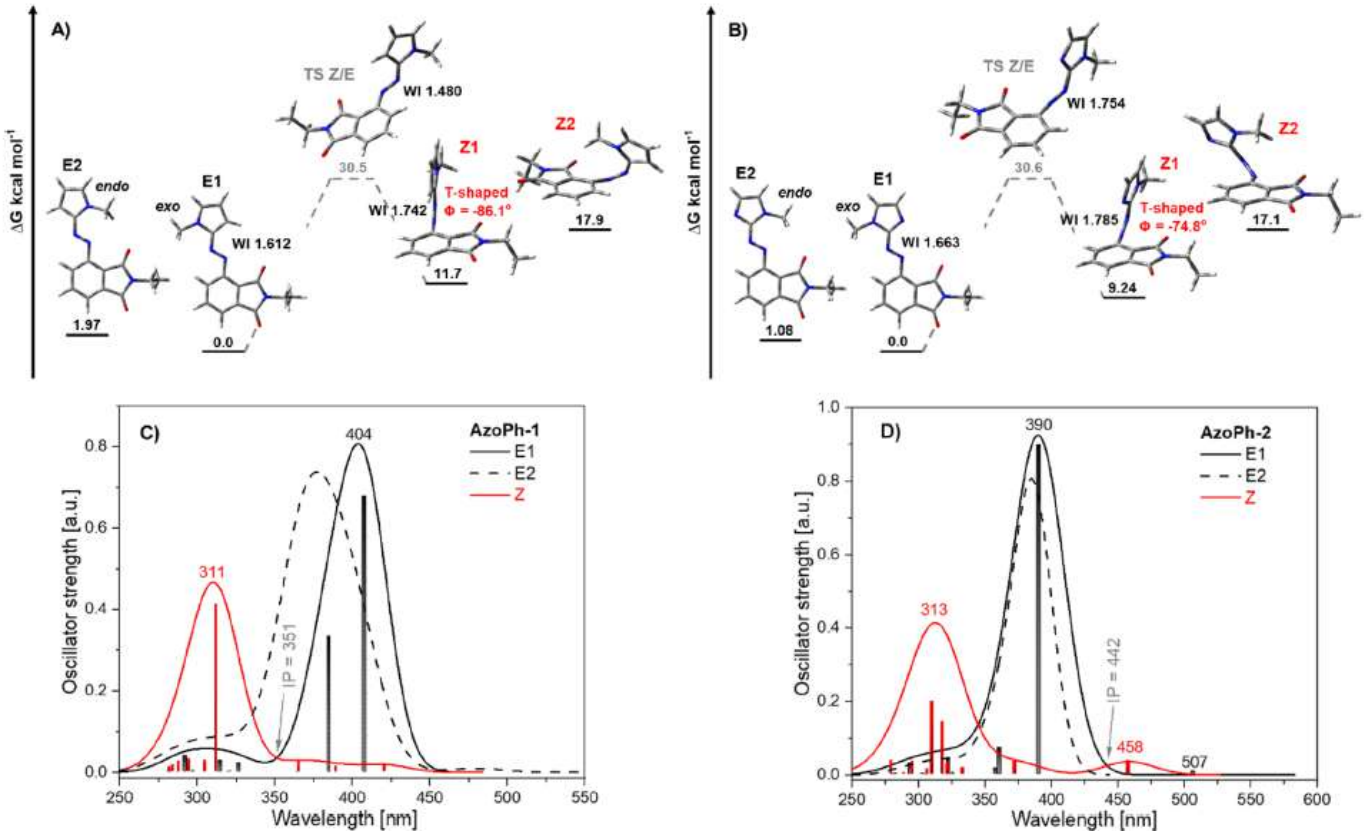


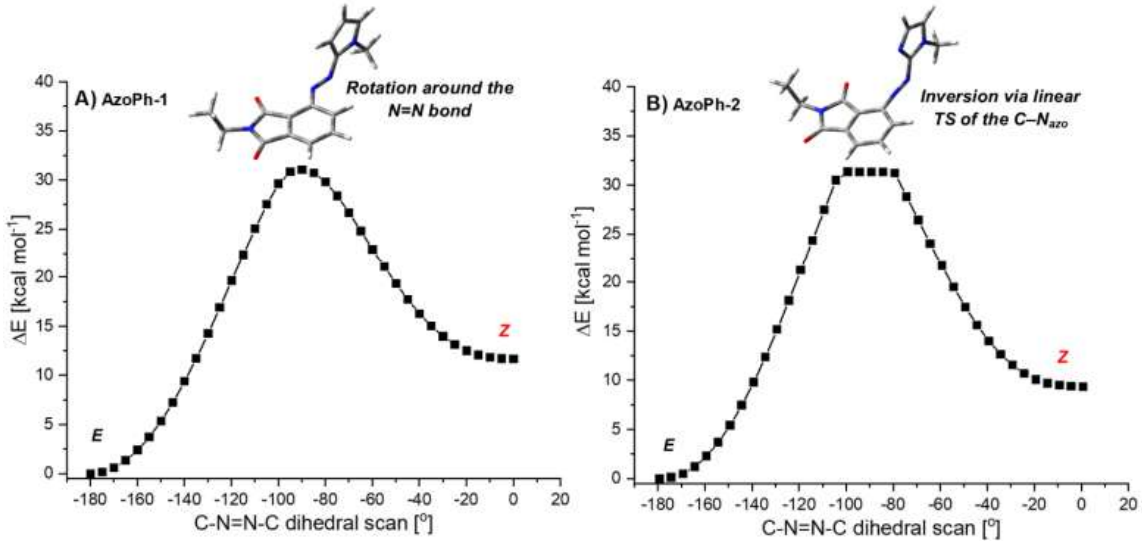




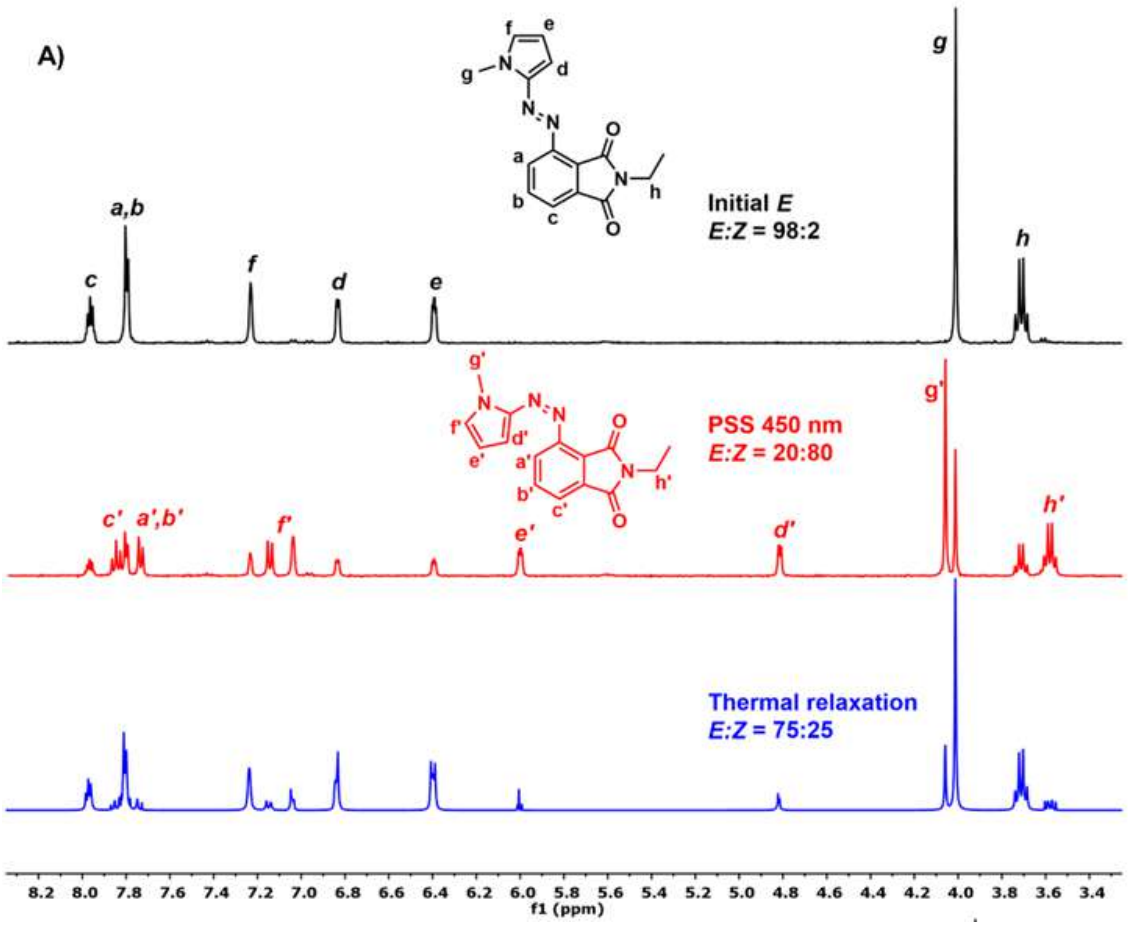
Molecular switches

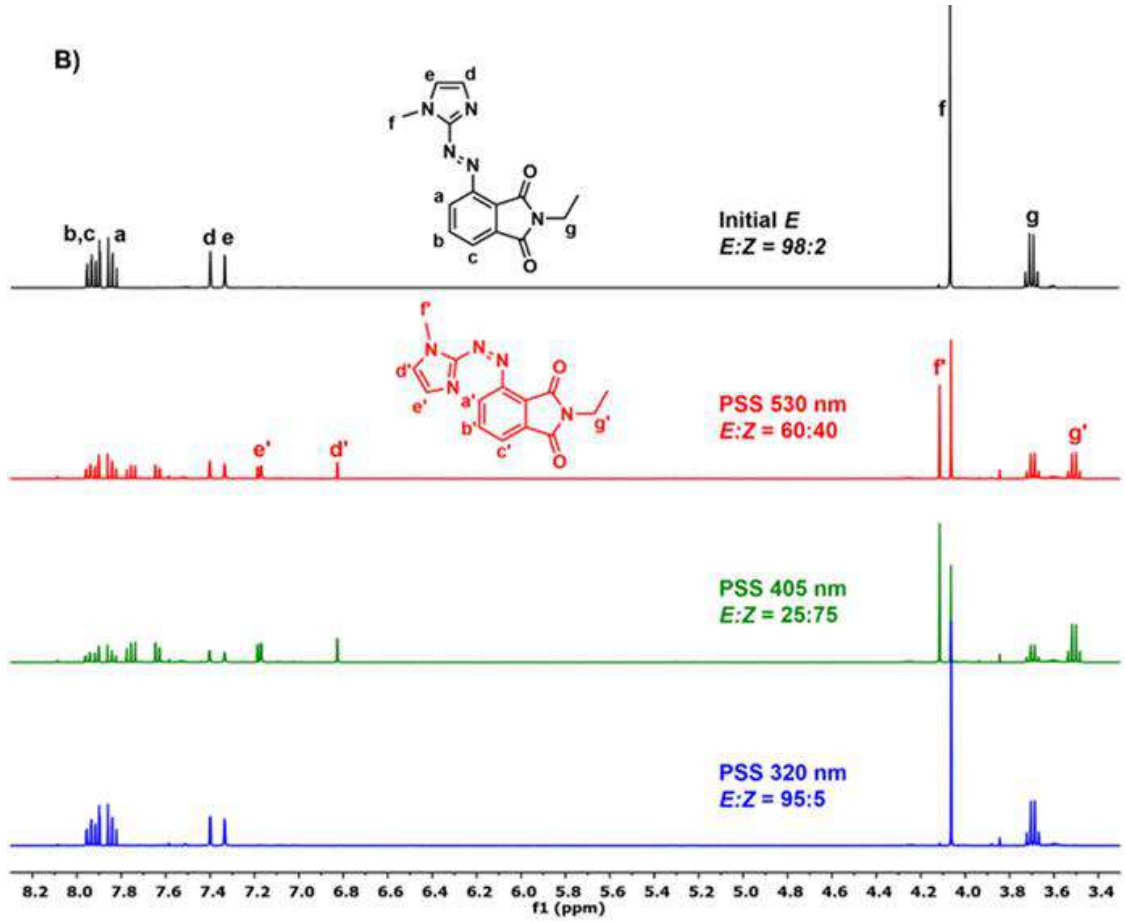
Ground state DFT TS state geometry to establish the mechanism of thermal relaxation





Z/E potential energy profiles obtained by relaxed scans of the C–N=N–C dihedral angle





^{1}H NMR (400 MHz, 25 ^{0}C, CD_3CN)

Anton Georgiev

1. Dancho Yordanova, Kosuke Nakashima, Rastislav Smolka, Yasuyuki Matsushima, Shin-ichi Hirashima, Martin Vala, Tsuyoshi Miura, Anton Georgiev, *"Visible Light Switching of ortho-Functionalized Azo Phthalimides with Tunable Z-Isomer Stability"* **The Journal of Organic Chemistry (American Chemical Society)** 2025, 90, 37, 12904–12915, https://doi.org/10.1021/acs.joc.5c01018 **Q1 (Web of Science)**
2. Kosuke Nakashima, Dancho Yordanov, Yasuyuki Matsushima, Shin-ichi Hirashima, Tsuyoshi Miura, Anton Georgiev, *"Rearrangement of C2-Spirooxindoles: Conversion to the 2-Hydroxyhemi-Indigo and Chromenoindole"*, **The Journal of Organic Chemistry (American Chemical Society)** 2024 89 (17), 12401-12409, https://doi.org/10.1021/acs.joc.4c01362 **Q1 (Web of Science)**
3. Dancho Yordanov, Rastislav Smolka, Kosuke Nakashima, Shin-ichi Hirashima, Yasuyuki Matsushima, Martin Vala, Jozef Krajčovič, Martin Weiter, Tsuyoshi Miura, and Anton Georgiev, *"Fluorescent Rotary Switches: 4- vs 3-Substituted Phthalimide Boron Difluoride Schiff Base Complexes"*, **The Journal of Organic Chemistry (American Chemical Society)** 2023, 88, 24, 17206–17214, https://doi.org/10.1021/acs.joc.3c02056 **Q1 (Web of Science)**
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5. Kosuke Nakashima, Aoi Imamura, Yasuyuki Matsushima, Shin-ichi Hirashima, Dancho Yordanov, Tsuyoshi Miura, Anton Georgiev, *"Intramolecular through-space conjugation of chiral C2-spirooxindole"* **Journal of Photochemistry and Photobiology A: Chemistry (Elsevier)** 463 (2025) 116316, https://doi.org/10.1016/j.jphotochem.2025.116316, **Q2 (Web of Science)**
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Anton Georgiev

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Nikolay Georgiev and Vecislav Bakov

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Desislava Staneva Grabcheva and Vesislava Toteva

22. A. I. Said, D. Staneva, D. Atanasova, A. Jordanova, I. Grabchev, "*A new photoactive water-soluble polypropylene imine dendrimer modified with 1,8-naphthalimide and N-glucosamine for light-driven self-sterilizing cotton fabrics*",, **Journal of Photochemistry and Photobiology A Chemistry (Elsevier)** 2025, 464, 116306, https://doi.org/10.1016/j.jphotochem.2025.116306 **Q2 (Web of Science)**
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30. Stratiev, D.; Shishkova, I.; Georgiev, G.; Dinkov, R.; Nedelchev, A.; Nikolova, R.; Veli, A.; Bureva, V.; Atanassov, K.; Berg, F.v.d.; et al. *„The Incompatibility Pitfall in Refining Opportunity Crude Oils",* **Processes (MDPI)** 2025, 13, 593. https://doi.org/10.3390/pr13020593 **Q2 (Web of Science)**
31. Stratiev, D.; Nikolova, R.; Veli, A.; Shishkova, I.; Toteva, V.; Georgiev, G., *"Mitigation of Asphaltene Deposit Formation via Chemical Additives: A Review*", **Processes (MDPI)** 2025, 13, 141. https://doi.org/10.3390/pr13010141 **Q2 (Web of Science)**

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1. Kosuke Nakashima, Aoi Imamura, Yasuyuki Matsushima, Shin-ichi Hirashima, Dancho Yordanov, Tsuyoshi Miura, Anton Georgiev, *"Intramolecular through-space conjugation of chiral C2-spirooxindole"* **Journal of Photochemistry and Photobiology A: Chemistry (Elsevier)** 463 (2025) 116316, https://doi.org/10.1016/j.jphotochem.2025.116316 **IF = 4.1, Q2 (Web of Science)**
2. Dancho Yordanova, Kosuke Nakashima, Rastislav Smolka, Yasuyuki Matsushima, Shin-ichi Hirashima, Martin Vala, Tsuyoshi Miura, Anton Georgiev, *"Visible Light Switching of ortho-Functionalized Azo Phthalimides with Tunable Z-Isomer Stability"* **The Journal of Organic Chemistry (American Chemical Society)** 2025 https://doi.org/10.1021/acs.joc.5c01018 **IF = 3.6, Q1 (Web of Science)**
3. Awad I. Said, D. Staneva, D. Atanasova, A. Jordanova, I. Grabchev, *„A new photoactive water-soluble polypropylene imine dendrimer modified with 1,8-naphthalimide and N-glucosamine for light-driven self-sterilizing cotton fabrics"*, **Journal of Photochemistry and Photobiology A Chemistry (Elsevier),** 464 (2025) 116306, https://doi.org/10.1016/j.jphotochem.2025.116316 **IF = 4.1, Q2 (Web of Science)**
4. Bryaskova, R.; Philipova, N.; Bakov, V.; Georgiev, N., "Innovative Antibacterial Polymer Coatings" **Applied Science (MDPI) 2025**, *15*, 1780. https://doi.org/10.3390/app15041780 , **IF = 2.5**, **Q1 (Web of Science)**
5. Atanassova, M.; Todorova, N.; Simova, S., *"Synergistic Solvent Extraction of Lanthanoids with Traditional Ligands (4-Acylpyrazolone and Bidentate Nitrogen Bases) in a Nontraditional Diluent Confirmed by Slope Analysis and NMR",* **Molecules (MDPI)** 2025, 30, 786. https://doi.org/10.3390/molecules30040786 **IF = 4.2, Q2 (Web of Science)**
6. Angelova, D.; Staneva, D.; Atanasova, D.; Toteva, V., *"Application of Textile Composite Materials as a Sorbent for Cleaning Up Oil Spills"*, **Materials (MDPI)** 2025, 18, 1146. https://doi.org/10.3390/ma18051146 **IF = 3.1, Q2 (Web of Science)**
7. Staneva, D., Said, A.I., Grozdanov, P., Nikolova, I., Stoyanova, R., Jordanova, A., Grabchev, I. *„Light-driven self-sterilizing cotton fabric and drug delivery: improvement of the antimicrobial activity of 4-sulfo-1,8-naphthalimide via its dendrimer and metallic dendrimer formation"*, **Photochemistry and Photobiology Science (Springer Nature)** 24, 593–606 (2025), https://doi.org/10.1007/s43630-025-00710-1 , **IF = 2.5, Q2 (Web of Science)**
8. Staneva, D.; Bosch, P.; Grozdanov, P.; Nikolova, I.; Grabchev,I., *"Fluorescent Hyperbranched Polymers and Cotton Fabrics Treated with Them as Innovative Agents for Antimicrobial Photodynamic Therapy and Self-Disinfecting Textiles"*, **Macromol** (MDPI) **2025**, 5, 26. https://doi.org/10.3390/macromol5020026 , **IF = 4.4, Q2 (Web of Science)**

Publications only in 2025

9. Ventsislav V. Bakov, Nikolai I. Georgiev, Nikol G. Donkova,Vladimir B. Bojinov, *"Ratiometric 1,8-naphthalimide/1,2,4-triazole conjugates as higly sensitive and self-regenerating solid-state "naked eye" probes or a monia and low molecular weight volatile amines"*, **Journal of Photochemistry & Photobiology, A:Chemistry (Elsevier)** *469 (2025) 116590,* https://doi.org/10.1016/j.jphotochem.2025.116590 **Q2 (Web of Science)**
10. Shishkova, I.; Stratiev, D.; Kirov, P.; Dinkov, R.; Sotirov, S.; Sotirova, E.; Bureva, V.; Atanassov, K.; Toteva, V.; Vasilev, S.; et al., *"Root Cause Analysis for Observed Increased Sedimentation in a Commercial Residue Hydrocracker",* **Processes (MDPI)** 2025, *13*, 674 https://doi.org/10.3390/pr13030674 **Q2 (Web of Science)**
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RESEARCH ARTICLE

Determinants of Z-Isomer Stability in Phthalylhydrazones: Dual Light and Acid Control

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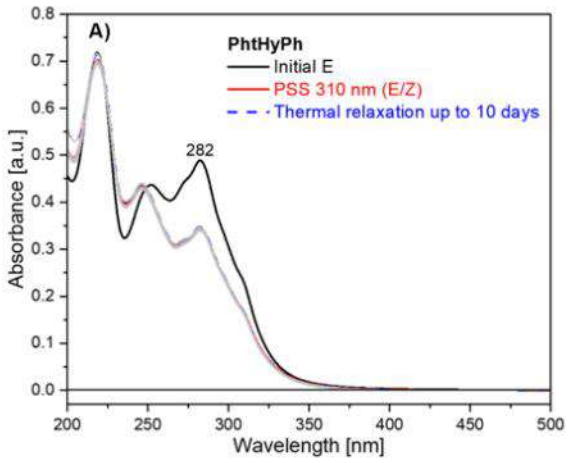

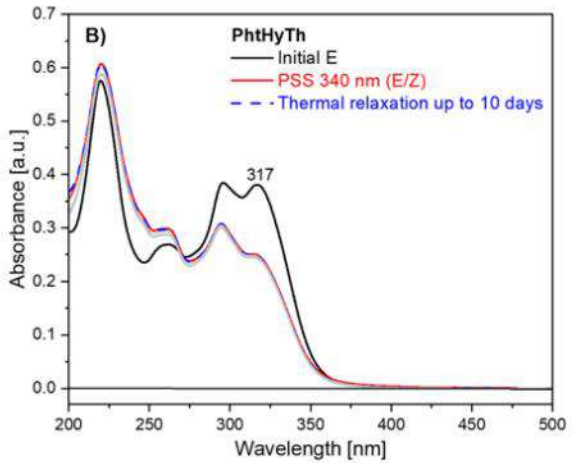

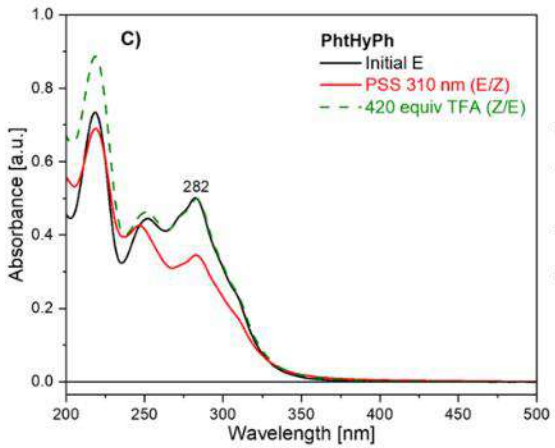

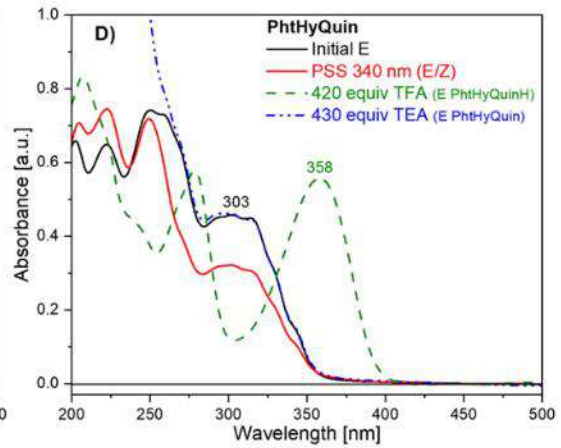

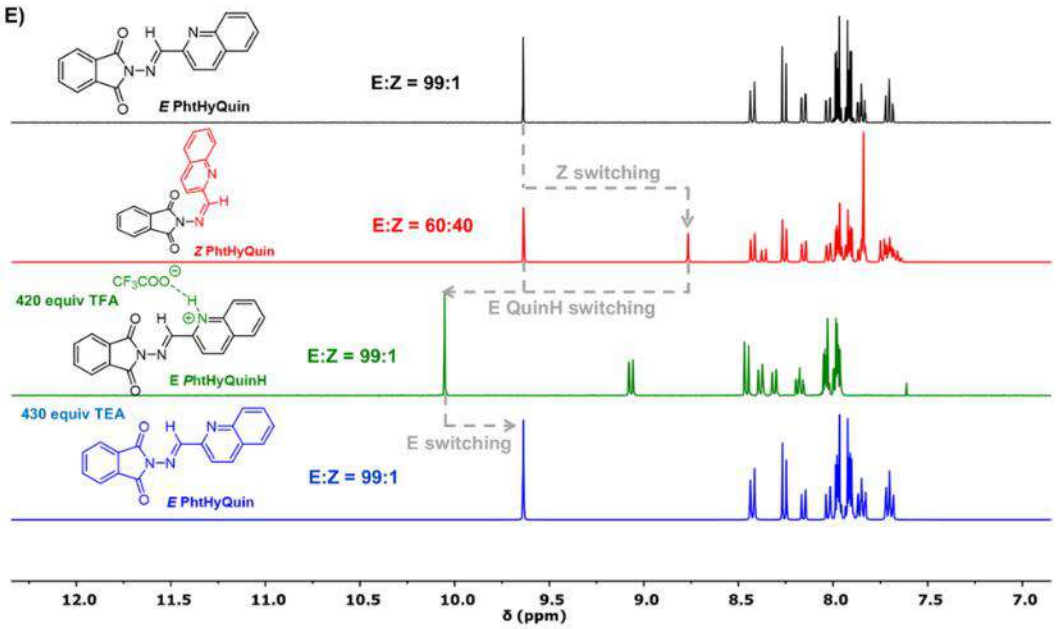

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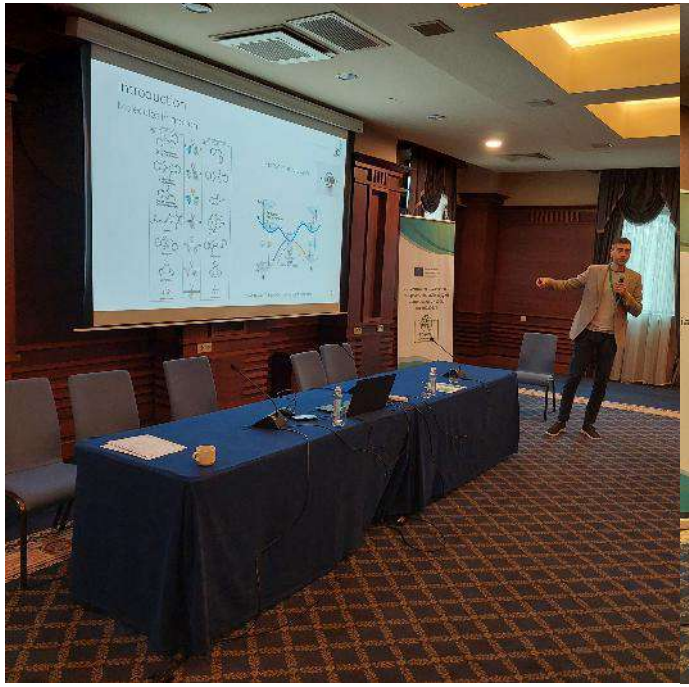


The researcher's form: Japan, Czech Republic, Italy, France, Germany, Switzerland, United Kingdom

Dissemination of the results and EU Network establishing

Established European network for Functional Organic Materials by 1st meeting November 2023. 2nd meeting September 2024.
3rd meeting Octomber 2025.

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