Silica-Based Optical Chemosensors for Rapid and Reliable On-Site Detection of GHB in Beverages and Oral Fluids

Jordi Hernández-Contreras[1], Jordi Roig-Rubio[1], Margarita Parra[1,2,3], Salvador Gil[1,2,3], Pau Arroyo[1,2], José A. Sáez[1,2], Carlos Lodeiro[4,5], Pablo Gaviña[1,2,3,*]

[1] Instituto Interuniversitario de Investigación de Reconocimiento Molecular y Desarrollo Tecnológico (IDM). Universitat Politècnica de València, Universitat de València, Doctor Moliner 50, Burjassot, 46100, Valencia.
[2] Departamento de Química Orgánica, Universitat de València, Doctor Moliner 50, Burjassot, 46100, Valencia, Spain.
[3] CIBER de Bioingeniería, Biomateriales y Nanomedicina (CIBER-BBN), Spain.
[4] BIOSCOPE Research Group, LAQV-REQUIMTE, Chemistry Department, NOVA School of Science and Technology, NOVA FCT, Universidade NOVA de Lisboa, 2829-516 Caparica, Portugal.
[5] PROTEOMASS Scientific Society, Costa de Caparica, 2825-466, Portugal

Supplementary Information

Contents

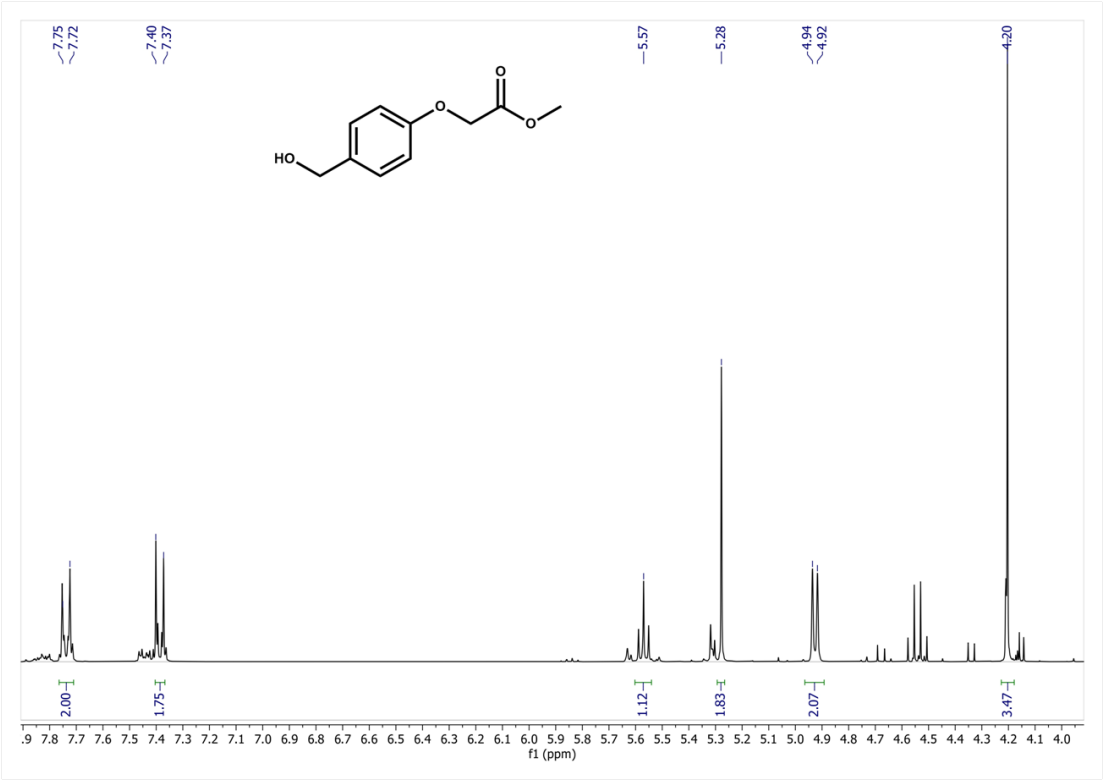

Figure S1. ^{1}H NMR spectrum of compound **3** in DMSO-d_6.

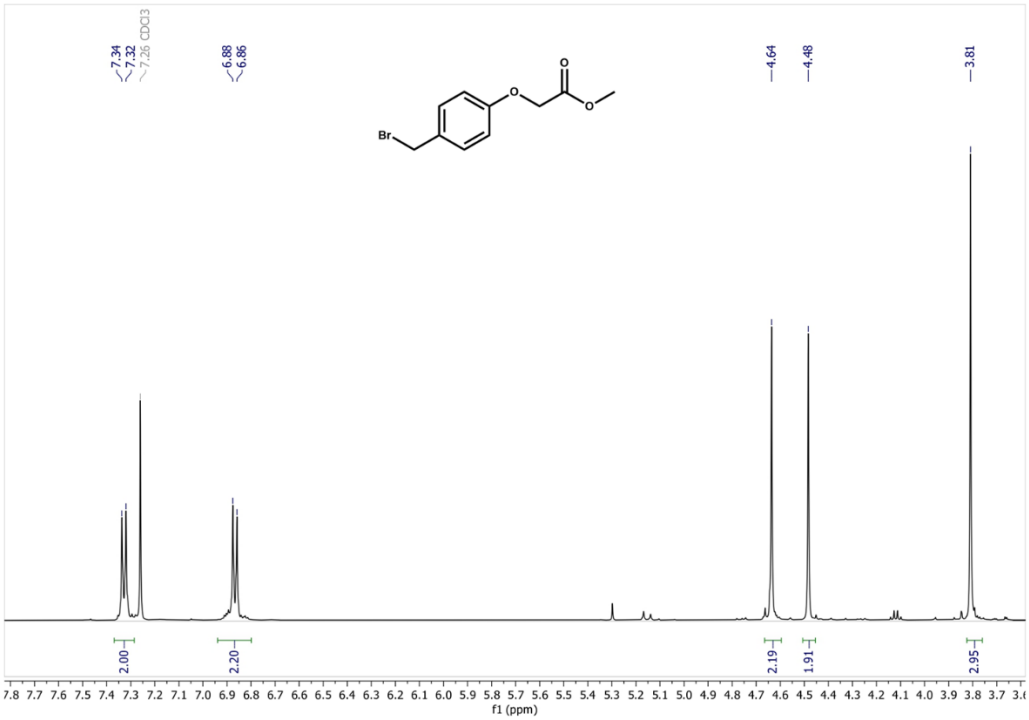

Figure S2. ^{1}H NMR spectrum of compound **4** in $CDCl_3$.

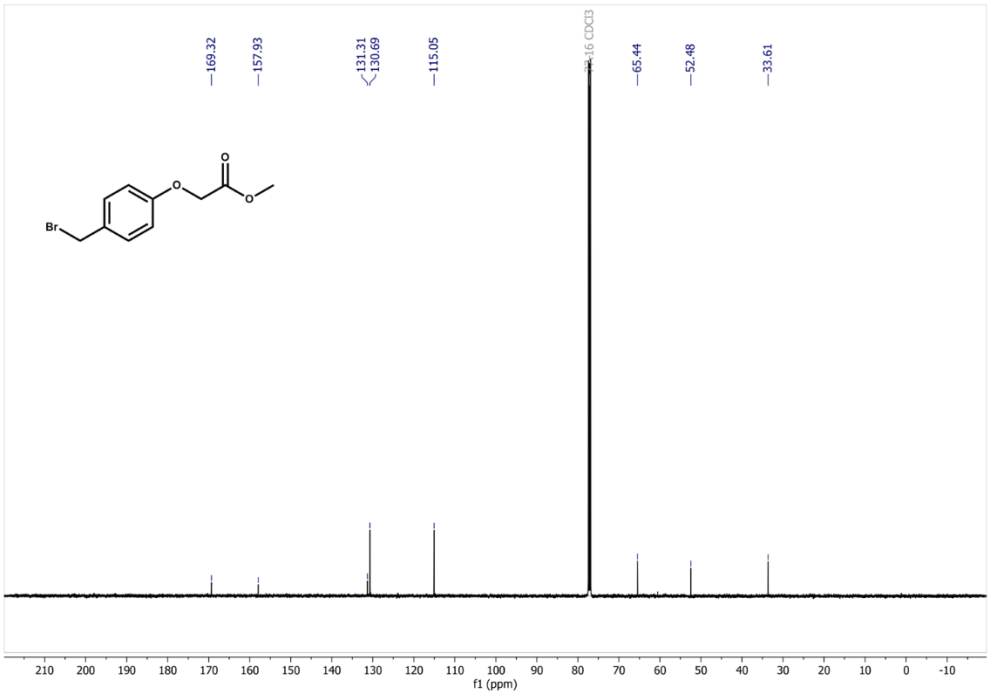

Figure S3. ^{13}C NMR spectrum of compound **4** in $CDCl_3$.

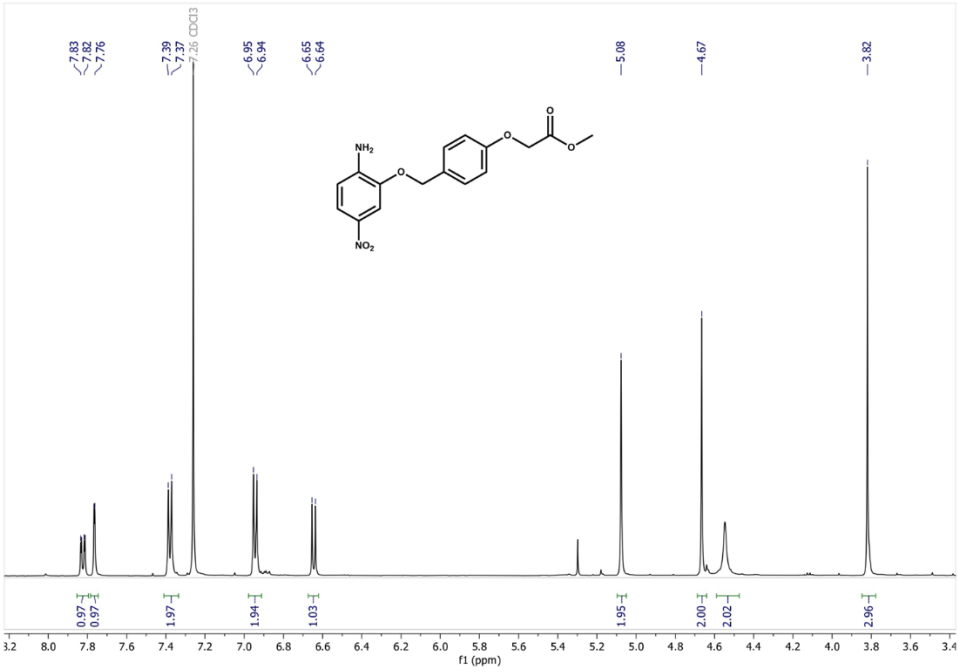

Figure S4. ^{1}H NMR spectrum of compound **5** in $CDCl_3$.

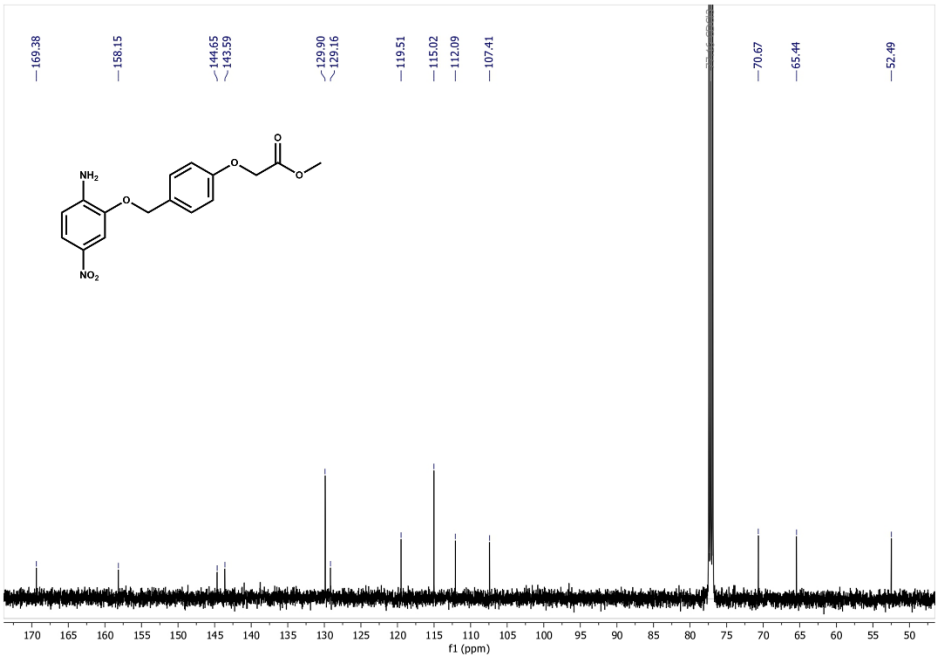

Figure S5. ^{13}C NMR spectrum of compound **5** in $CDCl_3$.

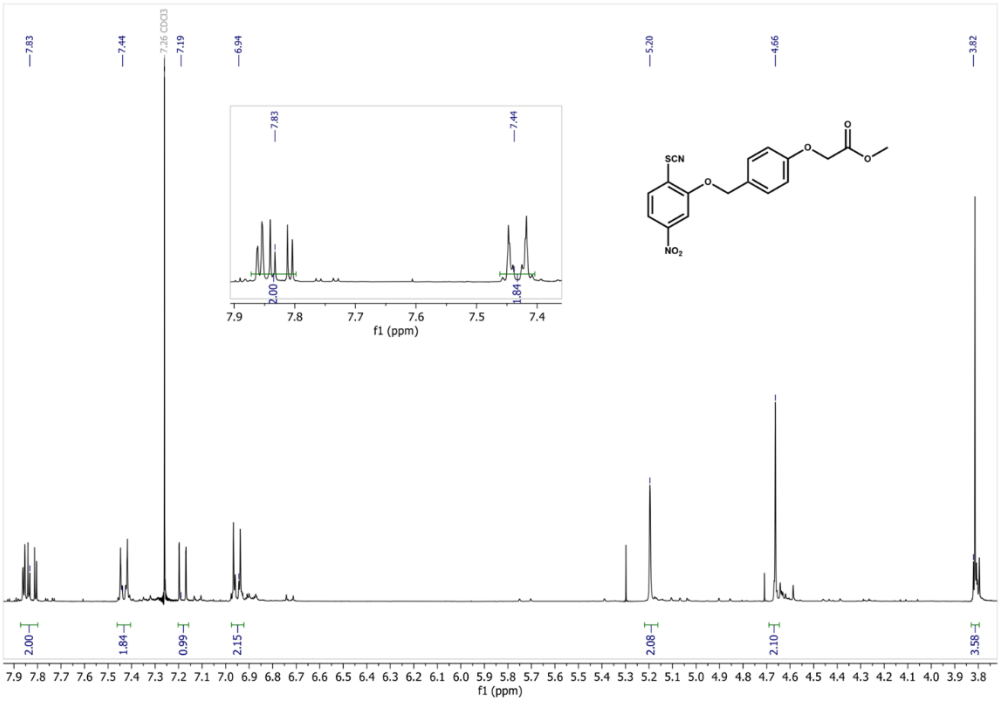

Figure S6. ^{1}H NMR spectrum of compound **6** in $CDCl_3$.

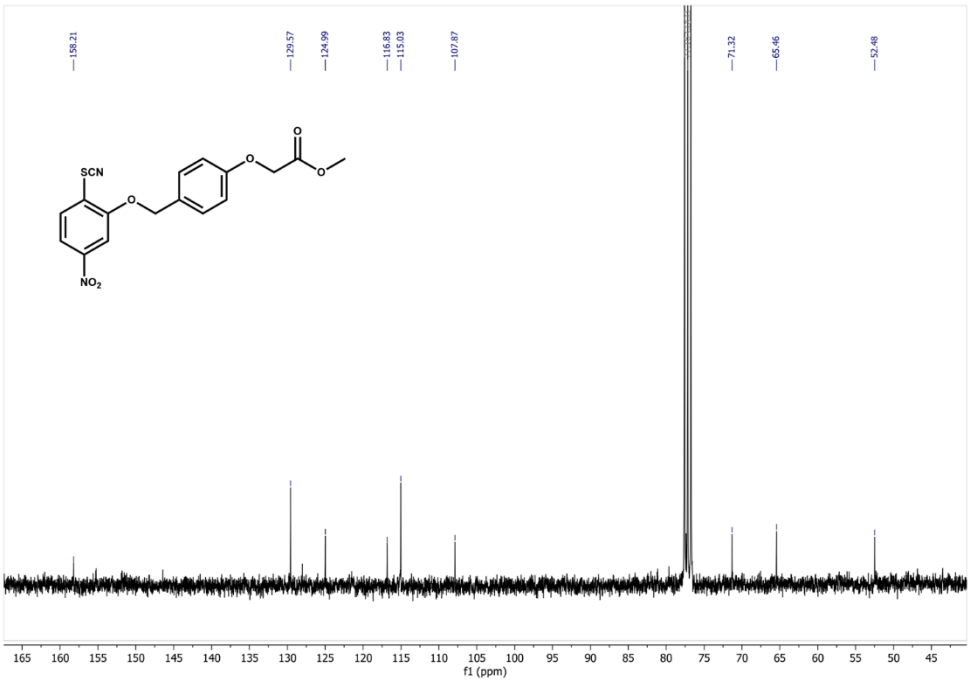

Figure S7. ^{13}C NMR spectrum of compound **6** in $CDCl_3$.

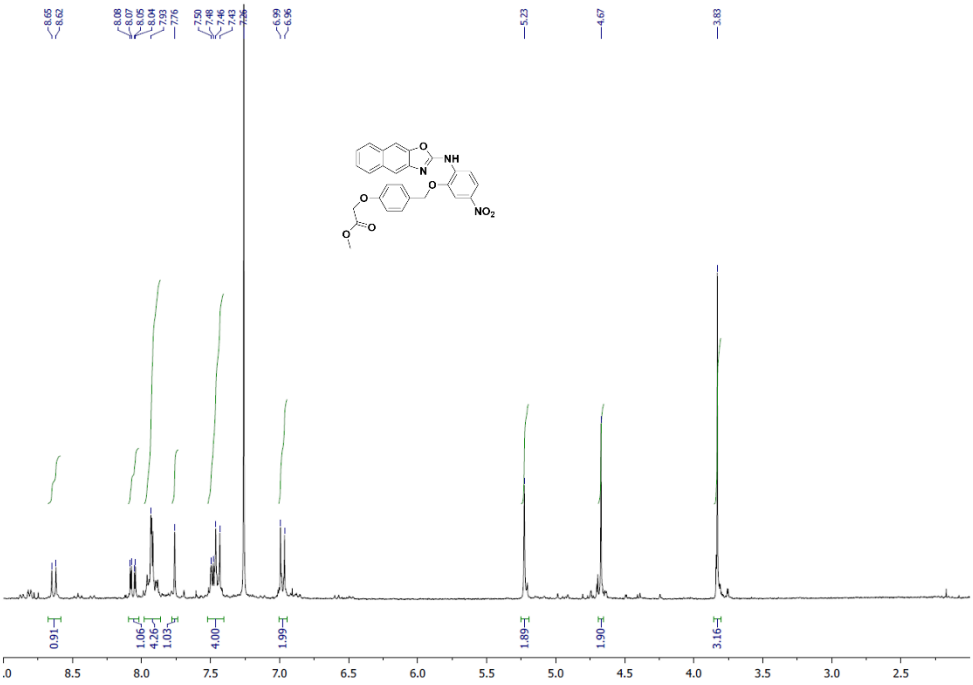

Figure S8. ^{1}H NMR spectrum of compound **1** in $CDCl_3$.

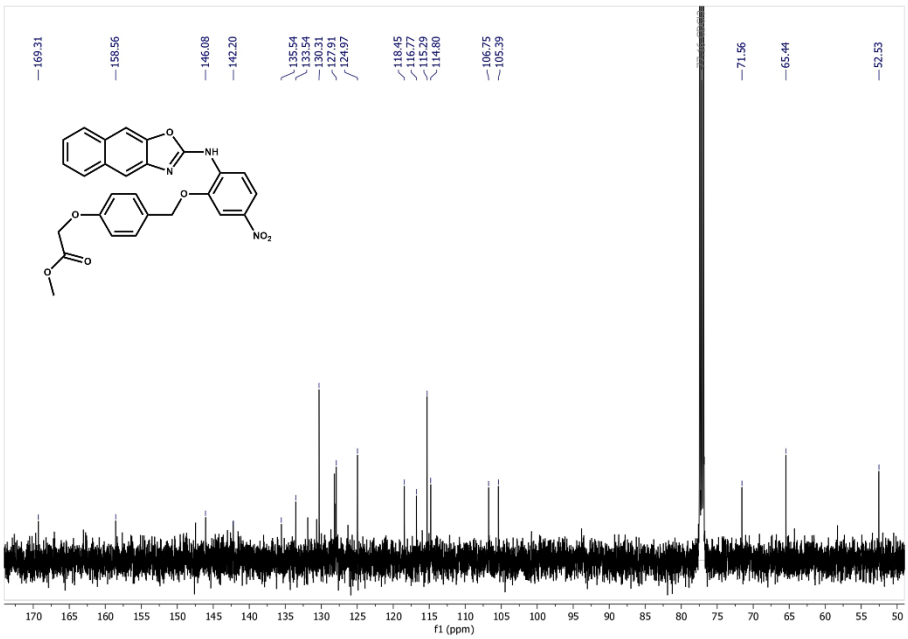

Figure S9. ^{13}C NMR spectrum of compound **1** in $CDCl_3$.

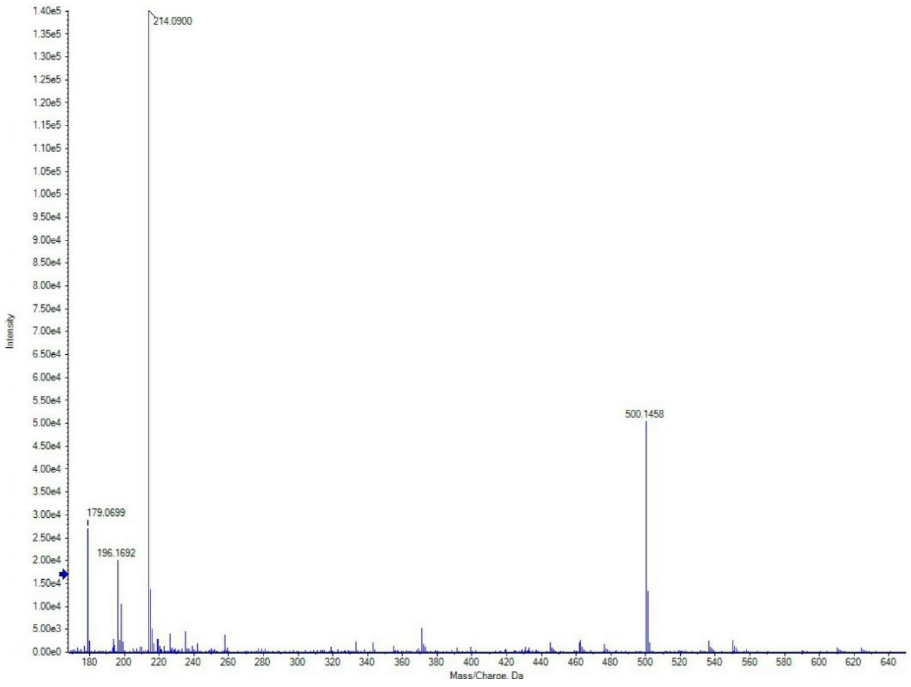

Figure S10. Mass spectroscopy data of compound **1**.

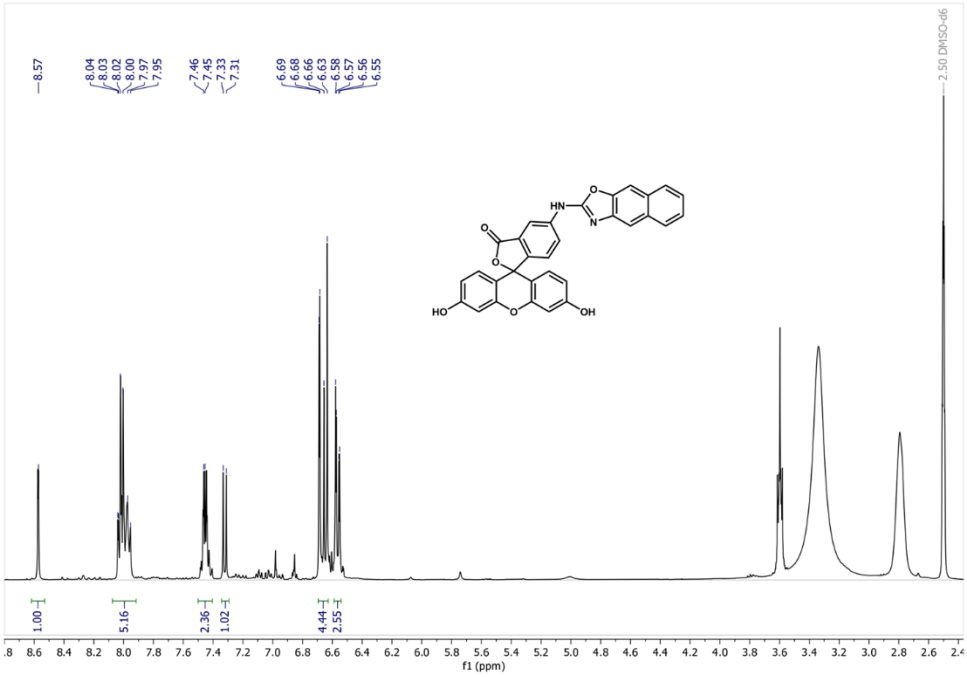

Figure S11. ^{1}H NMR spectrum of compound **9** in DMSO-d_6.

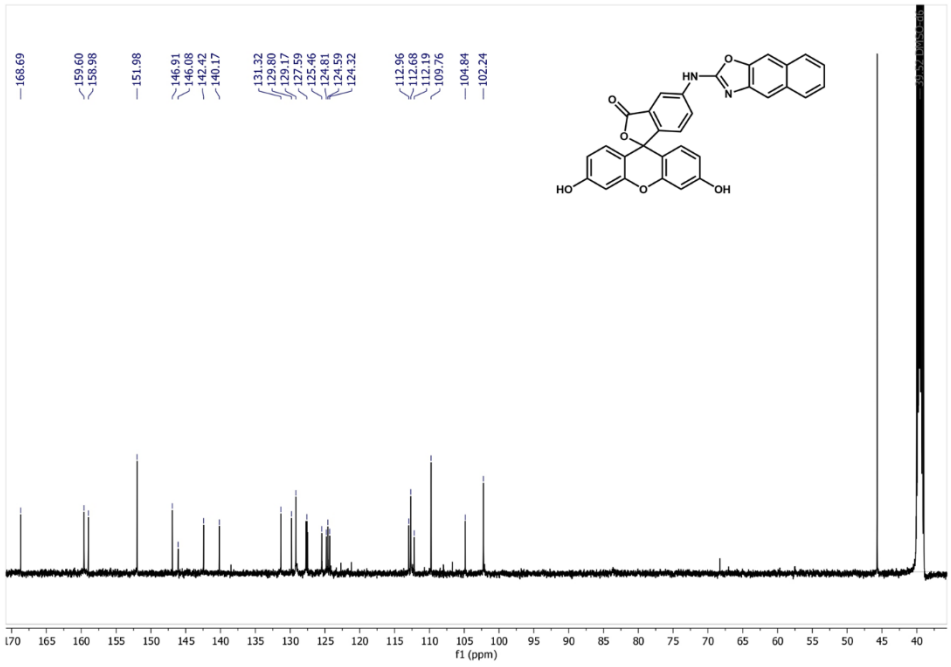

Figure S12. ^{13}C NMR spectrum of compound **9** in DMSO-d_6.

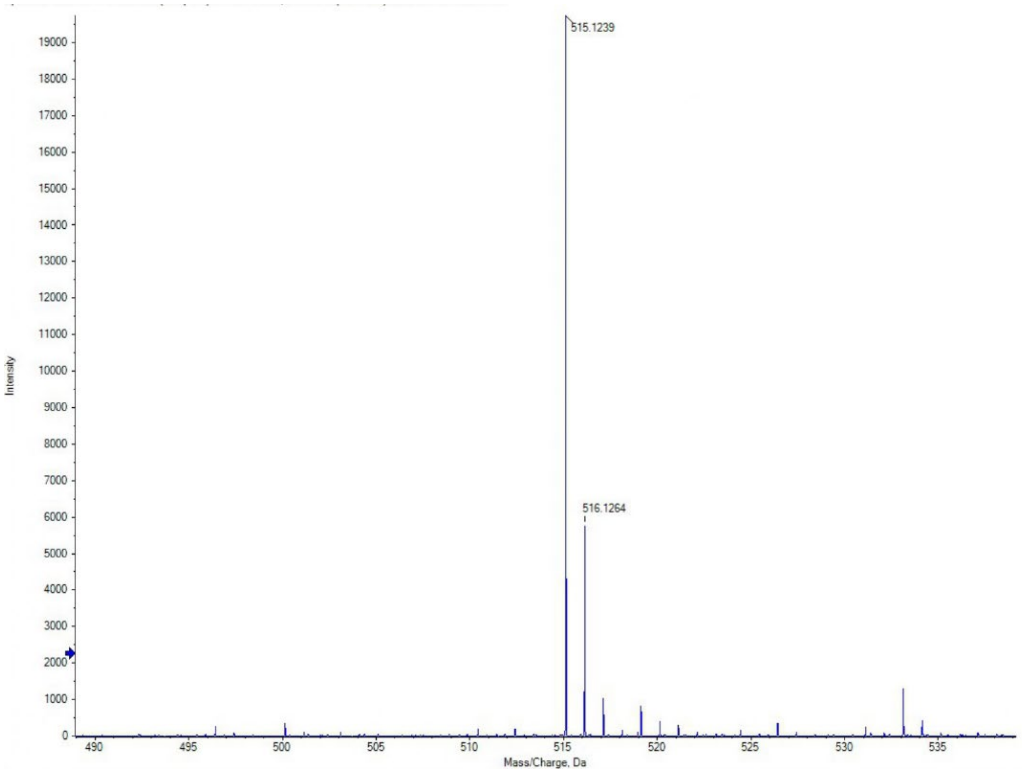

Figure S13. Mass spectroscopy data of compound 9.

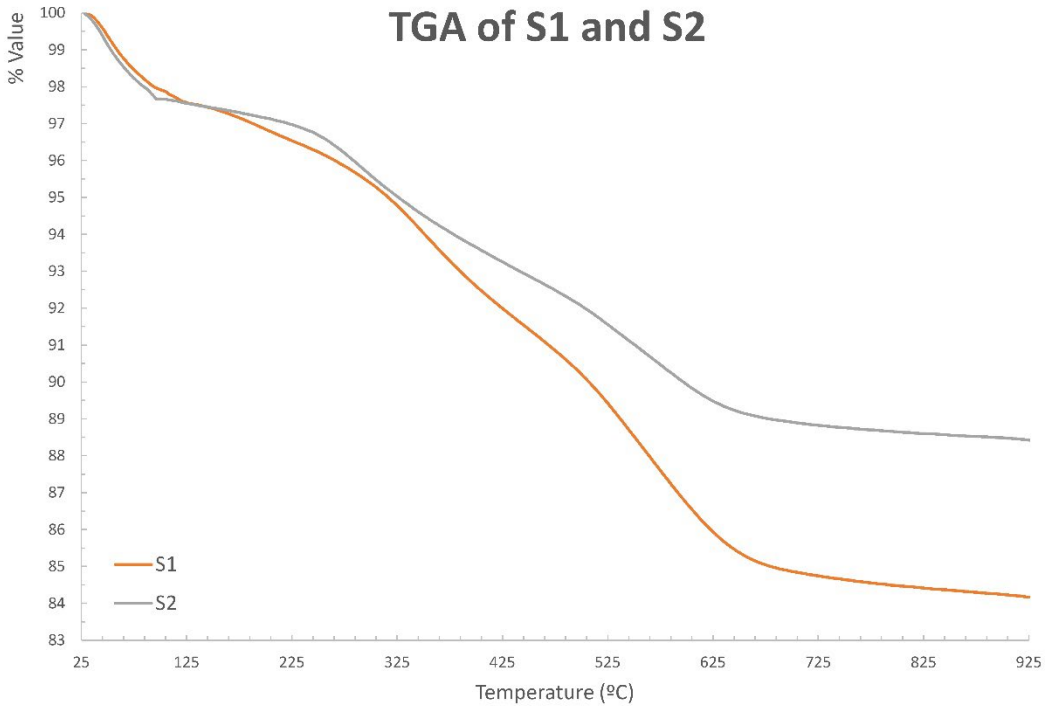

Figure S14. Thermogravimetric analysis (TGA) of solids S1 and S2.

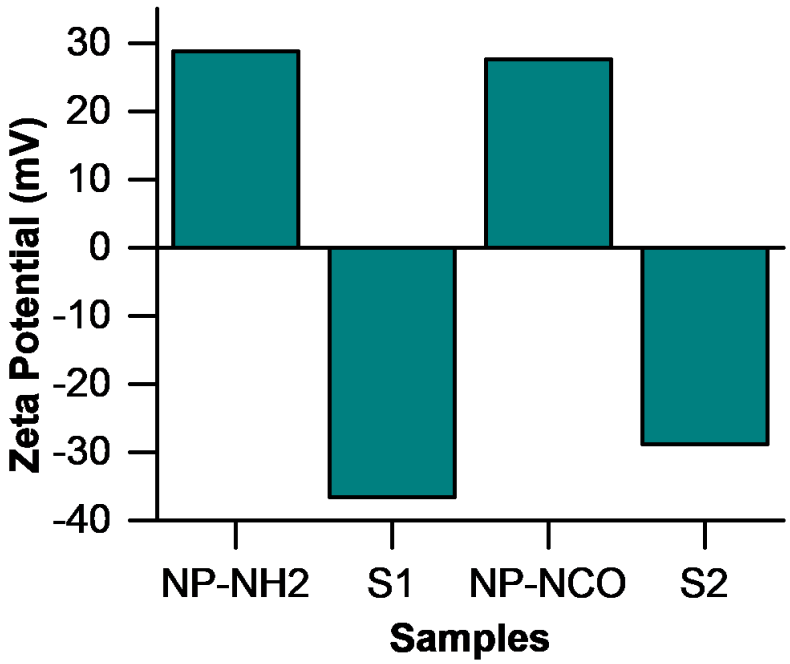

Figure S15. Zeta Potential for SiNPs-APTES (depicted as NP-NH2), S1, SiNPs-NCO (depicted as "NP-NCO") and S2.

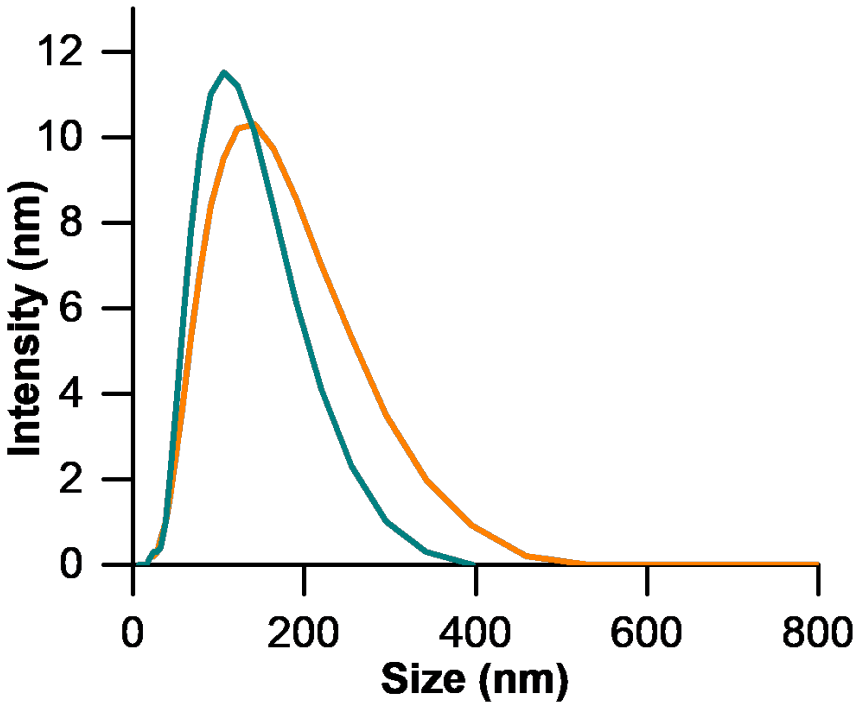

Figure S16. Hydrodynamic diameter distribution of S1 (green line) and S2 (orange line).

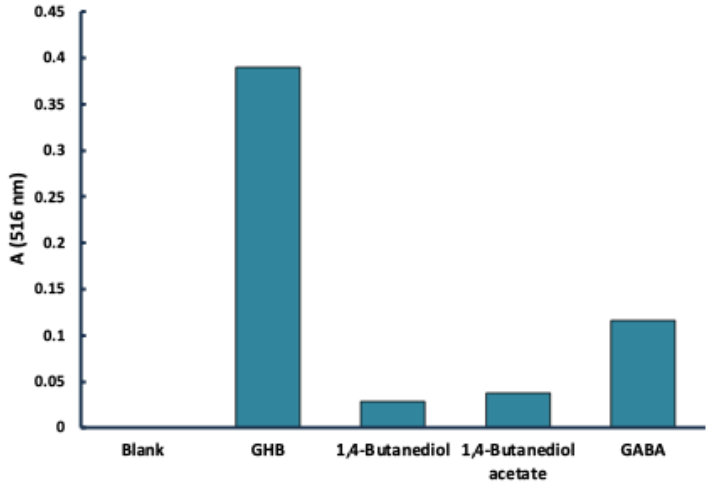

Figure S17. Absorbance at λ = 516 nm of nanosensor S1 (0.33 mg/mL in DMSO) solutions containing GHB and different possible interferents (49.2 µM).

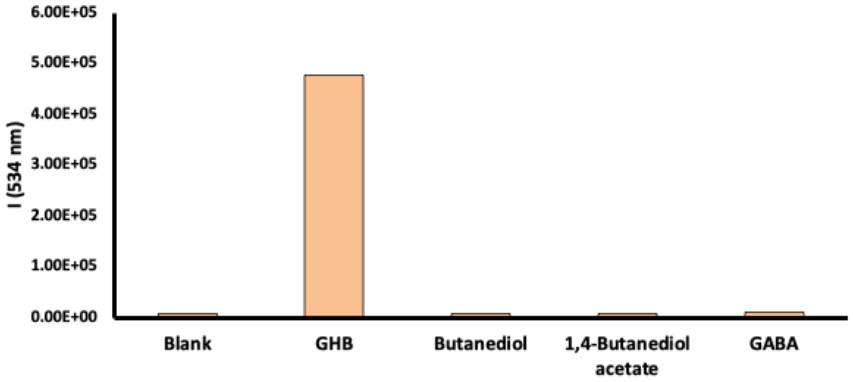

Figure S18. Emission intensity at λ = 534 nm (λ_{exc} = 490 nm) of nanosensor S2 (1 mg/mL in DMSO) solutions containing GHB and different interferents (189 µM).

Table S1. Recovery and accuracy of the method with S1 to detect GHB in aqueous samples were calculated according to reference K. A. Rawat, R. K. Singhal, S. K. Kailasa, RSC Adv. 6 (2016) 32025-32036. https://doi.org/10.1039/c6ra01575a

Analyte	Known concentration (μM)	Found concentration (μM)	Recovery %[a]	Accuracy %[b]
GHB	39	40.7	104%	4%

[a] recovery % (found concentration/known concentration) x 100
[b] accuracy % (found concentration – known concentration/known concentration) x 100

Table S2. Recovery and accuracy of the method with S2 to detect GHB in aqueous samples were calculated according to reference K. A. Rawat, R. K. Singhal, S. K. Kailasa, RSC Adv. 6 (2016) 32025-32036. https://doi.org/10.1039/c6ra01575a

Analyte	Known concentration (μM)	Found concentration (μM)	Recovery %[a]	Accuracy %[b]
GHB	100	95.5	96%	-4%

[a] recovery % (found concentration/known concentration) x 100
[b] accuracy % (found concentration – known concentration/known concentration) x 100

Table S3. Comparison of the sensing properties of different optical selective probes for GHB detection.

Probe	Detection	LOD	Linear Range	Response Time	Ref.
BODIPY derivative	Fluorescence "Turn off" *In solution*	5 mg mL^{-1}	5 - 100 mg mL^{-1}	No data available	*Chem. Commun*., **2014,** 50, 2904
Iridium (III) complex	Fluorescence "Turn off" *In solution*	0.15 mg mL^{-1}	0.15 – 1.3 mg mL^{-1}	No data available	*J. Mater. Chem. B*, **2017**, 5, 2739--2742
Naphthoxazole derivatives (**1** and **2**)	**1:** Colorimetric (yellow to red) **2:** Fluorescence "Turn on" *Both in solution*	**1:** 0.13 μM **2:** 0.12 μM	**1:** 0.2 - 8 μM **2:** 0.2 - 10 μM	Immediately after a basic pre-treatment of sample	*Chem. Commun*., **2020,** 56, 12600-12603

Thiourea derivatives (**1** and **2**)	Colorimetric (Yellow to orange) *In solution*	**1:** 1.75 µM **2:** 0.77 µM	**1**: 2 - 12 µM **2:** 1 - 9 µM	Immediately after a basic pre-treatment of sample	*Analyst, **2021**, 146, 5601-5609*
PCDA-Gabazine	Colorimetric (blue to red) *In PCDA nanofibers*	9.6 µg mL^{-1}	0.015 – 0.5 µg μL^{-1}	No data available	*Sens. Actuators B: Chem.,* **2021,** *347, 130598*
Iron (III) complex	Colorimetric (red to yellow) Fluorescence "Turn on" *Both in solution*	0.25 µg mL^{-1} (abs.) 0.01 µg mL^{-1} (em.)	0.3 – 10 µg mL^{-1} (abs.) 0.05 – 10 µg mL^{-1} (em.)	Less than 5 seconds	*Sens. Actuators B: Chem.,* **2022,** *364, 131861*
Fluorene-containing cyanostilbenes	Fluorescence "Turn on" *In solution and chromatographic paper*	5 mM	5 - 50 mM	No data available	*J Photochem Photobiol A Chem., **2022**, 427, 113844*
Copper (II) complex	Fluorescence "Turn on" *In glass fiber paper*	0.03 µM	0.02 – 0.5 µM	60 seconds (measured through smartphone)	*Sens. Actuators B: Chem.,* **2023,** *137, 133043*
Naphthoxazoles and benzoxazole derivatives	Fluorescence "Turn on" *In cellulose-based paper*	7.3 mM	10 - 125 mM	Immediately, but Maximum response after 1 hour	*Sens. BioSensing Res., **2024**, 46, 100691*
Amino quinazolinone-based derivatives	Colorimetric (colorless to yellow) *In solution and LPAD paper*	0.012 mM (sol.) 4.13 mM (LPAD)	0.013 – 0.1 mM (sol.) 13.76 – 20 mM (LPAD)	Immediately	*Sens. Actuators B: Chem.,* **2024,** *418, 136228*
Naphthoxazole derivatives (**S1** and **S2** in silica nanoparticles)	**S1:** Colorimetric (yellow to red) **S2:** Fluorescence "Turn on" "Both *In suspension*" **1**: Colorimetric (pale pink to deep pink) "*In solution*"	**S1:** 2.21 µM **S2:** 1.65 µM **1:** 19.2 µM	**S1:** 3.7 -49.2 µM **S2:** 2.85-118.3 µM **1:** 32-132 µM	Immediately	*This work*