Supporting Information

Expression of Sensitized Eu^{3+} Luminescence at a Multivalent Interface

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Control experiment with the sulfonate-modified naphthalene derivative **4**

A β -CD SAM substrate was printed with an equimolar ratio of **1** and **4** for 30 min (Figure S1 A and B inset), followed by immersion in aqueous EuCl_3 . As observed from Figure S1 B, no significant Eu^{3+} emission was observed for $\mathbf{1} \cdot \text{Eu}^{3+}$, which demonstrates that energy transfer only by the effective coordination from the carboxylate of **2** to the Eu^{3+} center.

Figure S1. Fluorescence microscopy images (884 μm x 666 μm) of 50 μm dots onto a β -CD SAM made by μCP of a mixture of **1** and **4** for 30 min before (insets) and after (main images) immersion in a solution of EuCl_3 for 30 min, monitoring Eu^{3+} (A) and antenna (B) emission.

Control experiment with the EDTA-based ligand **3**

A β -CD SAM substrate was printed with **2** for 30 min (Figure S2), followed by immersion in a solution of $\mathbf{3}\cdot\text{Eu}^{3+}$ for 30 min. As observed from Figure S2 B, no significant Eu^{3+} emission was observed for $\mathbf{3}\cdot\text{Eu}^{3+}$, which demonstrates that direct coordination of the carboxylate is too weak to occur on its own, and has to be assisted by anchoring of both ligands on the receptor surface leading to efficient energy transfer from **2** to the Eu^{3+} center.

Figure S2. Fluorescence microscopy images ($884\ \mu\text{m} \times 666\ \mu\text{m}$) of $50\ \mu\text{m}$ dots onto a β -CD SAM made by μCP of a solution of **2** for 30 min, before (insets) and after (main images) immersion in a solution of $\mathbf{3}\cdot\text{Eu}^{3+}$ for 30 min, monitoring Eu^{3+} (A) and antenna (B) emission.

Time-resolved fluorescence measurements

To obtain sufficient signal, a stack of 6 glass slides coated on both sides with a monolayer of **2** or an equimolar mixture of **2** and **1**·Eu³⁺ was sampled at a time. The excitation source was a LED emitting at 282 nm at 1 MHz repetition rate. Emitted photons were detected in a narrow wavelength range around the naphthalene emission maximum at 370 nm (slit 10 nm). The emission lifetime from the naphthalene compound on the surface in the absence of the Eu³⁺ could be fitted with a double exponential with one strongly dominating component of $\tau_1 = 2.3$ ns (89% relative amplitude) and a minor component of 7.0 ns (11% relative amplitude) (Figure S3). In the presence of **1**·Eu³⁺, the lifetime of both components significantly dropped to 1.5 ns and 5.3 ns, respectively, while the relative amplitudes were preserved (91% and 9%). From these lifetimes we determined the dominant energy transfer efficiency to be 35% for the major and 25% for the minor component. To exclude any effect from possible energy transfer acceptor saturation due to the very long Eu³⁺ emission lifetime on the recorded decay characteristics, the experiment was repeated using a reduced excitation frequency of 100 kHz. The obtained results were identical to the ones obtained with 1 MHz excitation.

Figure S3. Time-resolved fluorescence measurements of **2** alone and of **2** and **1**·Eu³⁺ on a β -CD SAM excited at 282 nm with a 1 MHz LED. The 2.3 ns and 7.0 ns lifetime components were derived from fitting the decay curves of **2**.

Stoichiometry analysis

Solutions of different molar ratios of **1** and **2** were prepared in order to study the extent of coordination between **2** and $1 \cdot \text{Eu}^{3+}$ (method **ii**) and the stoichiometry of the resulting complex. Solution mixtures of **1** and **2** were prepared, for which the concentration of **2** was varied to be 0%, 20%, 40%, 50%, 60%, 80% and 100% (all with saturated native β -CD present). The samples were imaged with fluorescence microscopy before (**ii_a**) and after (**ii_b**) EuCl_3 incubation with both filters **B** (Figure S4 A and B) and **R** (Figure S4 C).

Figure S4. Fluorescence microscopy images of 50 μm dots prepared on β -CD monolayers by μCP (30 min) of solution mixtures of different ratios of **1** and **2** (the concentration of **2** varying from 0%, 20%, 40%, 50%, 60%, 80% and 100%) (**ii_a**), followed by rinsing with MilliQ water (A), and subsequently immersed in a solution of EuCl_3 for 30 min (**ii_b**) (B, C), monitoring antenna (A, B; **B** filter) and Eu^{3+} emission (C; **R** filter). The percentages of antenna **2** in the mixture of **1** and **2** are given in the images. The intensity profiles (bottom) are also shown before (A) and after (B, C) EuCl_3 immersion.

Complex formation in solution

Luminescence spectroscopy measurements were performed to study the sensitized luminescence of the lanthanide complex $1 \cdot \text{Eu}^{3+}$ in solution in the absence and presence of **2**. The luminescence intensity of a 10 μM solution of $1 \cdot \text{Eu}^{3+}$ in H_2O did not show typical Eu^{3+} emission at 615 nm upon addition of an equimolar amount of **2**, excited at 350 nm while recording the luminescence spectrum between 350 nm and 650 nm (Figure S5). The broad band from 350 nm to 500 nm was attributed to the emission of **2**.

Figure S5. Luminescence emission spectra of 10 μM solution of **2**, $2+1 \cdot \text{Eu}^{3+}$ and $1 \cdot \text{Eu}^{3+}$ in H_2O excited at 350 nm.

Thermodynamic complexation model at interfaces

Complexation of $1 \cdot \text{Eu}^{3+}$ by **2** on a β -CD SAM was modeled using a thermodynamic model governed by effective concentration,¹ using a spreadsheet approach. Because each ligand **1** and **2** is bound in a divalent fashion, the maximum coverage of $1 \cdot \text{Eu}^{3+}$ and **2** is only half of the coverage of the β -CD SAM. The model employs binding constants for interaction of an adamantyl group to a β -CD surface site ($5 \times 10^4 \text{ M}^{-1}$) and for the 1:1 interaction of the antenna carboxylate group to the Eu^{3+} center (K). The latter one is varied to show the effect on the simulated Job plot. The modeled fluorescence intensities are obtained by relating the fractions of unbound and bound antenna **2** and Eu^{3+} complex $1 \cdot \text{Eu}^{3+}$, assuming arbitrarily set values for the emission of **2**, $1 \cdot \text{Eu}^{3+}$ and the complex $1 \cdot \text{Eu}^{3+} \cdot \text{2}$.

The modeled data presented in Figure S6 (triangles, green) show that the fraction of unbound **2** at the surface increases after > 50 % of **2** in the printed mixture. The curves start to show a sharp inflection point when $K > 10^3 \text{ M}^{-1}$. There is no significant difference of Eu^{3+} emission (Figure S6 circles, red) between the model and the experimental graphs when $K > 10^3 \text{ M}^{-1}$ which means that this K is a lower limit for the complex formation on the β -CD SAM. However, since the samples presented in Figure S4 were measured in the dry state, the absolute value of K is probably unreliable. Due to the fact that the sensitized luminescence is practically absent at $10 \text{ }\mu\text{M}$ in solution (Figure S5), the binding constant K probably has an upper limit of about 10^4 M^{-1} .

Figure S6. Simulated fluorescence intensity data showing the emission of antenna and Eu^{3+} as a function of the ratio of antenna and Eu^{3+} while varying the binding constant K of the carboxylate group of **2** to Eu^{3+} in $1 \cdot \text{Eu}^{3+}$ at the surface.

Experimental procedures

General

All reactions involving air- or moisture-sensitive reagents or intermediates were performed under an inert atmosphere of argon in glassware. Unless otherwise noted, solvents and reagents were reagent grade and used without further purification: Ethylene diamine tetraacetic dianhydride (Aldrich), Europium chloride hexahydrate (Acros), 3,5-dihydroxy benzyl alcohol (Aldrich), methyl-6-hydroxy-2-naphthoate (TCI Europe), 6-hydroxy-2-naphthalene sulfonic acid sodium salt (Aldrich). β -CD heptamine, amino ethyl triethylene glycol adamantyl ether and bromo triethylene glycol ethyl adamantyl ether were synthesized as described before.^{2,3} NMR spectra were recorded on Varian AC300 spectrometer in the indicated solvent at rt. Chemical shifts are reported in parts per million (ppm) downfield from (CH₃)₄Si (TMS). Coupling constants are reported in hertz (Hz). Spectral splitting patterns are designated as follows: s, singlet; d, doublet; t, triplet; q, quartet; m, multiplet. ESP-MS spectra were recorded with a WATERS-LCT spectrometer.

Synthesis

Compound 1:

A solution of amino ethyl triethylene glycol adamantyl ether (511.2 mg, 1.56 mmol) and Et₃N (3 ml) was added dropwise to a solution of ethylenediaminetetraacetic dianhydride (200 mg, 0.78 mmol) in DMF at 0 °C. The reaction mixture was stirred for 2 days at rt. After evaporation of the solvent, the residue was dissolved in water and the pH was adjusted to 7. Water was removed under reduced pressure and methanol was added to separate insoluble salts. The solvent was removed by rotary evaporator after filtration, and the residue was washed several times with diethyl ether. The product was obtained as a colorless oil, yield 80%. ¹H NMR (300 MHz, CD₃OD) δ 3.70-3.55 (m, 28H), 3.35-3.29 (m, 8H), 3.19-3.13 (m, 4H), 2.71-2.67 (m, 4H), 2.20-2.15 (m, 6H), 1.80-1.79 (m, 12H), 1.75-1.63 (m, 12H). ¹³C

NMR (75 MHz, CD₃OD) δ 174.9, 170.3, 71.0, 69.5, 68.7, 57.6, 56.6, 51.2, 39.8, 34.8, 29.3. MS (ESP) calcd for C₄₆H₇₈N₄O₁₄ (M+H) 912.1; found 912.0.

Compound 1·Eu³⁺:

The Eu(III) complex of compound **1** was prepared by adding a solution of EuCl₃·6H₂O in water to a solution of **1**, adjusting the pH to 7 with overnight stirring at rt. A slight excess of **1** relative to Eu(III) (1.03:1) was used, ensuring quantitative complexation of the lanthanide ion. MS (ESP) calcd for C₄₆H₇₆EuN₄O₁₄ (M) 1061.0; found 1061.2.

Compound 2:

A suspension of **6** (340 mg, 0.413 mmol), methyl-6-hydroxy-2-naphthoate (83.44 mg, 0.413 mmol), dried potassium carbonate (57.04 mg, 0.5 mmol), and 18-crown-6 (10.5 mg, 0.04 mmol) in acetone (50 mL)

was refluxed overnight. The solvent was evaporated and the residue was partitioned between water (50 mL) and diethyl ether (50 mL). The aqueous layer was extracted with diethyl ether (3x25 mL) and the combined extracts were dried over MgSO₄. The solvent was evaporated and the residue was purified by column chromatography (EtOAc, eluent) to give the methyl ester of **2** as a colorless oil (273.2 mg, 70%). ¹H NMR (300 MHz, CDCl₃) δ 8.49 (s, 1H), 7.98 (d, *J*=9 Hz, 1H), 7.81 (d, *J*=9 Hz, 1H), 7.70 (d, *J*=9 Hz, 1H), 7.23 (d, *J*=9 Hz, 1H), 7.17 (s, 1H), 6.62 (s, 2H), 6.44 (s, 1H), 5.09 (s, 2H), 4.09 (t, *J*=4.8 Hz, 4H), 3.93 (s, 3H), 3.81 (t, *J*=4.8 Hz, 4H), 3.72-3.51 (m, 24H), 2.09-2.06 (m, 6H), 1.75-1.70 (m, 12H), 1.65-1.52 (m, 12H). ¹³C NMR (75 MHz, CDCl₃) δ 167.5, 160.4, 158.7, 138.9, 137.2, 131.1, 130.9, 128.2, 127.1, 126.1, 125.5, 120.0, 107.3, 106.2, 101.3, 72.3, 71.4, 71.3, 71.0, 70.8, 70.2, 69.8, 67.7, 60.5, 59.3, 52.3, 47.7, 36.6, 30.7. MS (ESP) calcd for C₅₅H₇₆O₁₃ (M) 945.1; found 945.4.

A solution of the methyl ester of **2** in THF (20 mL) was slowly added to a solution of excess NaOMe (freshly prepared) in MeOH (20 mL). The mixture was refluxed overnight, the solvent was removed, and the residue was acidified with HCl (aq) and extracted with EtOAc. The evaporation of solvent gave compound **2** (quantitative yield) ¹H NMR (300 MHz, CDCl₃) δ 8.54 (s, 1H), 8.00 (d, *J*=9 Hz, 1H), 7.80 (d, *J*=9 Hz, 1H), 7.68 (d, *J*=9 Hz, 1H), 7.21 (d, *J*=9 Hz, 1H), 7.14 (s, 1H), 6.59 (s, 2H), 6.43 (s, 1H), 5.04 (s, 2H), 4.07 (t, *J*=4.8 Hz, 4H), 3.80 (t, *J*=4.8 Hz, 4H), 3.70-3.52 (m, 24H), 2.13-2.04 (m, 6H), 1.74-1.69 (m, 12H), 1.65-1.50 (m, 12H). ¹³C NMR (75 MHz, CDCl₃) δ 170.9, 160.3, 158.9, 138.9, 137.5, 131.7, 131.2, 128.1, 127.1, 126.3, 125.0, 120.0, 107.3, 106.2, 101.3, 72.5, 71.4, 71.2, 70.9, 70.8, 70.1, 69.8, 67.7, 60.5, 59.3, 41.6, 36.6, 30.7. MS (ESP) calcd for C₅₄H₇₄O₁₃ (M) 931.1; found 931.4.

Compound 3:

A solution containing compound **1** (0.10 g, 0.14 mmol) in 50% trifluoroacetic acid-CH₂Cl₂ (10 mL) was stirred overnight at rt. Solvents were removed under reduced pressure followed by the addition and then evaporation of CH₂Cl₂ (3x10 mL) and finally diethyl ether (10 mL). The residue was taken up in H₂O,

filtered, and lyophilized to give **3** (quantitative yield). ^1H NMR (300 MHz, CDCl_3) δ 3.81-3.40 (m, 32H), 3.32-3.27 (m, 4H), 3.12-3.08 (m, 8H). MS (ESP) calcd for $\text{C}_{43}\text{H}_{68}\text{O}_{11}$ ($\text{M}+\text{H}$) 761.5; found 761.4.

Compound **3**· Eu^{3+} :

The Eu(III) complex of **3** was synthesized similar to that of **1**· Eu^{3+} . MS (ESP) calcd for $\text{C}_{26}\text{H}_{48}\text{EuN}_4\text{O}_{14}$ ($\text{M}+\text{H}$) 793.64; found 793.2.

Compound **4**:

Na (46.6 mg, 2.02 mmol) was dissolved in MeOH previously cooled in an ice-bath. 6-Hydroxy-2-naphthalene sulfonic acid sodium salt (0.498 g, 2.02 mmol) was added and the mixture was stirred and heated to 60 °C to dissolve any precipitated material. Compound **6** was added with small portions over a period of 15 min. The mixture was refluxed overnight, cooled to room temperature and the solvent was evaporated. The residue was dissolved in chloroform and filtered. The solvent was evaporated and washed several times with diethylether. The product was obtained as a white solid (0.6 g,

30%) ^1H NMR (300 MHz, CDCl_3) δ 8.29 (s, 1H), 7.81 (d, $J=9$ Hz, 1H), 7.51 (d, $J=9$ Hz, 1H), 7.31 (d, $J=9$ Hz, 1H), 7.01 (d, $J=9$ Hz, 1H), 6.91 (s, 1H), 6.57 (s, 2H), 6.43 (s, 1H), 4.94 (s, 2H), 4.07 (m, 4H), 3.76 (m, 4H), 3.70-3.52 (m, 24H), 2.12-2.01 (m, 6H), 1.72-1.64 (m, 12H), 1.61-1.46 (m, 12H). MS (ESP) calcd for $\text{C}_{53}\text{H}_{73}\text{NaO}_{14}\text{S}$ ($\text{M}+\text{H}-\text{Na}$) 967.19; found 967.5.

Compound 5:

A suspension of bromoethyl triethylene glycol adamantyl ether (1.5 g, 3.83 mmol), 3,5-dihydroxy benzyl alcohol (268.5 mg, 1.916 mmol), dried potassium carbonate (529.76 mg, 3.83 mmol), and 18-crown-6 (0.11 g, 0.42 mmol) in acetone (50 mL) was refluxed for 72 h. The solvent was evaporated and the residue was partitioned between water (50 mL) and diethyl ether (50 mL). The aqueous layer was extracted with diethyl ether (3x25 mL) and the combined extracts were dried over MgSO_4 . The solvent was evaporated and the residue was purified by column chromatography (EtOAc, eluent) to give **5** as a colorless oil (874.8 mg, 60%) ^1H NMR (300 MHz, CDCl_3) δ 6.50 (s, 2H), 6.35 (s, 1H), 4.55 (s, 2H), 4.06 (t, $J=4.8$ Hz, 4H), 3.79 (t, $J=4.8$ Hz, 4H), 3.69-3.53 (m, 24H), 2.12-2.08 (m, 6H), 1.72-1.68 (m, 12H), 1.64-1.50 (m, 12H). ^{13}C NMR (75 MHz, CDCl_3) δ 160.2, 143.7, 105.7, 101.4, 72.4, 71.4, 71.3, 71.0, 70.9, 69.9, 67.7, 65.3, 60.5, 59.3, 41.6, 36.6, 30.6. MS (ESP) calcd for $\text{C}_{43}\text{H}_{68}\text{O}_{11}$ ($\text{M}+\text{H}$) 761.5; found 761.4.

Compound 6:

A solution of phosphorus tribromide (78.65 mg, 0.29 mmol) in toluene (5 mL) was added dropwise to a cooled (0 °C) solution of **5** (562.0 mg, 0.73 mmol) in toluene (50 mL). The mixture was stirred for 1 h at room temperature. The solvent was removed under reduced pressure and the residue was partitioned between dichloromethane (100 mL) and water (100 mL). The organic layer was washed with water (3x50 mL) and brine (1x50 mL) and dried over MgSO₄. The solvent was removed under reduced pressure and the residue was purified by column chromatography (EtOAc, eluent) to give **6** as a colorless oil (456 mg, 75%). ¹H NMR (300 MHz, CDCl₃) δ 6.52 (s, 2H), 6.40 (s, 1H), 4.36 (s, 2H), 4.07 (t, *J*=4.8 Hz, 4H), 3.81 (t, *J*=4.8 Hz, 4H), 3.73-3.50 (m, 24H), 2.15-2.10 (m, 6H), 1.76-1.71 (m, 12H), 1.67-1.53 (m, 12H). ¹³C NMR (75 MHz, CDCl₃) δ 160.2, 139.8, 128.4, 108.1, 101.9, 72.4, 71.6, 71.5, 71.4, 71.3, 71.0, 70.8, 69.8, 67.7, 59.4, 41.6, 36.6, 30.7. MS (ESP) calcd for C₄₃H₆₇BrO₁₀ (M) 823.8; found 823.2.

Sample preparation

Substrate and Monolayer preparation. Microscope glass slides were used for β -cyclodextrin (β -CD) monolayer preparation.⁴ The substrates were cleaned with piranha solution for 15 min (concentrated H_2SO_4 and 33 % aqueous H_2O_2 in a 3:1 ratio; Caution: piranha should be handled carefully) and rinsed with MilliQ. After drying in a nitrogen stream, the substrates were used immediately for silanized monolayer formation. The substrates were enclosed in a low-vacuum desiccator with 0.1 ml TPEDA, continually pumping for 5 min to create a vapor phase of TPEDA. After overnight incubation, the slides were rinsed with ethanol and dichloromethane to remove any excess of silanes and subsequently dried in a nitrogen stream. The attachment of 1,4-phenylene diisothiocyanate was made in a 20 mM solution in toluene at 60°C during 2 h. Samples were thoroughly rinsed with toluene and dried in a nitrogen flow. The β -CD layer attachment was made during 2 h in an aqueous 0.1mM β -cyclodextrin-heptaamine solution (pH~7) at 60°C. Samples were thoroughly rinsed with water and dried in a nitrogen flow.

Microcontact printing. Patterned silicon substrates were made by photolithography followed by reactive ion etching (RIE) or e-beam lithography. They consisted of gratings of 50 μm dots at 70 μm period with the height of 1 μm . PDMS stamps were prepared by casting a 10:1 (v/v) mixture of poly(dimethylsiloxane) (PDMS) prepolymer and curing agent (Sylgard 184, Dow Corning) against a silicon master. After overnight curing at 60 °C, the stamps were oxidized by oxygen plasma for 1 min and subsequently inked by dropping aqueous adsorbate solution onto the stamp. Before printing, the stamps were blown dried in a stream of nitrogen. The stamps were brought into conformal contact with the substrate for 30 min. The stamps were changed for each new print and the same inking procedure was used. After stamp removal, the printed substrates were rinsed with copious amounts of water, blown dry with nitrogen and imaged with fluorescence microscopy.

Printing of 1 and 2 (or 4), followed by EuCl_3 immersion. The β -CD SAM substrate was printed for 30 min with a stamp inked with an equimolar ratio of **1** and **2** (or **4**) (2 mM each) in saturated β -CD in a 3:1 mixture of EtOH/water, followed by rinsing with water and drying in a stream of nitrogen. The printed substrate was immersed in a 4 mM aqueous solution of EuCl_3 for 30 min, followed by rinsing and drying in a stream of nitrogen.

Printing of 2, followed by $1\cdot\text{Eu}^{3+}$ (or $3\cdot\text{Eu}^{3+}$) immersion. The β -CD SAM substrate was printed for 30 min with a stamp inked with a solution of **2** in saturated β -CD in a 3:1 mixture of EtOH/water, followed by

rinsing with water and drying in a stream of nitrogen. The printed substrate was immersed in a 2 mM aqueous solution of $1\cdot\text{Eu}^{3+}$ (or $3\cdot\text{Eu}^{3+}$) for 30 min, followed by rinsing and drying in a stream of nitrogen.

Printing of different ratios of 1 and 2, followed by EuCl_3 immersion. The β -CD SAM substrate was printed for 30 min with a stamp inked with different molar ratio of **2** and **1** varying from 0%:100%, 20%:80%, 40%:60%, 50%:50%, 60%:40%, 80%:20%, and 100%:0% in saturated β -CD in a 3:1 mixture of EtOH/water, followed by rinsing with water and drying in a stream of nitrogen. The printed substrate was immersed in a 4 mM aqueous solution of EuCl_3 for 30 min, followed by rinsing and drying in a stream of nitrogen.

Time-resolved fluorescence measurements. Two sets of samples were prepared with or without $1\cdot\text{Eu}^{3+}$ present. The first sample was printed with a flat stamp inked with 2 mM of **2** for 30 min onto a β -CD SAM with saturated β -CD in 3:1 EtOH/water. The same procedure was used to prepare substrates with an equimolar ratio of **2** and $1\cdot\text{Eu}^{3+}$ (2 mM each). In order to enhance the total emission intensity, multiple slides were used in a cuvette during the measurement in air (6 double side printed slides in total). The samples were positioned at 45° orientation relative to the excitation light and the detector. The decay curves at 370 nm for the donor alone (**2**) and in the presence of the acceptor ($1\cdot\text{Eu}^{3+}$) were measured upon excitation at 282 nm.

Equipment

Fluorescence Microscopy

Fluorescence microscope images were taken using an Olympus inverted research microscope IX71 equipped with a mercury burner U-RFL-T as light source and a digital Olympus DR70 camera for image acquisition. UV excitation ($300\text{ nm} \leq \lambda_{\text{ex}} \leq 400\text{ nm}$) and blue emission ($410\text{ nm} \leq \lambda_{\text{em}} \leq 510\text{ nm}$) was filtered using a Dapi Olympus filter cube. UV excitation ($300\text{ nm} \leq \lambda_{\text{ex}} \leq 400\text{ nm}$) and red emission (narrow band pass at 615 nm) was filtered using a Olympus filter cube. All fluorescence microscopy images were acquired in air.

Fluorescence Spectral Microscopy

To record local emission spectra a custom built microscopy setup capable of spectral imaging was used. The sample was illuminated using a mercury lamp and a standard filter cube for UV excitation (excitation 300 nm to 400 nm, detection $> 400\text{ nm}$) via a 100x objective (1.3 NA, Olympus). The local emission was collected by the same objective. The emitted light was imaged via a pinhole and a prism spectrometer onto a cooled CCD camera (Newton EMCCD, Andor). Wavelength calibration was achieved using a calibrated light source (Cal-2000 Mercury Argon Calibration source, Ocean Optics, USA).

Fluorescence Lifetime Spectrophotometer

Fluorescence lifetimes were determined using a spectrophotometer (FluoroMax4, Horiba Jobin Yvon), equipped with a TCSPC extension and a pulsed 282 nm NanoLED for excitation (all Horiba Jobin Yvon). The recorded data was analyzed using the DAS6 software package of Horiba Jobin Yvon.

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