Electronic Supplementary Material (ESI) for Nanoscale.

Supporting information: Probing the interaction of nanoparticles with small molecules in real time via quartz crystal microbalance monitoring

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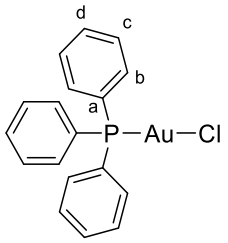
Contents

Synthesis of organic compounds

General experimental procedures

Unless otherwise stated, chemicals were purchased from commercial sources (Sigma Aldrich, Fluorochem, Acros, Fluka, Alfa Aesar, Apollo Scientific or TCI) and used without further purification. THF used in the purification of nanoparticles was stabiliser-free and purchased from Sigma Aldrich. Dry solvents were obtained by means of a MBRAUN MB SPS-800TM solvent purification system, where solvents were passed through filter columns and dispensed under an argon atmosphere. Flash column chromatography was performed using Geduran® Si60 (40-63 μm, Merck, Germany) as the stationary phase, and TLC was performed on pre-coated silica gel plates (0.25 mm thick, 60F254, Merck, Germany) and observed under UV-light λ_{max} = 254 nm), or visualized by staining with a basic potassium permanganate or an acidic cerium molybdate solution, followed by heating. NMR spectra were recorded on a Bruker AVIII 500 fitted with a CryoProbe Prodigy BBO or a Bruker AVIII-HD 500 fitted with a SmartProbe BBFO+. All the spectra were recorded at 296 K unless otherwise stated and chemical shifts are reported in ppm, from low to high field, relative to TMS for ^{1}H and ^{13}C NMR, and CCl_3F for ^{19}F NMR with reference to residual solvent peaks or an internal standard (CCl_3F: δ_F = 0 ppm in all solvents). Mass spectrometry was carried out on a Waters Xevo G2-S ASAP at the EPSRC UK National Mass Spectrometry Facility at Swansea University for isolated compounds.

Compound S1: Chloro(triphenylphosphine)gold(I)



A solution of PPh_3 (4.9 g, 19 mmol) in Et_2O (40 mL) was added dropwise over 30 minutes to a solution of $HAuCl_4{\cdot}3H_2O$ (3.5 g, 8.9 mmol) in Et_2O (150 mL) at 0 °C. The reaction mixture was stirred at 0 °C for 2 hours and then allowed to warm to room temperature. The reaction was stirred at room temperature until the yellow colour completely disappeared. Addition of more PPh_3 may be required for the yellow colour to completely disappear. The white precipitate obtained was then collected by filtration. The solid was washed with cold Et_2O. The solid recovered was then dissolved in CH_2Cl_2 and precipitated with Et_2O. The precipitate was collected and purified by column chromatography (SiO_2, CH_2Cl_2) to afford the desired product **S1** as a white solid (3.9 g, 7.9 mmol, 89 %, spectral data in agreement with the literature[1]); ^{1}H NMR (499.9 MHz, $CDCl_3$): δ 7.56–7.43 (15H, m, H_b, H_c and H_d); ^{13}C NMR (125.7 MHz, $CDCl_3$): δ 134.2 (d, J = 13.7 Hz, C_b), 132.1 (d, J = 2.4 Hz, C_d), 129.4 (d, J = 11.9 Hz, C_c), 128.7 (d, J = 62.5 Hz, C_a); ^{31}P NMR (202.4 MHz, $CDCl_3$): δ 33.2.

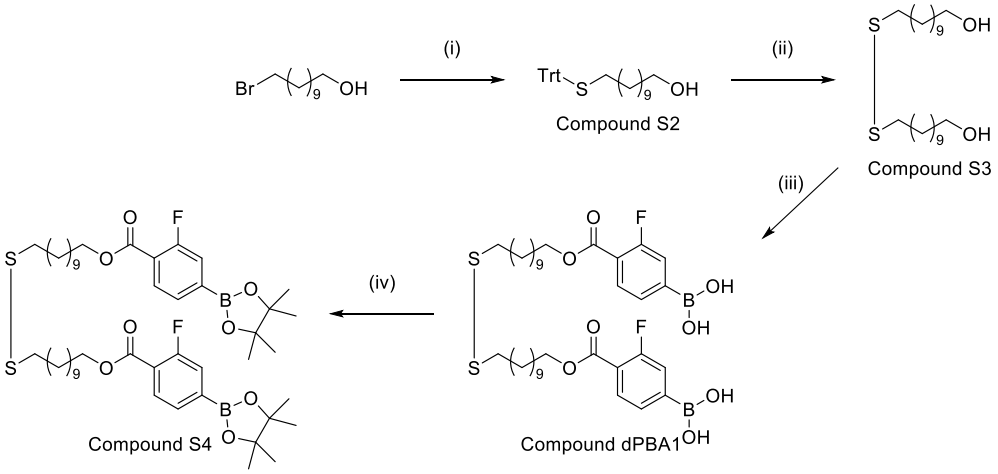
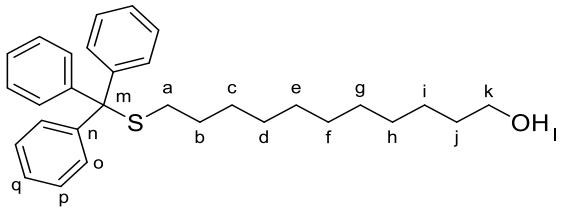


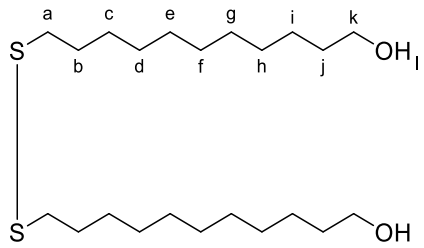
Figure S1. Synthetic procedures for the preparation of proligand **S4**. Reagents and conditions: (i) triphenylmethanethiol, NaOH, EtOH/PhH/H_2O, 18 h, rt, 88%; (ii) I_2, CH_2Cl_2/MeOH, 1 h, rt, 80%; (iii) 4-carboxy-3-fluorophenylboronic acid, EDC·HCl, DMAP, DMF, 3 d, rt, 90%; (iv) pinacol, $MgSO_4$, THF, reflux, 5 h, 99%.

Compound S2: 11-(tritylthio)undecanol



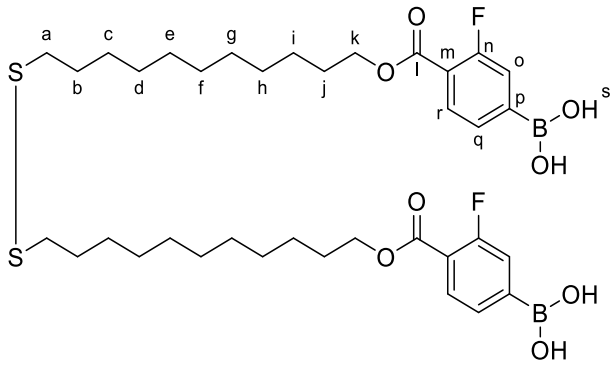
A solution of NaOH (2.67 g, 66.8 mmol) in H_2O (25 mL) was added to a solution of triphenylmethanethiol (12.3 g, 44.5 mmol) in a mixture of EtOH/PhMe (1:1v/v, 100 mL). 11-Bromoundecanol (11.2 mg, 44.5 mmol) was dissolved in a second solution of EtOH/PhMe (1:1 v/v, 100 mL), which was then added to the triphenylmethanethiol mixture in one portion. The reaction mixture was stirred for 18 hours at room temperature. The mixture was poured into a saturated solution of $NaHCO_3$ (50 mL) and extracted with Et_2O (3 × 40 mL). The combined organic layers were washed with brine (3 × 40 mL), dried over $MgSO_4$ and the solvent was removed under vacuum to give a pale yellow oil. The crude product was purified by column chromatography (SiO_2, hexane/EtOAc, 8:1 → 1:1) to afford the desired product **S2** as a pale yellow oil (17.4 g, 39.0 mmol, 88%, spectral data in agreement with the literature[1]); ^{1}H NMR (500.1 MHz, $CDCl_3$): δ 7.44–7.37 (6H, m, H_p), 7.32–7.24 (6H, m, H_o), 7.23–7.17 (3H, m, H_q), 3.63 (2H, t, J = 6.6 Hz, H_k), 2.13 (2H, t, J = 7.4 Hz, H_a), 1.61–1.51 (2H, m, H_j), 1.49–1.07 (16H, m, H_b, H_c, H_d, H_e, H_f, H_g, H_h and H_i); ^{13}C NMR (125.8 MHz, $CDCl_3$): δ 145.2 (C_n), 129.7 (C_p), 127.9 (C_o), 126.6 (C_q), 66.4 (C_m), 63.1 (C_k), 32.9, 32.1, 29.7, 29.6, 29.51, 29.49, 29.3, 29.1, 25.8.

Compound S3: bis(11-hydroxyundecyl) disulfide



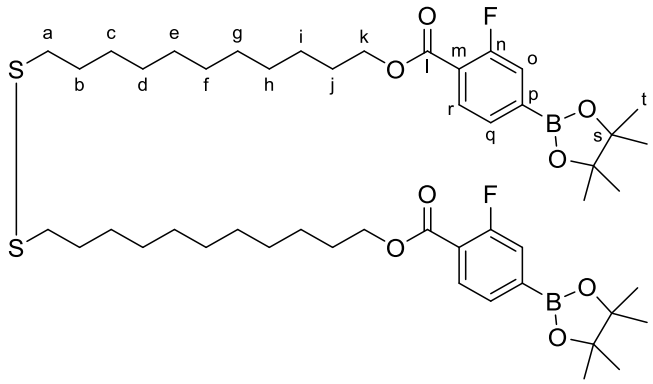
11-(tritylthio)undecanol **S2** (4.00 g, 8.95 mmol) was dissolved in a mixture of CH_2Cl_2 and MeOH (3:1v/v, 50 mL) and solid I_2 (9.1 g, 35.8 mmol) was added in one portion. The resulting solution was stirred at room temperature for 1 hour. The reaction mixture was diluted with CH_2Cl_2 (200 mL) and a saturated solution of sodium sulfite was added until complete decolouration and the volatiles. The organic layer was dried over $MgSO_4$, filtered and evaporated under vacuum. The residue was sonicated in cyclohexane, filtered and washed with cyclohexane. The solid obtained was recrystallized from $CHCl_3$ and cyclohexane to afford the desired product **S3** as a white solid (1.46 g, 3.58 mmol, 80%, spectra data in agreement with the literature[2]); ^{1}H NMR (500.1 MHz, $CDCl_3$): δ 3.63 (4H, q, J = 6.4 Hz, H_k), 2.67 (4H, t, J = 7.4 Hz, H_a), 1.66 (4H, quint, J = 7.4 Hz, H_b), 1.56 (4H, quint, J = 6.4 Hz, H_j), 1.42–1.22 (30H, m, H_c, H_d, H_e, H_f, H_g, H_h, Hi and H_l); ^{13}C NMR (125.8 MHz, $CDCl_3$): δ 63.1 (C_k), 39.2 (C_a), 32.8, 29.6, 29.53, 29.50, 29.4, 29.25, 29.22, 28.5, 25.8.

Compound dPBA1:



Diol **S3** (1.00 g, 2.46 mmol), 4-carboxy-3-fluorophenylboronic acid (1.81 g, 9.83 mmol), EDC·HCl (1.89 g, 9.83 mmol) and DMAP (3.00 g, 24.6 mmol) were added to a flask and dissolved in DMF (100 mL). The resulting solution was stirred at room temperature for 3 days. The reaction mixture was cooled in a freezer and cold 0.1 M HCl (100 mL) was rapidly added under stirring to precipitate a white spongy solid. The solid was redissolved in a mixture of CH_2Cl_2 and MeOH and washed with 0.1 M HCl and brine. The organic layer was dried over $MgSO_4$, filtered and evaporated under vacuum. The waxy residue was redissolved in DMF and precipitated with water. The precipitate was collected by filtration and washed with water to afford the desired product **S4** as a white solid (1.63 g, 2.21 mmol, 90%); ^{1}H NMR (500.1 MHz, DMSO-d_6): δ 8.44 (4H, bs, H_s), 7.81 (2H, t, J = 7.5 Hz, H_r), 7.67 (2H, dd, J = 7.7, 0.8 Hz, H_q), 7.62 (2H, d, J = 11.8 Hz, H_o), 4.25 (4H, t, J = 6.5 Hz, H_k), 2.66 (4H, t, J = 7.2 Hz, H_a), 1.67 (4H, quint, J = 6.6 Hz, H_j), 1.58 (4H, quint, J = 7.2 Hz, H_b), 1.45–1.12 (28H, m, H_c, H_d, H_e, H_f, H_g, H_h and H_i); ^{13}C NMR (125.8 MHz, DMSO-d_6): δ 163.7 (d, J = 3.0 Hz, C_l), 160.5 (d, J = 257.3 Hz, C_n), 142.7 (C_m), 130.6 (d, J = 3.1 Hz, C_r), 129.9 (d, J = 19.9 Hz, C_q), 121.7 (d, J = 10.3 Hz, C_o), 119.5 (d, J = 10.3 Hz, C_p), 65.0 (C_k), 37.9 (C_a), 28.9, 28.9, 28.6, 28.6, 28.5, 28.1, 27.7, 25.4; ^{19}F NMR (470.4 MHz, DMSO-d_6): δ -112.02; HRMS (ASAP+) m/z calculated for $C_{40}H_{59}B_2F_2O_8S_2^+$ [M + $C_2H_6O_2$ + H]$^+$ 791.3806, observed 791.3812.

Compound S4:



Bis(boronic acid) **dPBA1** (1.00 g, 1.35 mmol) was dissolved along with pinacol (0.320 g, 2.70 mmol) in dry THF (5 mL). After stirring for 5 minutes at room temperature, dry $MgSO_4$ was added and the resulting suspension was refluxed for 5 hours. The reaction mixture was filtered and evaporated to yield the desired product **S4** as a colourless transparent wax (1.21 g, 1.34 mmol, 99%); ^{1}H NMR (500.1 MHz, $CDCl_3$): δ 7.89 (2H, t, J = 7.3 Hz, H_r), 7.59 (2H, dd, J = 7.7, 0.8 Hz, H_q), 7.53 (2H, d, J = 11.0 Hz, H_o), 4.32 (4H, t, J = 6.7 Hz, H_k), 2.67 (4H, t, J = 7.4 Hz, H_a), 1.74 (4H, m, H_j), 1.66 (4H, quint, J = 7.4 Hz, H_b), 1.35 (24H, s, Ht), 1.48–1.20 (28H, m, H_c, H_d, H_e, H_f, H_g, H_h and H_i); ^{13}C NMR (125.8 MHz, $CDCl_3$): δ 164.8 (d, J = 3.4 Hz, C_l), 161.5 (d, J = 260.3 Hz, C_n), 131.4, 130.0 (d, J = 3.7 Hz, C_r), 122.8 (d, J = 20.9 Hz, C_q), 121.2 (d, J = 10.0 Hz, C_o), 84.6 (C_s), 65.7 (C_k), 39.3 (C_a), 29.6, 29.4, 28.7, 28.7, 26.1, 25.0 (C_t); ^{19}F NMR (470.4 MHz, $CDCl_3$): δ -111.88; HRMS (ASAP+) m/z calculated for $C_{48}H_{75}B_2F_2O_8S_2^+$ $[M + H]^+$ 903.5058, observed 903.5073.

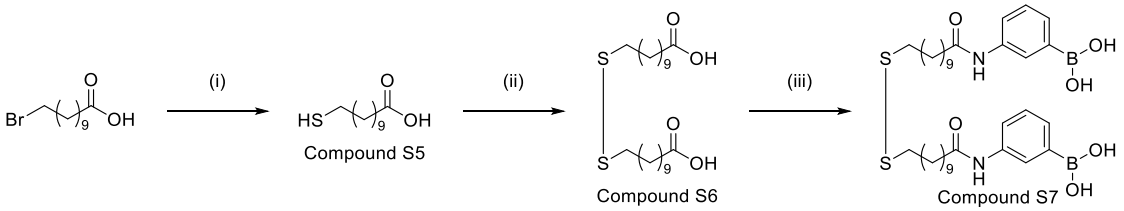
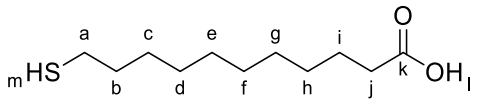


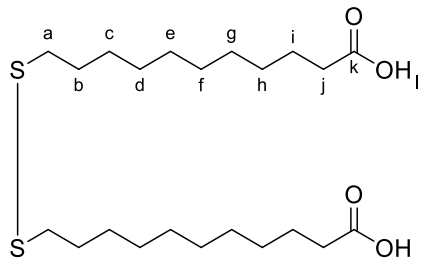
Figure S2. Synthetic procedures for the preparation of proligand **S7**. Reagents and conditions: (i) 1. thiourea, H_2O, reflux, 4 h, 2. NaOH, H_2O, reflux, 1 h, 94%; (ii) SO_2Cl_2, CH_2Cl_2, rt, 30 min, 99%; (iii) 3-aminophenylboronic acid monohydrate, EDC·HCl, DIPEA, THF/MeCN, rt, 16 h, 82%.

Compound S5: 11-mercaptoundecanoic acid



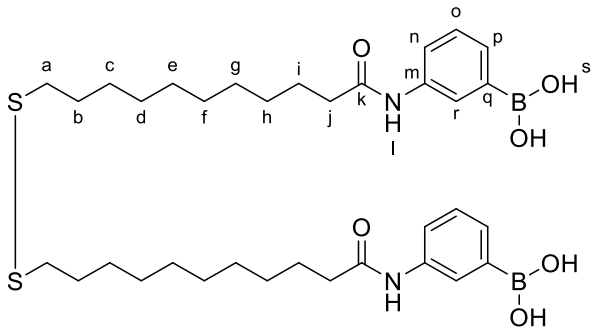
11-bromoundecanoic acid (8.00 g, 30.2 mmol, 1 eq) is added along with thiourea (3.16 g, 41.5 mmol, 1.3 eq) and water to a round bottom flask and the mixture was refluxed for 4 hours. 3 M NaOH (21 mL, 63 mmol, 2.1 eq) was then added and a white solid precipitated. The suspension was refluxed for 1 hour and became clear. The solution was cooled in an ice bath and dilute H2SO4 was added till pH = 1, resulting in the precipitation of a white solid. The suspension was transferred to a separating funnel and and the mixture was extracted with Et_2O (500 mL). The organic layer was isolated, dried with $MgSO_4$, filtered and evaporated udner vacuum at 25 °C to afford the desired product **S5** as a white solid (6.13 g, 28.1 mmol, 93%, spectral data in agreement with the literature[3]); ^{1}H NMR (500.1 MHz, $CDCl_3$): δ 11.7 (1H, s, H_l), 2.50 (2H, q, *J* = 7.5 Hz, H_a), 2.33 (2H, t, *J* = 7.5 Hz, H_j), 1.66–1.54 (4H, m, H_b and H_i), 1.32 (1H, t, *J* = 7.8 Hz, H_m), 1.40–1.21 (12H, m, H_c, H_d, H_e, H_f, H_g and H_h); ^{13}C NMR (125.8 MHz, $CDCl_3$): δ 180.7 (C_k), 34.2, 34.1, 29.5, 29.4, 29.3, 29.13, 29.12, 28.5, 24.8, 24.7.

Compound S6: bis(10-carboxydecyl) disulfide



A solution of SO_2Cl_2 (1.24 g, 0.77 mL, 9.16 mmol) in dry CH_2Cl_2 (30 mL) was added to a solution of thiol **S5** (4.00 g, 18.3 mmol) in dry CH_2Cl_2 (60 mL) at 0 °C. When the reaction reached completion, the volatiles were removed under vacuum to afford the desired product **S6** as an off-white solid (3.96 g, 9.1 mmol, 99%, spectral data in agreement with the literature[4]); ^{1}H NMR (500.1 MHz, $CDCl_3$): δ 2.69 (4H, t, J = 7.4 zHz, H_a), 2.35 (4H, t, J = 7.3 Hz, H_j), 1.71–1.58 (8H, m, H_b and H_i), 1.44–1.23 (24H, m, H_c, H_d, H_e, H_f, H_g and H_h); ^{13}C NMR (125.8 MHz, $CDCl_3$): δ 180.3 (C_k), 39.4 (C_a), 34.2 (C_j), 29.5, 29.4, 29.34, 29.30 (2C), 29.1, 28.6, 24.8.

Compound S7:



Bis(carboxylic acid) **S6** (1.00 g, 2.30 mmol), 3-aminophenylboronic acid monohydrate (0.891 g, 5.75 mmol) and EDC·HCl (1.10 g, 5.75 mmol) were dissolved in THF (10 mL) and MeCN (10 mL). *N*,*N*-diisopropylethylamine (1.49 g, 11.5 mmol) was added and the reaction was stirred at room temperature for 16 hours. The solution was poured into a mixture of EtOAc and 1 M HCl, and allowed to stand for 2 hours, during which time a white solid precipitated at the phase-boundary. The solid was filtered, washed with 1M HCl and CH_2Cl_2 and

dried to afford the desired product **S7** as an off white solid. (1.26 g, 1.88 mmol, 82%, spectral data in agreement with the literature[4]); ^{1}H NMR (500.1 MHz, DMSO-d_6): δ 9.78 (2H, s, H_l), 8.00 (4H, s, H_s), 7.81 (2H, s, H_r), 7.71 (2H, m, H_p), 7.45 (2H, d, J = 7.3 Hz, H_n), 7.23 (2H, t, J = 7.7 Hz, H_o), 2.67 (4H, t, J = 7.2 Hz, H_a), 2.27 (4H, t, J = 7.4 Hz, H_j), 1.63–1.51 (8H, m, H_b and H_i), 1.40–1.18 (24H, m, H_c, H_d, H_e, H_f, H_g and H_h); ^{13}C NMR (125.8 MHz, DMSO-d_6): δ 171.2 (C_k), 138.5 (C_m), 128.8 (C_n), 127.6 (H_o), 125.1 (C_r), 121.1 (C_p), 37.9 (C_a), 36.4 (C_j), 29.0, 28.94, 28.87, 28.7, 28.63, 28.56, 27.8, 25.2.

NMR spectra

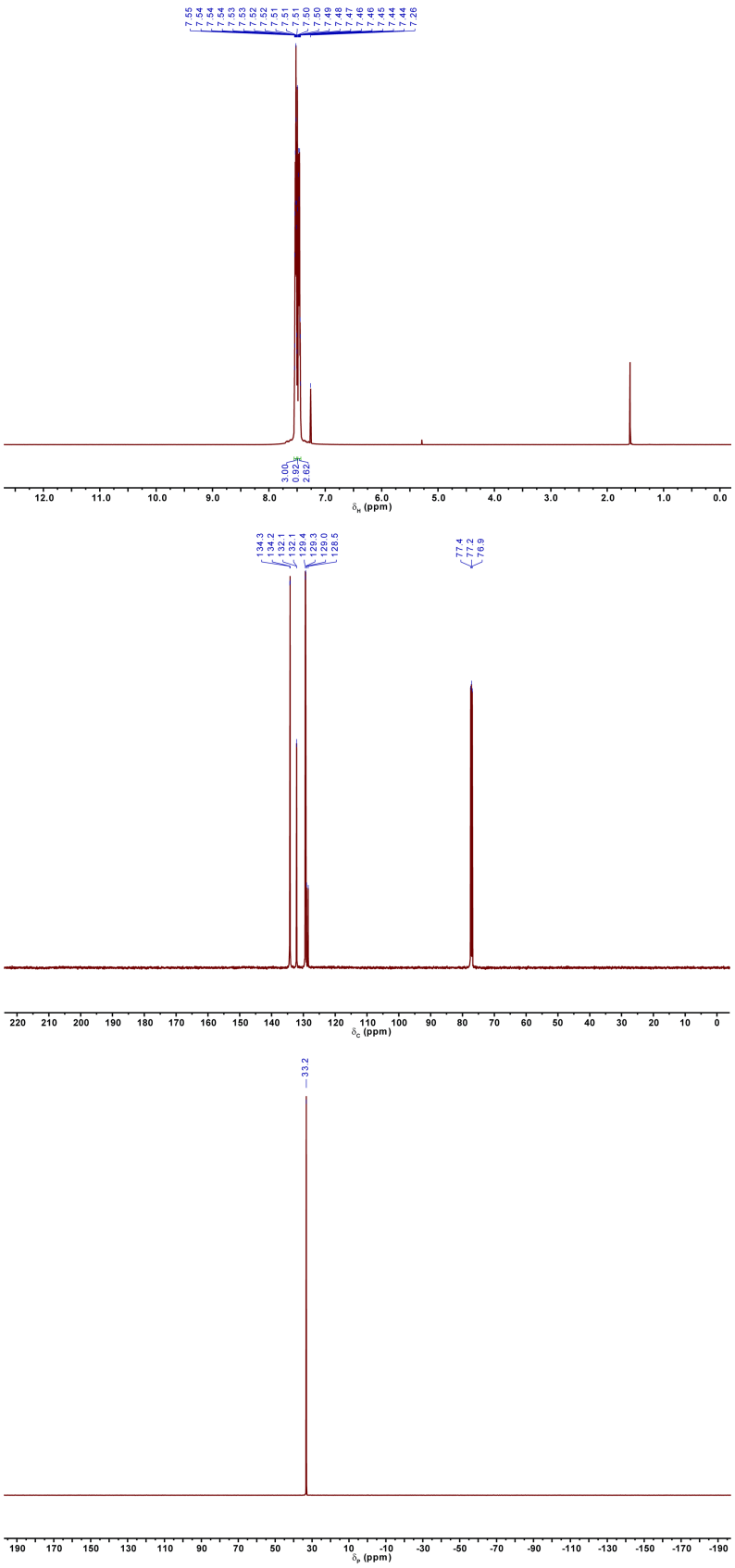


Figure S3. ^{1}H NMR (499.9 MHz, $CDCl_3$), ^{13}C NMR (125.7 MHz, $CDCl_3$) and ^{31}P NMR (202.4 MHz, $CDCl_3$) spectra of compound **S1**.

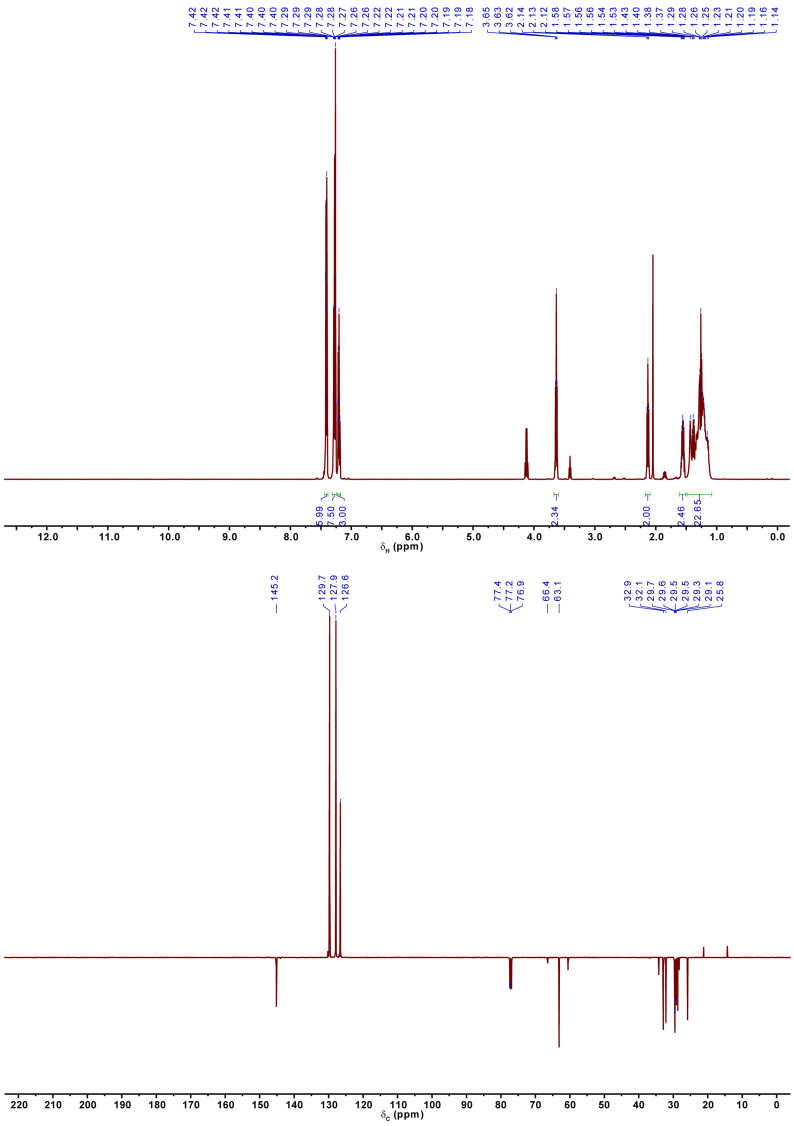


Figure S4. ^{1}H NMR (500.1 MHz, $CDCl_3$) and ^{13}C NMR (125.8 MHz, $CDCl_3$) spectra of compound **S2**.

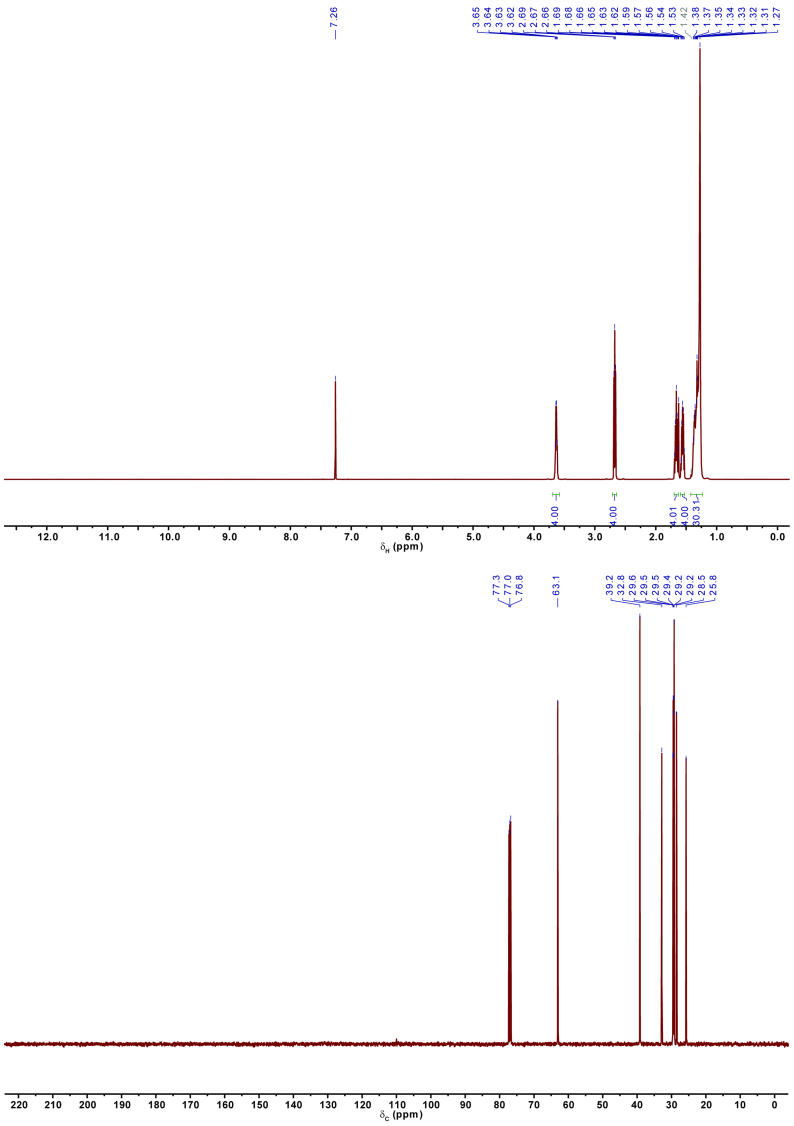


Figure S5. ^{1}H NMR (500.1 MHz, $CDCl_3$) and ^{13}C NMR (125.8 MHz, $CDCl_3$) spectra of compound **S3**.

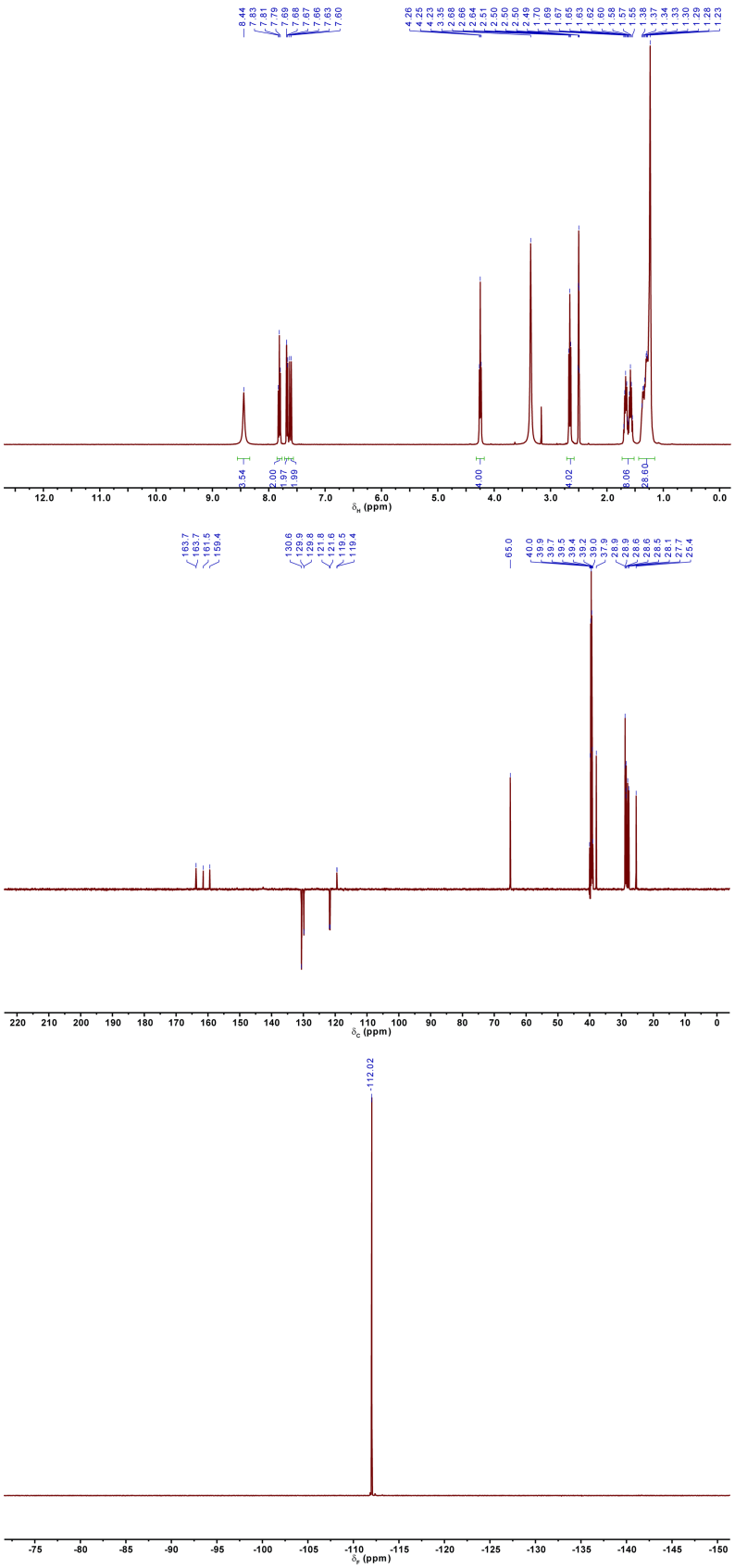


Figure S6. ^{1}H NMR (500.1 MHz, DMSO-d_6), ^{13}C NMR (125.8 MHz, DMSO-d_6) and ^{19}F NMR (470.4 MHz, DMSO-d_6) spectra of compound **dPBA1**.

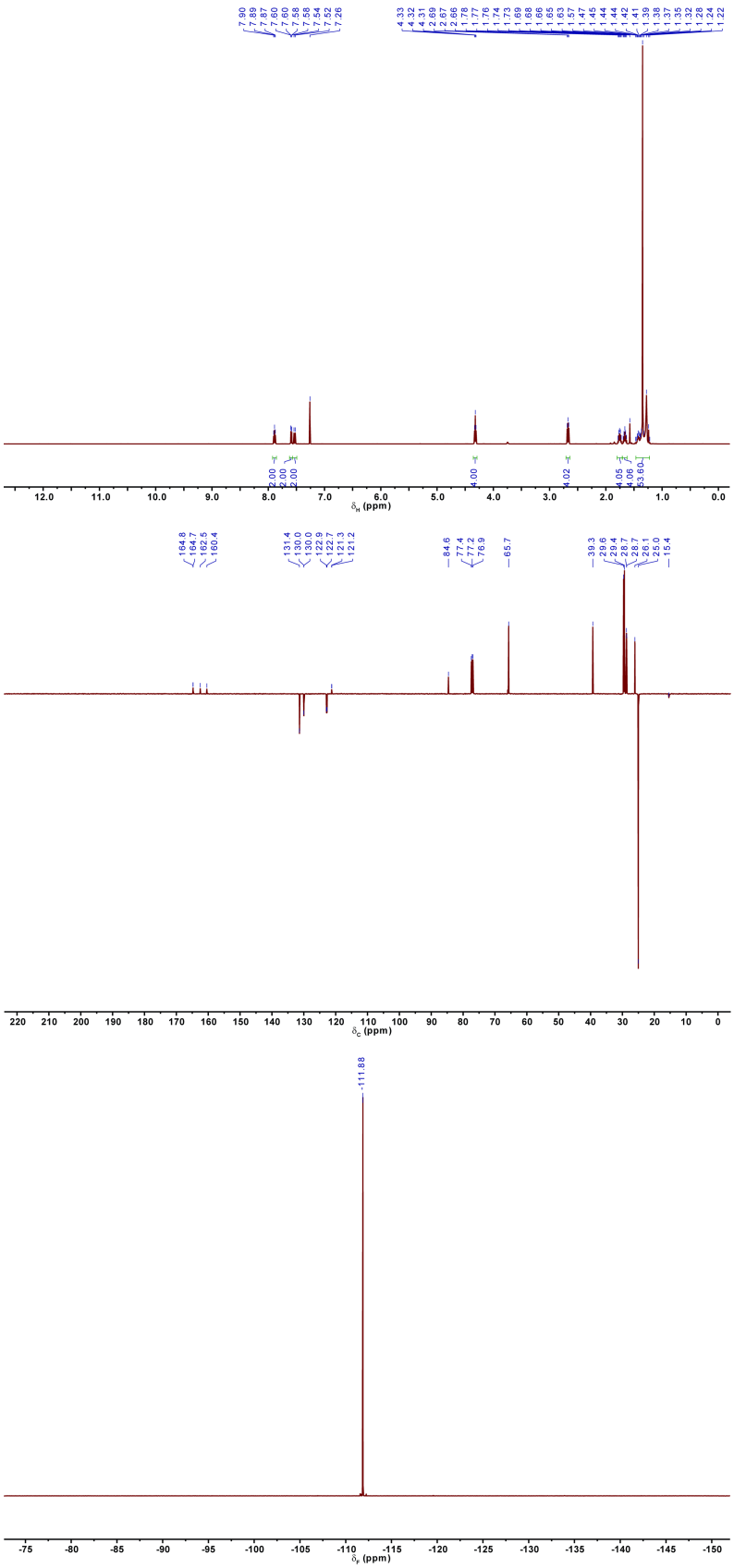


Figure S7. ^{1}H NMR (500.1 MHz, $CDCl_3$), ^{13}C NMR (125.8 MHz, $CDCl_3$) and ^{19}F NMR (470.4 MHz, $CDCl_3$) spectra of compound **S4**.

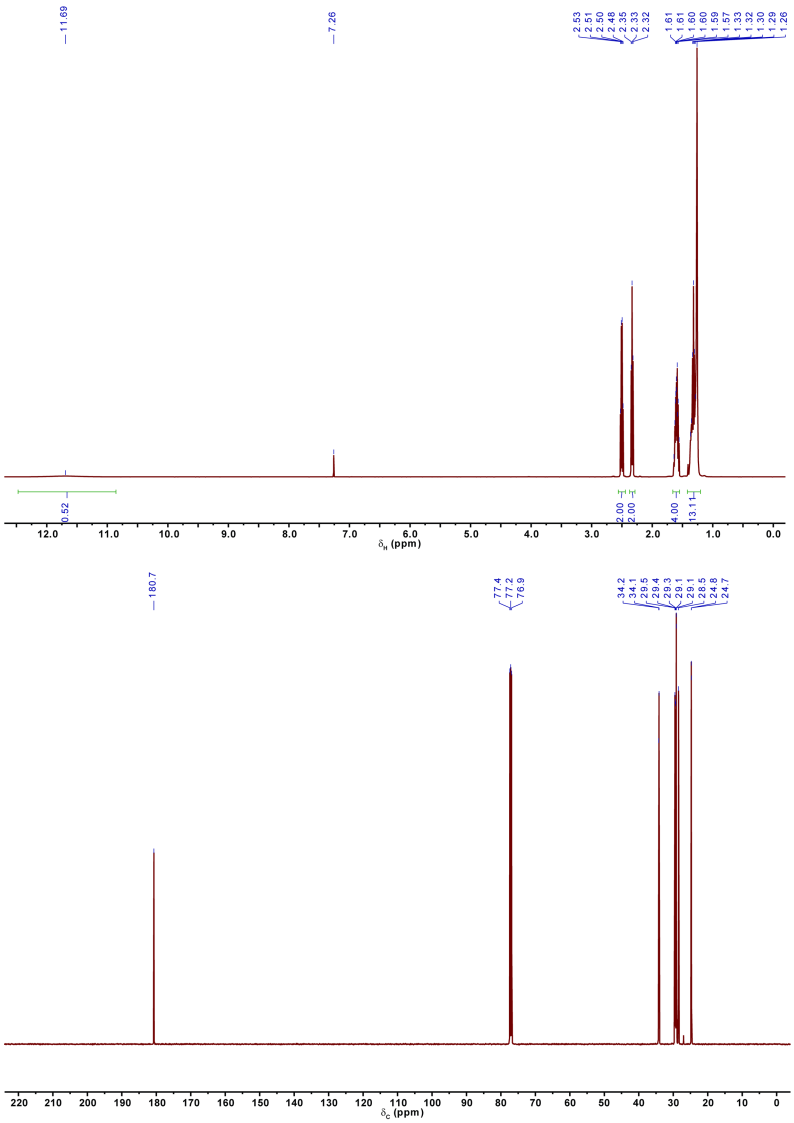


Figure S8. ^{1}H NMR (500.1 MHz, $CDCl_3$) and ^{13}C NMR (125.8 MHz, $CDCl_3$) spectra of compound **S5**.

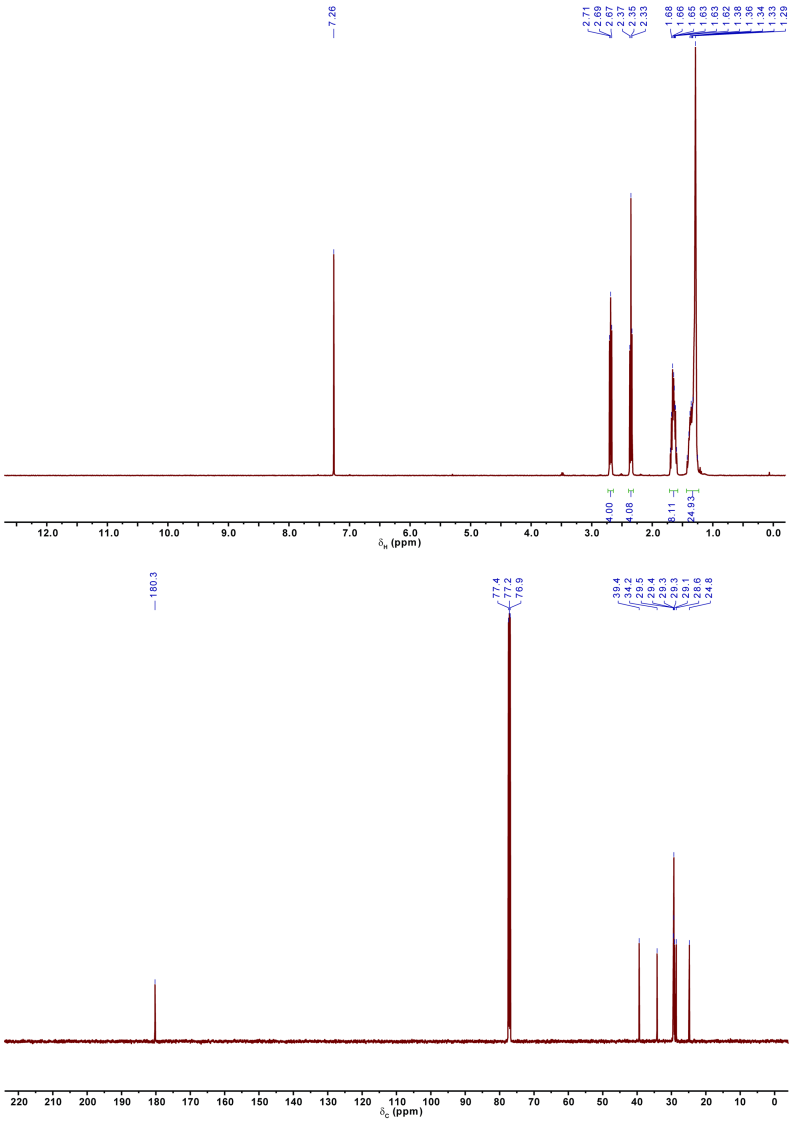


Figure S9. ^{1}H NMR (500.1 MHz, $CDCl_3$) and ^{13}C NMR (125.8 MHz, $CDCl_3$) spectra of compound **S6**.

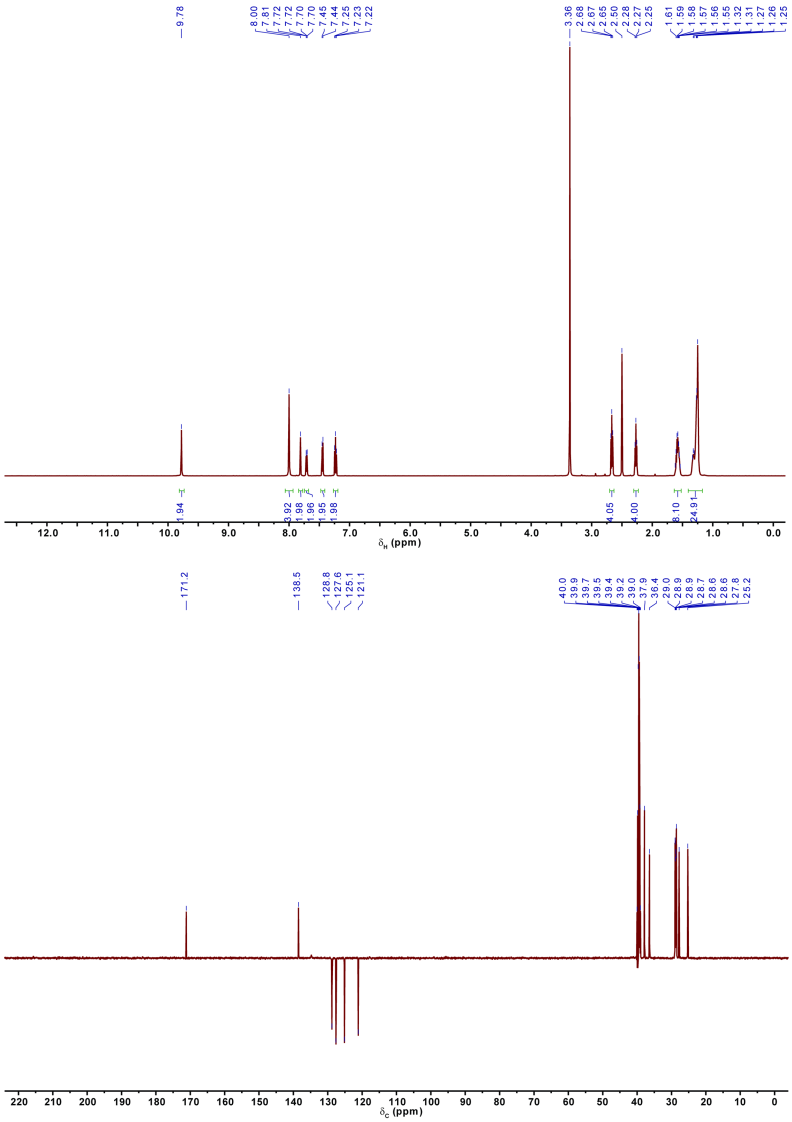


Figure S10. ^{1}H NMR (500.1 MHz, DMSO-d_6) and ^{13}C NMR (125.8 MHz, DMSO-d_6) spectra of compound **dPBA2**.

Synthesis and characterisation of PBA1-NPs and PBA2-NPs

General experimental procedures

The TEM images were recorded using a Jeol JEM-2011 on samples prepared on Holey Carbon Films on 300 mesh Cu grids (Agar Scientific®), and processed with the software ImageJ. Particles on the edges and overlapping with each other were excluded. The nanoparticles were centrifuged in a Beckman Avanti J-25 Centrifuge, using a JA-25.50 rotor.

Synthesis of PBA1-NPs

Ph_3PAuCl (**S1**) (200.0 mg, 404.3 μmol) and disulfide (**S5**) were dissolved in a mixture of DMF and MeOH (10:1v/v, 19 mL) in a 50 mL flask. The reaction mixture was heated at 55 °C for 5 minutes and TBAB (362.5 mg, 4.043 mmol) dissolved in a mixture of DMF and MeOH (10:v/v, 6.3 mL) was added with a syringe as rapidly as possible to the reaction mixture under vigorous stirring (850 rpm). The reaction mixture was stirred for 2 hours at 55 °C, then 3 hours at room temperature. After this time, Et_2O was added to precipitate a black solid. The solvent was decanted and THF was added. The suspension was sonicated and the black fine suspension was transferred to 4×15 mL screw-top glass vials. The vials were centrifuged at 18 °C and 4000 rpm for 5 minutes. The solvent was decanted and fresh THF (15 mL) was added in each vial. The whole sonication, centrifugation and decantation process was repeated another 3 times. Then, MeOH (2 mL) and 0.1 M HCl (few drops) were added to each vial and they were sonicated until a homogeneous solution was obtained. 0.1 M HCl was added to precipitate a black solid. The vials were centrifuged at 18 °C and 4000 rpm for 15 minutes. This process was repeated another 2 times. The black solid was dissolved in the minimum amount of MeOH and precipitated with water. The vials were sonicated and centrifuged. This process was repeated again. The black solid was freeze-dried to afford clean **PBA1-NPs** (85 mg).

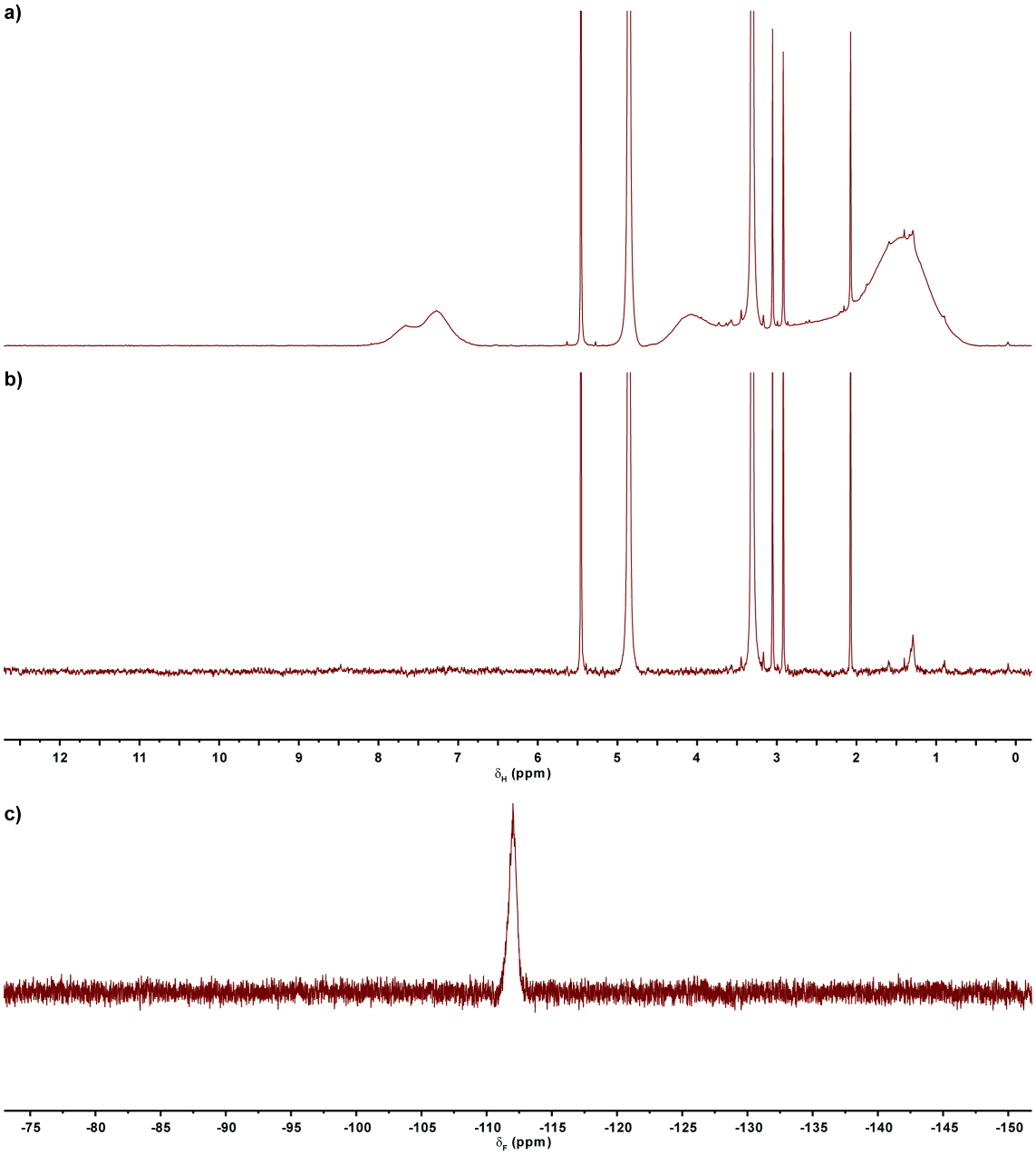


Figure S11. NMR characterization of **PBA1-NPs**. a) ^{1}H NMR (500.1 MHz, CD_3OD) spectrum. b) T_2-filtered ^{1}H NMR (500.1 MHz, CD_3OD) spectrum acquired using the CPMG-z pulse sequence[5]. c) ^{19}F NMR (470.4 MHz, CD_3OD) spectrum.

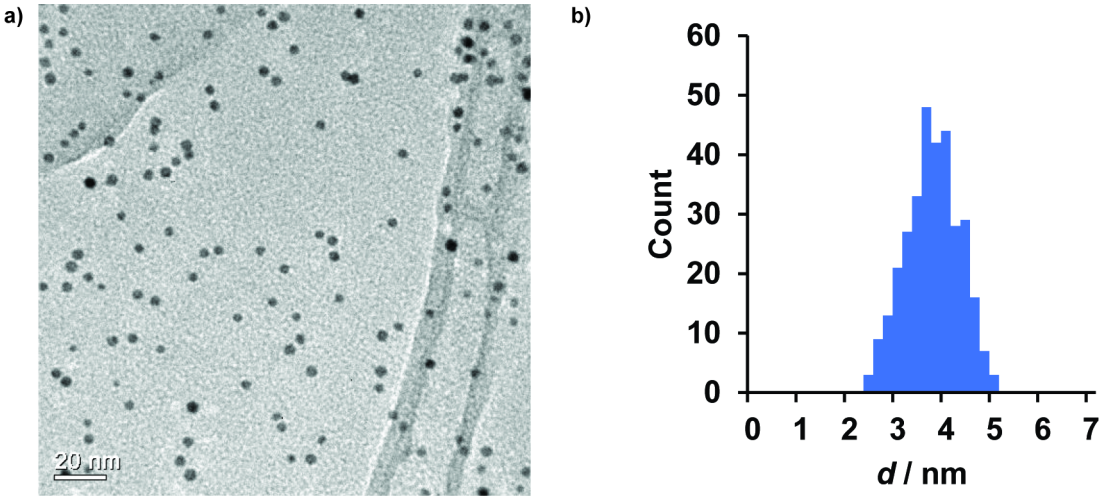


Figure S12. a) Representative TEM image and b) histogram of size distribution as found through analysis of multiple images for **PBA1-NPs** (<d> = 3.62 ± 0.55 nm).

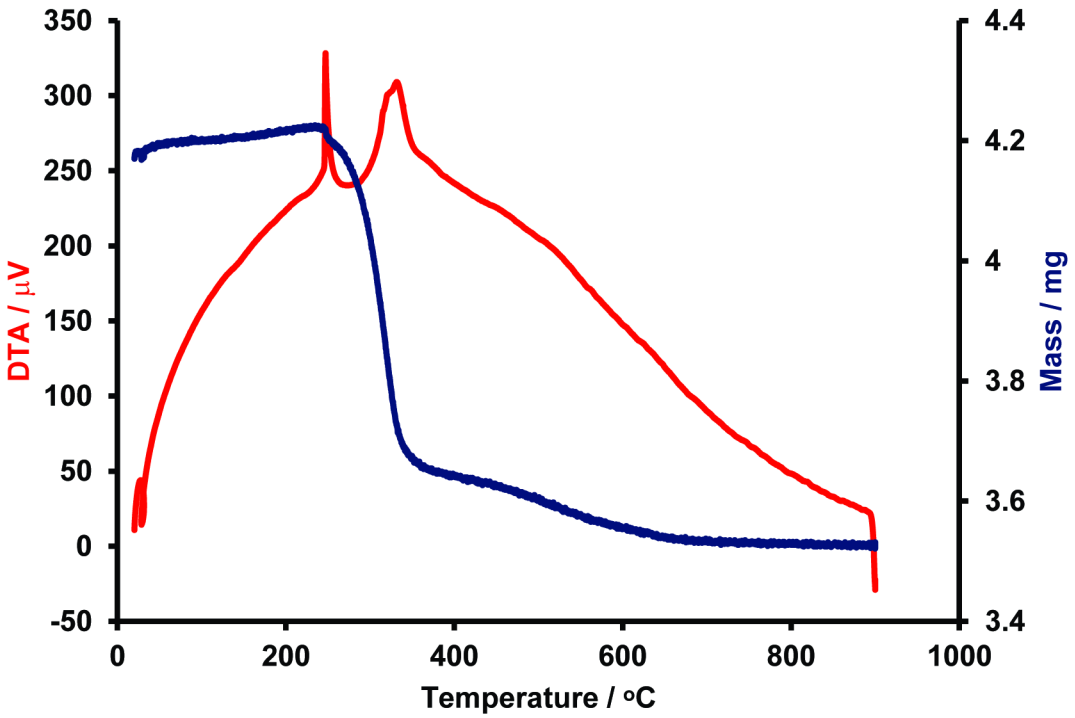


Figure S13. TGA thermogram obtained for the combustion of **PBA1-NPs** (4.17 mg) in air (mass loss = 0.645 mg), suggesting a ligand density of 3.8 PBA1 molecules per nm^2.

Synthesis of PBA2-NPs

Ph_3PAuCl (50.00 mg, 101.1 μmol) (**S1**) and disulfide (40.78 mg, 60.64 μmol) (**dPBA2**) were dissolved in a mixture of THF and MeOH (10:1v/v, 4.7 mL) in a 20 mL screw-top vial flask. The vial was sealed and the reaction mixture was heated a 55 °C for 5 minutes and TBAB (90.62 mg, 1.011 mmol) dissolved in a mixture of THF and MeOH (10:1v/v, 1.6 mL) was added with a syringe as rapidly as possible to the reaction mixture under vigorous stirring (850 rpm). The vial was sealed again and the reaction mixture was stirred for 2 hours at 55 °C, then 3 hours at room temperature. By this time, a black solid had precipitated. The solvent was decanted and fresh THF was added. The vial was sonicated and centrifuged at 18 °C and 4000 rpm for 5 minutes. The solvent was decanted and fresh THF (15 mL) was added. The whole sonication, centrifugation and decantation process was repeated another 3 times. Then, MeOH (2 mL) and 1 M HCl (few drops) were added and the vial was sonicated until a homogeneous solution was obtained. 1 M HCl was added to precipitate a black solid. The vial was centrifuged at 18 °C and 4000 rpm for 10 minutes. This process was repeated another 2 times. The black solid was dissolved in the minimum amount of MeOH and precipitated with water. The vial was sonicated and centrifuged. This process was repeated again. The black solid was dried under high vacuum to afford clean **PBA2-NPs** (17 mg). The ligand density was estimated to be 4.7 PBA2 molecules per nm^2 according to the reported ICP-OES results.[4]

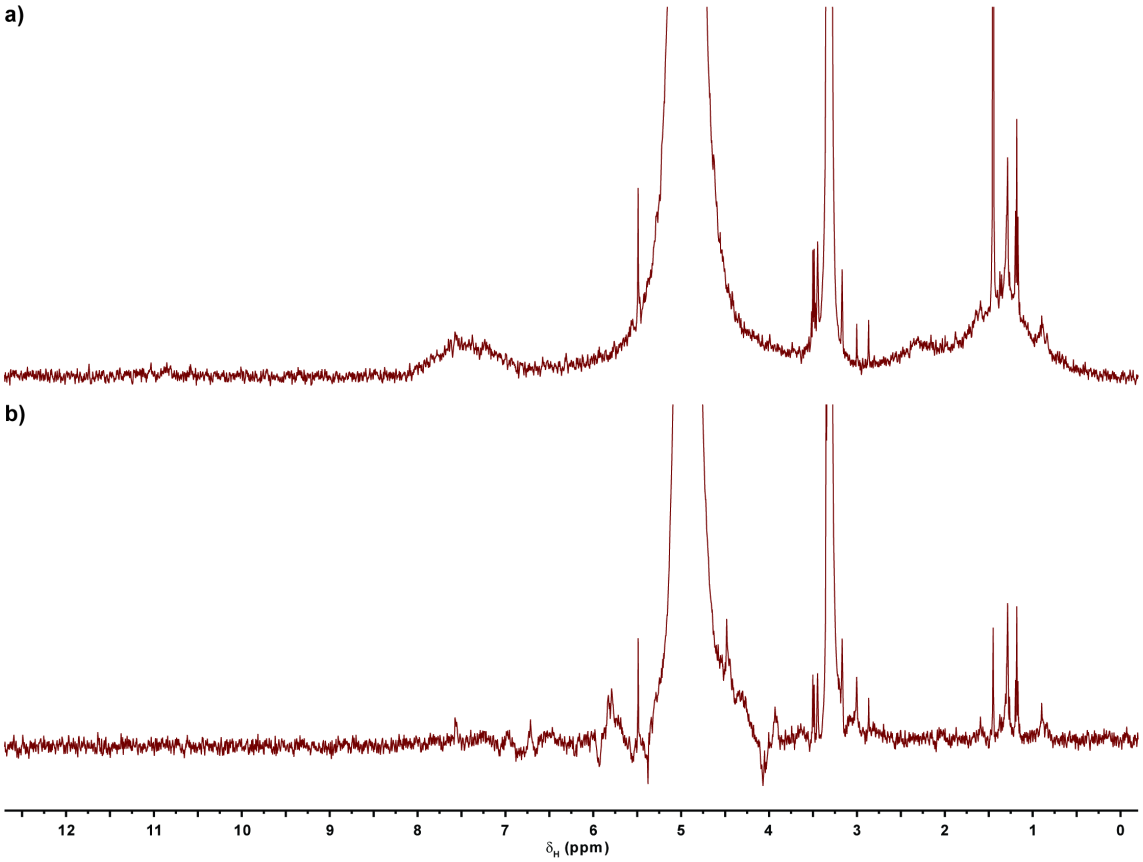


Figure S14. NMR characterization of **PBA2-NPs**. a) ^{1}H NMR (500.1 MHz, CD_3OD) spectrum. b) T_2-filtered ^{1}H NMR (500.1 MHz, CD_3OD) spectrum acquired using the CPMG-z pulse sequence[5].

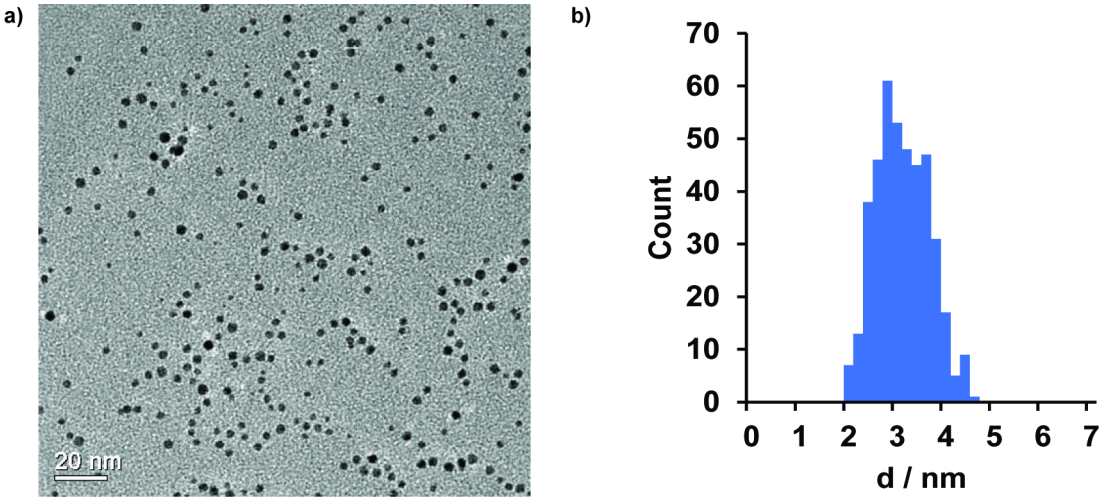


Figure S15. a) Representative TEM image and b) histogram of size distribution as found through analysis of multiple images for **PBA2-NPs** (<d> = 3.01 ± 0.54 nm).

DNSA binding with specificity

QCM-D monitoring – Dissipation

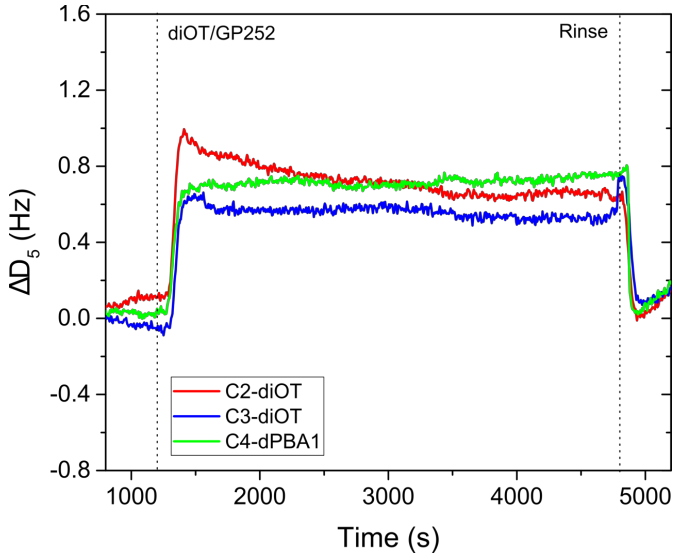


Figure S16. Dissipation shift (5th overtone) of 100 mM **diOT** and 10mM **dPBA1** grafting in MeOH.

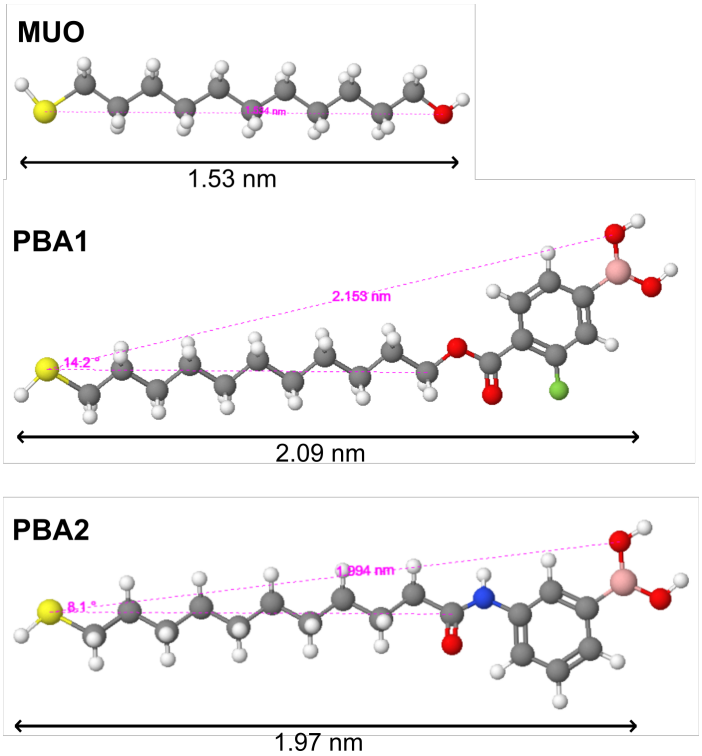


Figure S17. Ligand length estimation for **MUO**, **PBA1** and **PBA2** (MolView).

Table S1. Grafting density calculation for **MUO-NPs** and **PBA1-NPs**.

NP	NP core size, nm	Weight of NP core, ng	Organic content	Weight of NP, ng	AM change, ng/cm^2	Grafting density, cm^{-2}
MUO	3.7	5.12E-10	13.0%	5.89E-10	2120	3.60E+12
PBA1	3.6	4.72E-10	15.5%	5.59E-10	2109	3.78E+12

Table S2. Packing density calculation for **MUO-NPs** and **PBA1-NPs**.

NP	Ligand length, nm	NP size, nm	Grafting density of close packing, cm^{-2}	Packing density
MUO	1.53	6.76	2.53E+12	1.42
PBA1	2.09	7.78	1.91E+12	1.98

In consideration of the AuNP core size (determined by TEM) and ligand content (determined via TGA), the mass uptake corresponds to a grafting density of 3.60E+12 AuNPs per cm^2 for MUO and 3.78E+12 for PBA1, respectively. For hard spheres with diameters of $\mathbf{D=D_{core}+2L}$ (**D** diameter, **L** ligand length of Fig. S17), this would relate to a packing density of 1.42 and 1.98, respectively. We relate the value of >0.907 (the expected number from a hexagonally packed monolayer) to three factors: (1) interdigitation between the ligand shells is likely occurring; (2) the significant surface roughness increases the available contact area for grafting; (3) the size dispersity of AuNPs allows a more efficient packing than for spheres all of the same size.

Variable screening of PBA-NPs and salicylates binding

Preparation of sensor surfaces with PBA-NPs

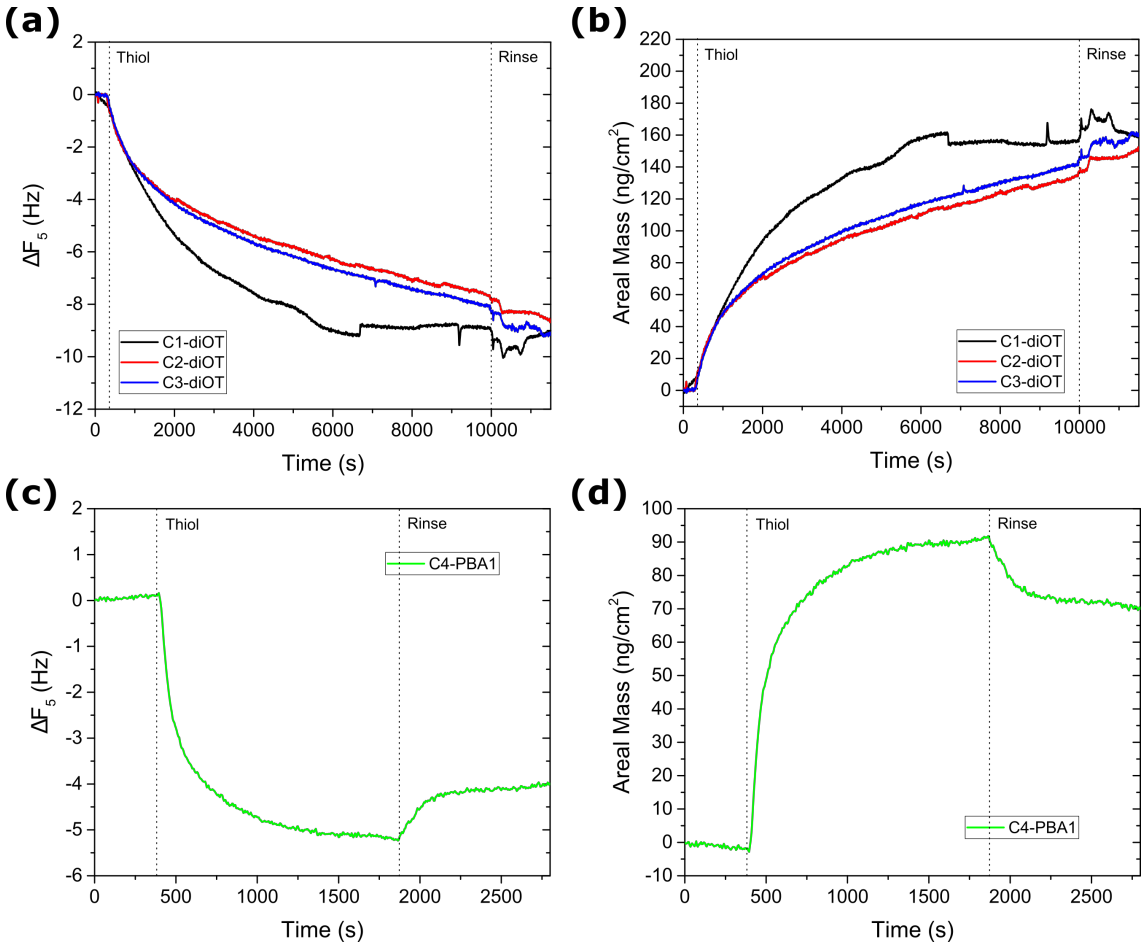


Figure S18. Thiol-grafted surface preparation for **PBA1-NPs**. Frequency shift and AM change: grafting of (a),(b) 100 mM **diOT** and (c),(d) 10 mM **PBA1** onto gold surface.

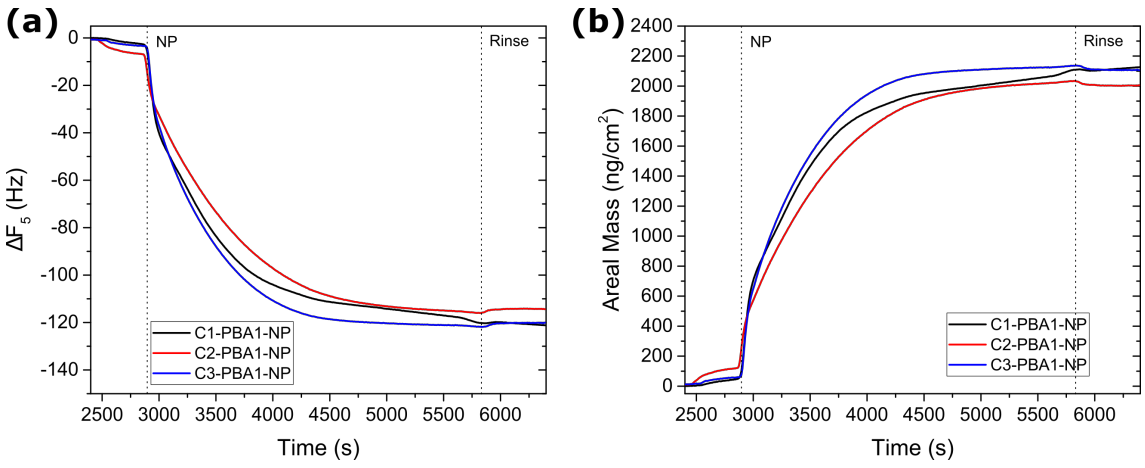


Figure S19. Immobilisation of 0.1 mg/ml **PBA1-NPs**: (a) frequency shift and (b) AM change.

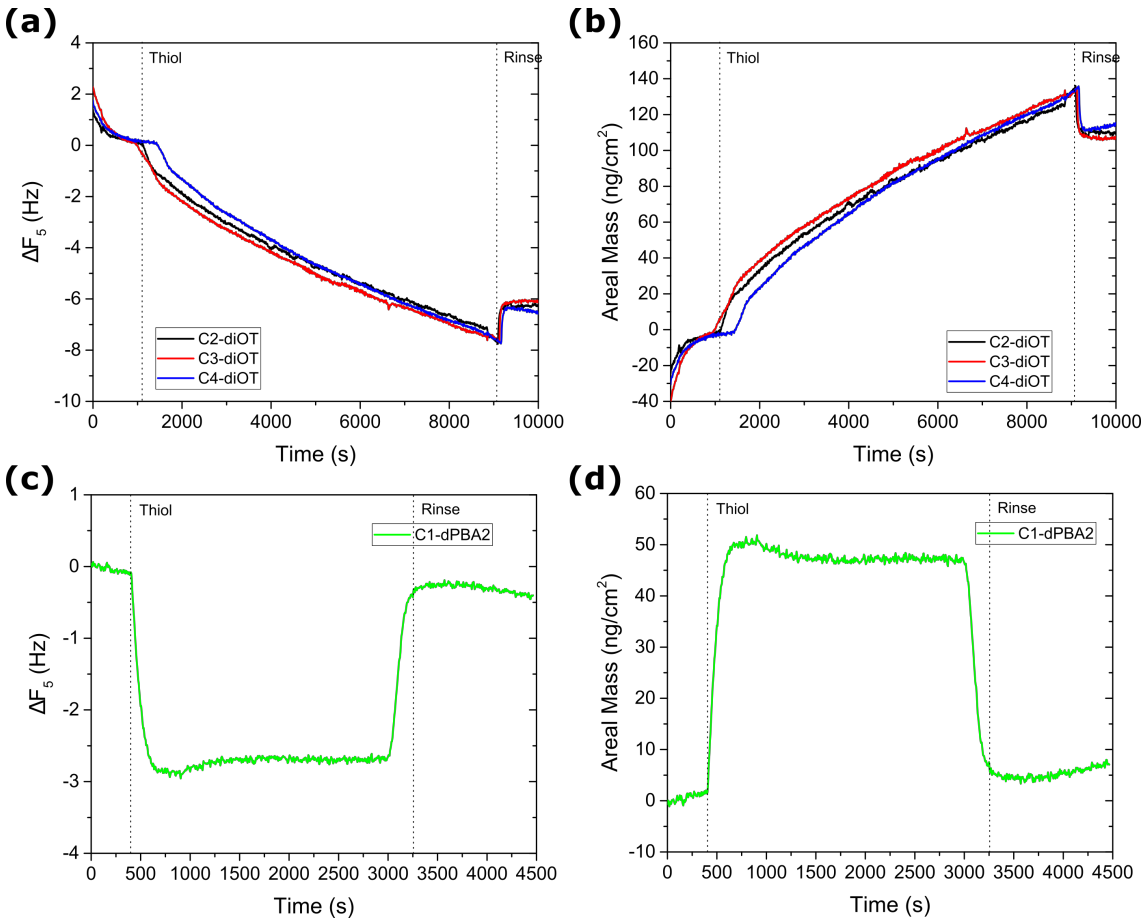


Figure S20. Thiol-grafted surface preparation for **PBA2-NPs**. Frequency shift and AM change: grafting of (a), (b) 100 mM **diOT** and (c), (d) 10 mM **dPBA2** onto gold surface.

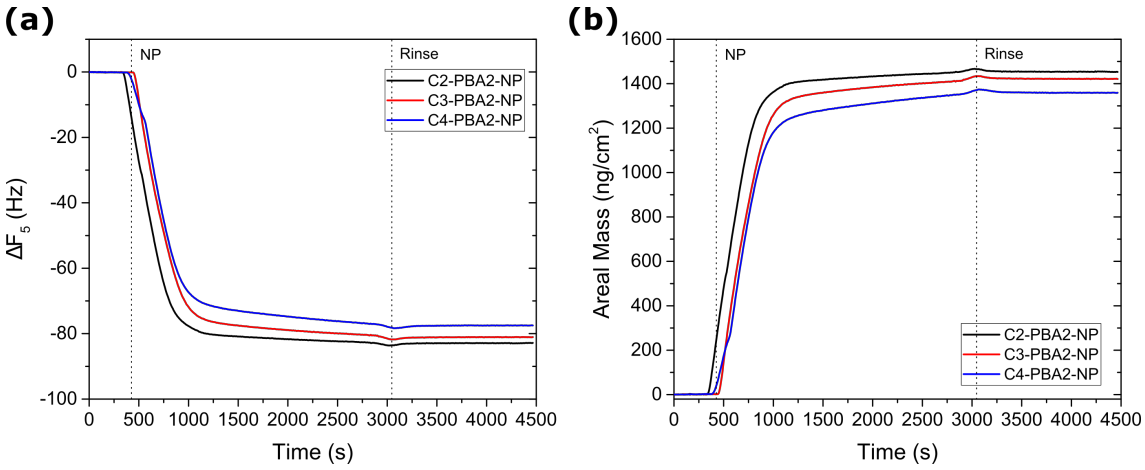


Figure S21. Immobilisation of 0.1 mg/ml **PBA2-NPs**: (a) frequency shift and (b) AM change.

Binding with salicylates

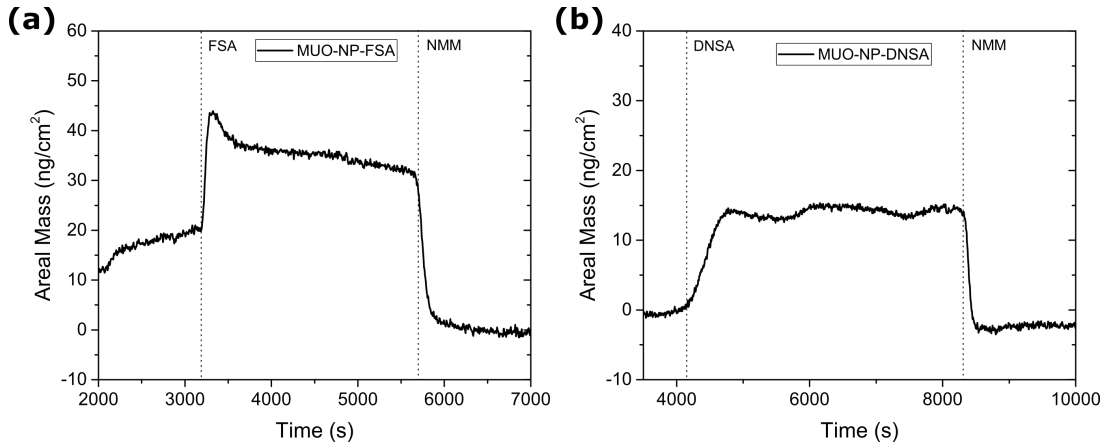


Figure S22. Areal mass change (from frequency shift of 7th overtone) of flowing 5 mM SA solution at 5 mM NMM on sensor surface immobilised with non-interacting NPs (**MUO-NPs**): (a) FSA and (b) DNSA.

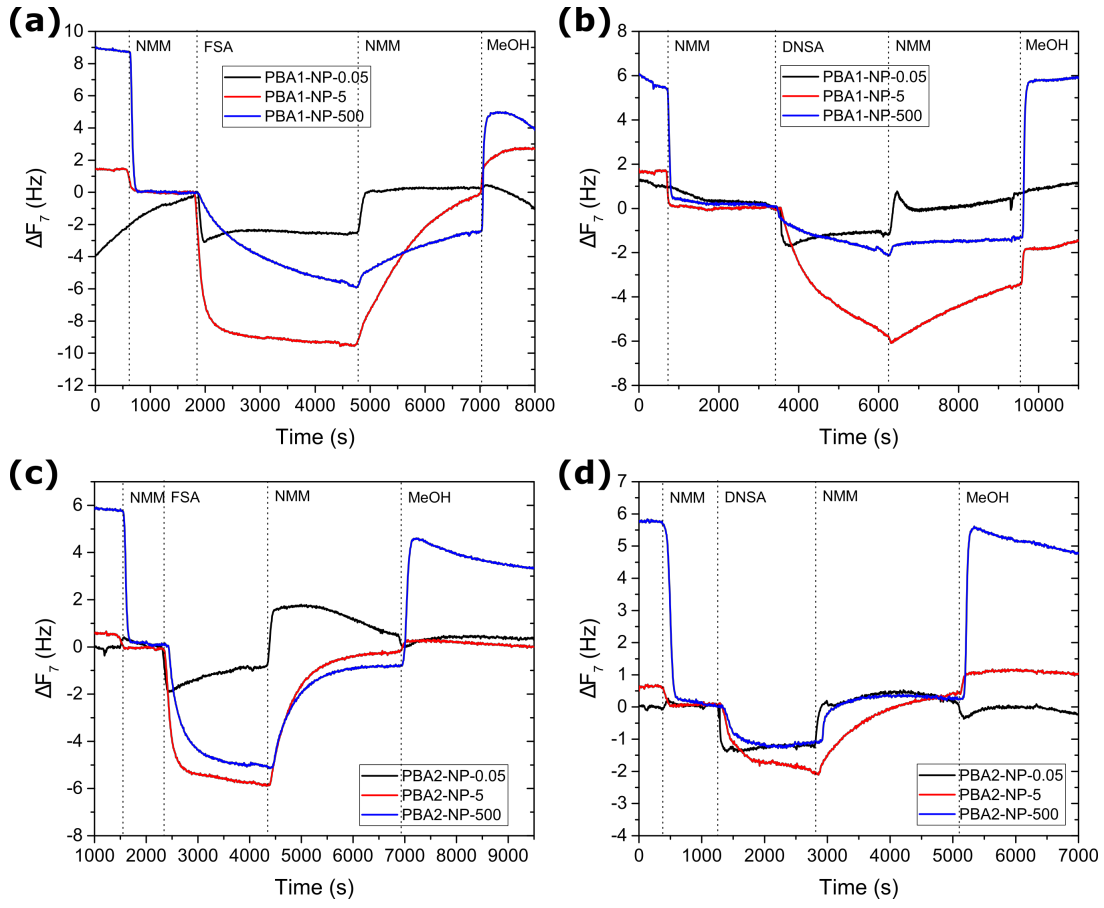


Figure S23. Frequency shift (7th overtone) at NMM base concentration of 0.05, 5 and 500 mM: **PBA1-NPs** with 5 mM of (a) FSA and (b) DNSA; **PBA2-NPs** with 5 mM of (c) FSA and (d) DNSA.

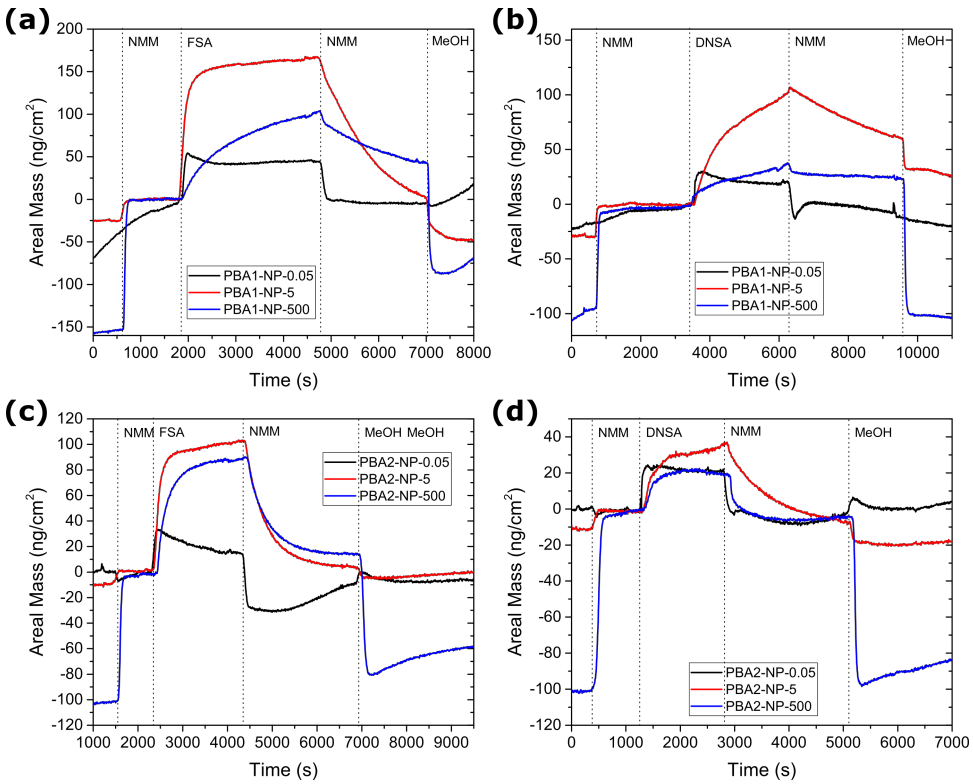


Figure S24. AM change (7th overtone) at NMM base concentration of 0.05, 5 and 500 mM: **PBA1-NPs** with 5 mM of (a) FSA and (b) DNSA; **PBA2-NPs** with 5 mM of (c) FSA and (d) DNSA.

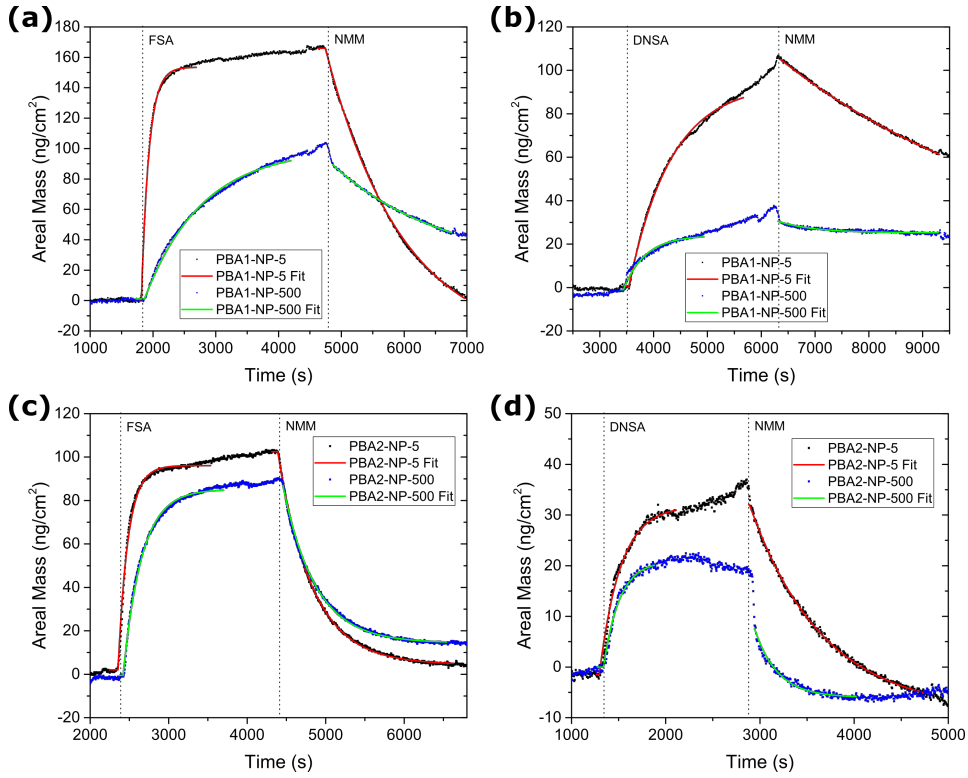


Figure S25. Kinetic analysis of AM change (7th overtone) at NMM base concentration of 5 and 500 mM: **PBA1-NPs** with 5 mM of (a) FSA and (b) DNSA; **PBA2-NPs** with 5 mM of (c) FSA and (d) DNSA.

Table S3. Grafting density calculation for **PBA1-NPs** and **PBA2-NPs** for variable screening experiments.

NP	Weight of NP, ng	NP ligand density, nm^{-2}	AM change, ng/cm^2	Grafting density, cm^{-2}	Sensor ligand density, nm^{-2}
PBA1	5.59E-10	3.8	2077±38	3.79E+12	5.82
PBA2	3.46E-10	4.7	1418±40	4.22E+12	5.49

Table S4. Bound SA density calculated from net AM change at 0.05, 5 and 500 mM NMM. The error estimation is based on control subtraction and sensor ligand density variation.

Sensor type	Bound SA density, nm^{-2}		
	Conc. NMM, mM		
	0.05	5	500
PBA1-NP/FSA	0.30±0.45	3.54±0.51	1.71±0.48
PBA1-NP/DNSA	0.06±0.18	1.75±0.21	0.39±0.18
PBA2-NP/FSA	-0.03±0.45	1.91±0.50	1.50±0.49
PBA2-NP/DNSA	0.06±0.18	0.41±0.19	0.08±0.18

References

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