

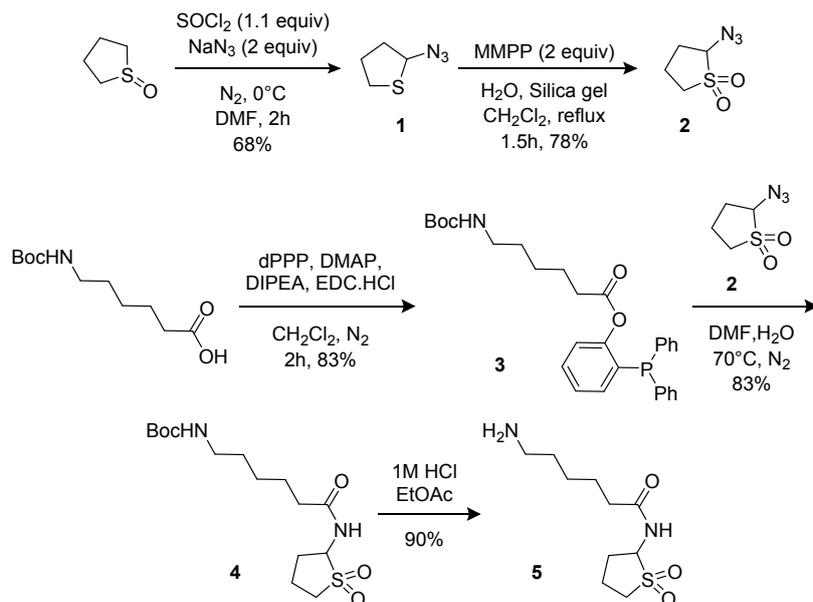
Electronic Supplementary Information (ESI)

The supplementary information section contains the experimental protocols, synthesis of TSA and NPs and methods of characterisation of NPs.

Materials All chemicals were purchased from Aldrich, Fisher Scientific, Arcos Organics and TCI (UK) and used without further purification. Millipore (MilliQ) purification system was used to obtain deionized water with a resistivity of 18.2 MΩ cm. Dry solvents were prepared using molecular sieves 4Å (beads) purchased from Sigma-Aldrich, UK.

Instrumentation Dynamic Light Scattering (DLS) measurements were performed using a Zetasizer Nano (Nano-S) Particle Size Analyzer from Malvern Instruments Ltd, UK. The quantification of AHL was carried out using a High Performance Liquid Chromatography–Mass Spectrometry (LC-MS/MS) set-up consisting of WATERS 2795, Luna reverse phase C18(2) column, 3.0 × 50 mm, 3 μm; Quattro Micro Mass spectrometer detector, electrospray, positive ionisation mode. IR spectroscopy was performed using spectrophotometer Avatar 370 FTIR (Thermo Nicolet, UK). Nuclear magnetic resonance (NMR) measurements were made using Bruker DPX400 at 400 MHz. ¹H and ¹³C NMR spectra were recorded at room temperature with chemical shifts quoted in ppm and referenced using TMS or residual solvent signals as internal standards.

Synthesis of 2-azidotetrahydrothiophene (1). Sodium azide (1.25 g, 19.23 mmol) and 1-oxidotetrahydrothiophene (1.0 g, 9.62 mmol) were added to anhydrous *N,N*-dimethylformamide (DMF, 2 mL) and placed in an ice bath. Then, thionyl chloride (1.62 g, 10.58 mmol) was slowly dropwise added. The mixture was stirred for 2 h under N₂. After this time, water (20 mL) was added and the resultant mixture was extracted with diethyl ether (2 × 50 mL). The organic layer was washed with 10 % LiCl (15 × 30 mL), once with brine (30 mL) and then dried over magnesium sulfate. The solvent was removed by rotary evaporation. The product did not require further purification. Product **1** was obtained as a yellow liquid (750 mg, 5.82 mmol, 58 %). ¹H-NMR (CDCl₃): δ = 5.08 (1 H, dd, J 4.79 Hz, 1.89 Hz, CHN₃), 3.01 (1 H, m, SCHH'), 2.80 (1 H, m, SCHH'), 2.10 (2 H, m, CHN₃CH₂), 1.88 (2 H, m, SCH₂CH₂). ¹³C-NMR (CDCl₃): δ = 69.49, 37.93, 31.63, 27.46. IR ν_{max} (cm⁻¹): 2957 and 2865 (alkane), 2105 (azide). MS (ESI+) *m/z* found [M]⁺ 129, [M-N₂]⁺ 102, [M-N₃]⁺ 87, [SC₃H₆]⁺ 74. The analytical data agrees with the literature.¹



Scheme 1. Outline of the synthetic pathway followed to obtain 6-amino-*N*-(1,1-dioxidothiophen-2-yl)hexanamide (5), the immobilisable TSA (“TSA-template”).

Synthesis of 1,1-dioxide-2-azidotetrahydrothiophene (2). Based on the protocol of Ali and Bohnert for the oxidation of sulfides,² a 50 mL round bottom flask containing a magnetic stirring bar and fitted with a reflux condenser was charged with dry silica gel (2.6 g). Subsequently, water (1.3 mL) was added to the mixture and shaken until a free-flowing powder was obtained. Magnesium monoperoxyphthalate (MMPP, 1.6 g, 2.58 mmol) was added and the mixture was shaken further followed by dichloromethane (CH₂Cl₂, 15 mL) and stirred vigorously. After obtaining a heterogeneous mixture, **1** was added (170 mg, 1.29 mmol) in CH₂Cl₂ (1 mL) and the mixture was stirred at 50 °C (reflux) for 90 min. The mixture was then filtered through a 3A sintered glass funnel and the silica gel was washed with CH₂Cl₂ (3 × 20 mL). The combined washings were added to the filtrate and they were washed with 1M NaOH (3 × 30 mL) before drying over magnesium sulfate. CH₂Cl₂ was removed by rotary evaporation. The crude product was purified by column chromatography (SiO₂; CH₂Cl₂). Product **2** was obtained as a pale yellow very viscous oil (0.15 g, 78%). ¹H-NMR (CDCl₃): δ = 4.40 (1 H, dd, J 5.97 Hz, 4.21 Hz, CHN₃), 3.09 (2 H, m, S(=O)₂CH₂), 2.39 (1 H, m, CHN₃CHH'), 2.24 (1 H, m, CHN₃CHH'), 2.16 (1 H, m, CHN₃CH₂CHH'), 2.03 (1 H, m, CHN₃CH₂CHH'). ¹³C-NMR (CDCl₃): δ = 73.61, 48.01, 27.11, 17.92. IR ν_{max} (cm⁻¹): 2956 (alkane), 2111 (azide),

1312 and 1133 (S=O). MS (ESI+) m/z found $[M-N_2+H]^+$ 134.0, $[M-N_3]^+$ 119.1, $[C_4H_7NSO]^+$ 116.9, $[C_3H_7SO_2]^+$ 107.0, $[C_3H_5SO]^+$ 89.0. The analytical data was in agreement with the literature.³

Synthesis of 2-(diphenylphosphino)phenyl-6-(Boc-amino)hexanoate (3). Compound **3** was prepared according to the previously published synthesis.³ 2-(diphenylphosphino) phenol (dPPP, 0.5 g, 1.8 mmol), Boc-6-aminocaproic acid (0.5 g, 2.16 mmol), DIPEA (0.43 mL, 0.32 g, 2.5 mmol), EDC-HCl (0.48 g, 2.5 mmol) and DMAP (25 mg, 0.2 mmol) were dissolved in CH_2Cl_2 (25 mL). The reaction was performed under N_2 at room temperature for 2 h and followed by TLC. When the reaction was complete, CH_2Cl_2 (75 mL) was added to the reaction mixture which was then washed with 10% HCl (3 × 30 mL). The organic phase was dried over magnesium sulfate, filtered and the solvent removed by rotary evaporation. The crude product was purified by column chromatography (SiO_2 ; EtOAc: CH_2Cl_2 , 1:20). Product **3** was obtained as a colorless oil (0.714 g, 83 %). 1H -NMR ($CDCl_3$): δ = 7.22-7.16 (11 H, m, aryl CH), 7.02-6.99 (2 H, dd, aryl CH), 6.68 (1 H, m, aryl CH), 4.78 (1 H, s, NH), 3.59 (2 H, s, CH_2NH), 2.12 (2 H, t, C(=O) CH_2), 1.57-1.68 (2 H, m, CH_2CH_2NH), 1.33 (11 H, m, C(=O) CH_2CH_2 and $3CH_3$), 1.32-1.18 (2 H, m, $CH_2CH_2CH_2NH$). ^{13}C -NMR ($CDCl_3$): δ = 171.34 (C=O ester), 152.87 (C=O, carbamate), 144.14, 135.70, 135.55, 134.11, 133.84, 133.70, 129.89, 129.04, 128.65, 128.55, 126.07, 122.53, 76.06, 40.36, 33.85, 29.67, 28.45, 26.20, 24.12. IR ν_{max} (cm^{-1}): 3361, 1761 (C=O, ester) 1705 (C=O, carbamate). MS (ESI+) m/z found $[M+H]^+$ 492, $[M+Na]^+$ 514, $[M+K]^+$ 530. The analytical data is in agreement with the literature.³

Synthesis of tert-butyl-6-((1,1-dioxidotetrahydro-thiophen-2-yl)amino)-6-oxohexyl)carbamate (4). Compound **4** was prepared according to the previously published synthesis.³ In a 50 mL round bottom flask, compound **2** (160 mg, 1.0 mmol) was dissolved in anhydrous DMF (10 mL) and **3** (321.9 mg, 0.66 mmol) was added. The resulting mixture was stirred under N_2 at 70 °C for 1 h, then water (5 mL) was added and the mixture was left to stir overnight. The solvent was removed by rotary evaporation. The crude product was purified by column chromatography (SiO_2 ; 0.1:10, MeOH: $CHCl_3$). Product **4** was obtained as a white solid (161 mg, 71%). 1H -NMR ($CDCl_3$): δ = 6.98 (1H, d, CHNH), 5.12 (1H, q, CHNH), 4.79 (1H, s, CH_2NH), 3.18-3.07 (3H, m, CH_2NH , $CHH'SO_2$), 3.00 (1H, ddd, $CHH'SO_2$), 2.51 (1H, m, $CHH'CHNH$), 2.29 (2H, t, $COCH_2$), 2.22 (1H, m, SO_2CHCHH'), 2.11 (1H, m, SO_2CHCHH'), 2.00 (1H, m, $CHH'CHNH$), 1.68 (2H, m, C(=O) CH_2CH_2), 1.45 (11H, m, $NHCH_2CH_2CH_2CH_2$, $3CH_3$), 1.36 (2H, m, $NHCH_2CH_2CH_2CH_2$). ^{13}C -NMR ($CDCl_3$): δ = 173.64 (C=O amide), 156.14 (C=O Carbamate), 79.12, 66.80, 50.12, 40.26, 35.89, 29.54, 29.00, 28.41, 26.08, 24.89, 18.50. IR ν_{max} (cm^{-1}): 3349, 2937 (alkane), 1688 (C=O amide), 1659 (C=O carbamate), 1140 (S=O). MS (ESI+) m/z found $[M+Na]^+$ 371, $[M-Boc+H]^+$ 249, $[C_4H_{10}NO_2S]^+$ 136, $[C_6H_{12}NO]^+$ 114. The analytical data is in agreement with the literature.³

Synthesis of 6-amino-N-(1,1-dioxidotetrahydro-thiophen-2-yl)hexanamide, TSA (5). In a 25 mL round bottom flask, compound **4** (100 mg, 0.287 mmol) was dissolved in EtOAc (5 mL) and 1M HCl (5 mL). The mixture was stirred for 5 h, at room temperature until TLC shown completion of the reaction. The solvent was removed by rotary evaporation. The product did not require further purification. Product **5** (template) was obtained as a white solid (64.1 mg, 90%). 1H -NMR (D_2O): δ = 4.97 (1H, t, CHNH), 4.70 (1H, s, CHNH), 3.29-3.23 (1H, m, $CHH'SO_2$), 3.09-3.01 (1H, ddd, $CHH'SO_2$), 2.96 (2H, t, NH_2CH_2), 2.59-2.51 (1H, m, $SO_2CHCH'H$), 2.34 (2H, td, $COCH_2$), 2.26-2.15 (1H, m, $SO_2CHCH'H$), 2.16-2.06 (2H, m, $SO_2CH_2CH_2$), 2.06-1.96 (2H, m, $CH_2CH_2NH_2$), 1.68-1.55 (2H, m, $COCH_2CH_2$), 1.43-1.30 (2H, m, $NH_2CH_2CH_2CH_2$). ^{13}C -NMR (D_2O): δ = 177.79, 68.39, 50.50, 39.32, 34.80, 27.49, 26.38, 24.92, 24.52, 18.71. IR ν_{max} (cm^{-1}): 3198 (NH, NH_2), 2940 (alkane), 1677 (C=O amide), 1529 (NH amide), 1258 and 1113 (S=O). MS (ESI+) m/z found $[M+H]^+$ 249, $[C_4H_{10}NO_2S]^+$ 136, $[C_6H_{12}NO]^+$ 114. The analytical data is in agreement with the literature.³

Preparation of the glass beads with immobilised template The glass beads were modified according to the protocol described previously.⁴ Firstly, the glass beads were activated by boiling in 1 M NaOH for 15 min, then washed with double-distilled water followed by 0.1 M HCl and distilled water again until pH 7. The beads then were rinsed with acetone and oven dried at 80 °C for three hours. Subsequently, the beads were incubated overnight in a solution of 2% v/v GLYMO in dry toluene with the addition of DIPEA (2 mg mL^{-1}) at 65 °C. The silanised beads (90 g) were placed in a bottle with a solution of 5 (TSA) (1 mg mL^{-1}) and DIPEA (1 mg mL^{-1}) in dry DMF (60 mL). The mixture was incubated at 60 °C overnight. After functionalisation, ethanolamine (1 eq. to GLYMO) was added to the reaction mixture for 3 h at 60 °C to block the unreacted epoxy groups. The functionalised glass beads were washed five times with acetone and three times with methanol, dried under the vacuum and stored under N_2 at -20 °C until use. For the preparation of the control-NPs (melamine-imprinted), the glass beads were incubated with 2% APTMS (v/v) in dry toluene at room temperature overnight. Once the glass beads were silanised, they were incubated in GA/PBS solution (7%, v/v) at pH 7.2 for 2 h and then washed with deionised water (8 × 20 mL) to remove any excess GA. They were incubated with 30 mL of 1 mg mL^{-1} of melamine PBS solution (pH 7.2) overnight to perform the immobilisation. After the reaction, the functionalized glass beads were washed with deionised water (3 × 20 mL), dried under vacuum and stored in a dry bottle under N_2 at 4 °C.

Synthesis of nanoMIPs In total six different MIPs were prepared, using TRIM (1.62 g) and EGDMA (1.62 g) as a cross-linkers, *N,N*-diethyldithiocarbamic acid benzyl ester (0.37 g) as iniferter and PETMP as chain transfer agent (0.09 g). Three functional monomers were used separately for both types of immobilised GB (TSA and melamine GB): 1.44 g of MAA, 2.99 g of DEAEM or 2.10 g of IA. For MAA and DEAEM polymerisation mixture was mixed with 5.29 g of MeCN or with DMF in

the case of IA. The polymerisation mixture was purged by bubbling nitrogen for 10 min to remove oxygen. Then this solution was added to 30 g of glass beads bearing the immobilised template and placed between two UV-lamps (Philips HB/171/A, each with 4 × 15 W tubes, one above and one below) for 1.5 mins. After this time, the beads were transferred into an SPE cartridge (60 mL) fitted with PE frit (20 µm pores diameter). Unreacted monomers and other low-affinity materials were removed by washing with cold MeCN or DMF at 0 °C (8 × 30 mL). Next, the temperature was raised to 65 °C and the fractions of high-affinity nanoparticles were collected by washing with pre-warmed MeCN at 65 °C (8 × 30 mL).

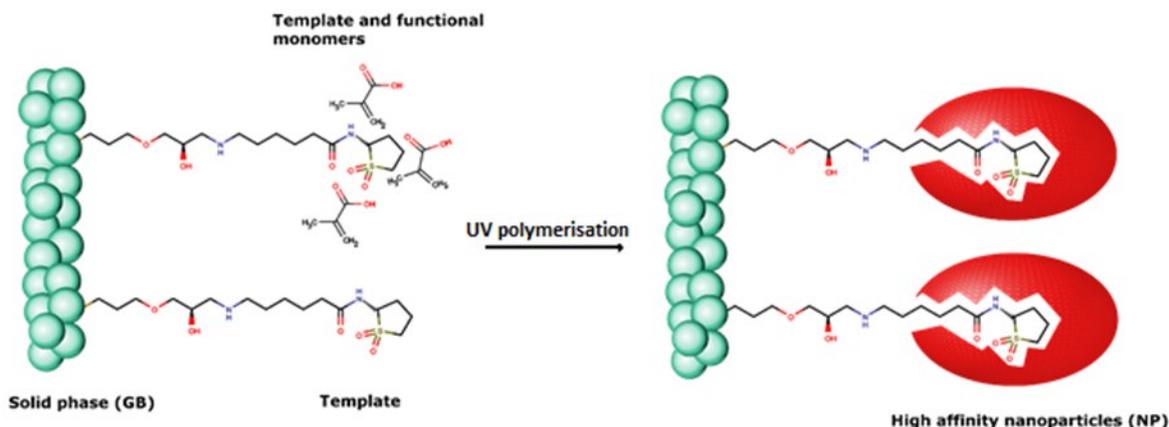


Fig. 1S. Scheme of the synthesis of the high affinity MIP NPs using solid-phase with immobilised TSA-template.

Evaluation of nanoMIPs concentration and size The concentration of nanoMIPs was calculated from the residual mass after evaporation of a known volume of the nanoMIPs solution in water. The size of the nanoparticles was determined by DLS at 25 °C. Every measurement was performed in triplicate.

HPLC-MS experiments The hydrolytic activity of the MIP NP was evaluated by HPLC-MS. The samples were prepared using an aqueous solution of 1 mg mL⁻¹ MIP NPs and several concentrations of C₆-AHL. They were incubated at 25 °C and filtered using PTFE syringe filters (0.1 µm cut-off) before the injection into a LC-MS/MS set-up consisting of HPLC WATERS 2795 coupled with a Quattro Micro Mass spectrometer detector (ES+) and equipped with a reverse phase column Luna C18(2), 3.0 × 50 mm. Acetonitrile acidified with 0.1% of formic acid was used as isocratic mobile phase at a flow rate of 0.2 mL min⁻¹. The retention time of the C₆-AHL was detected at 0.8 min. Every sample was measured in triplicate.

TEM measurements The MIPs were visualised by TEM (JEOL 1400, USA) with an accelerating voltage of 80 kV. MIP NPs (3 µL) were deposited on a carbon-coated grid and incubated for 2 min. Subsequently, an excess of liquid was removed with tissue paper and then a drop of uranyl acetate stain (1 % v/v aqueous) was deposited and again an excess was blotted with tissue paper and washed out with distilled water.



Fig 2S. TEM image of the catalytic MIP NPs.

References

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