Electronic Supporting Information

Synthesis and Electrochemical Properties of TTF Modified Oligodeoxynucleotides

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Oligodeoxynucleotides Synthesis and Characterisation

4'-(2-Hydroxy-1-hydroxymethyl-propylcarbamoyl)-[2,2']bi[1,3]dithiolylidene-4-carboxylic acid (2) - A solution of D-threoninol (105 mg, 1.0 mmol), [2,2']bi[1,3]dithiolylidene-4-carboxylic acid (**1**) (298 mg, 1.2 mmol), hydroxybenzotriazole (HO-Bt) (162 mg, 1.2 mmol) and dicyclohexylcarbodiimide (DCC) (248 mg, 1.2 mmol) in dry DMF (10 ml) was stirred at room temperature for 16 h. The mixture was filtered and concentrated *in vacuo*. Purification by column chromatography (silica gel, EtOAc) yielded the compound **2** (312 mg, 0.93 mmol, 93%) as a slightly orange foam. TLC (silica gel; EtOAc): $R_f = 0.2$. ^{1}H-NMR (300 MHz, DMSO-d_6, δ(ppm)): 7.85 (d, 1H, J = 8.9); 7.65 (s, 1H); 6.73 (s, 2H); 4.65-4.55 (m, 2H); 3.88-3.77 (m, 1H); 3.76-3.65 (m, 1H); 3.58-3.47 (m, 1H); 3.45-3.35 (m, 1H); 1.01 (d, 3H, J = 6.4). ^{13}C-NMR (75 MHz, DMSO-d_6, δ(ppm)): 159.02 (s); 133.88 (s); 124.67, 120.21, 119.92 (3d); 111.75, 106.43 (2s); 64.83 (d); 60.34 (t); 56.97 (d); 20.12 (q). HR-EI-MS: found: 334.9779; calc: 334.9778.

4'-{1-[Bis-(4-methoxyphenyl)phenyl-methoxymethyl]-2-hydroxy-propylcarbamoyl}-[2,2']bi[1,3]dithiolylidene]-4-carboxylic acid (3) - Compound **2** (270 mg, 0.80 mmol) was coevaporated with pyridine (3 x 2 ml) and dissolved in pyridine (43.5 ml). DMT-Cl was added in 4 portions over 2 h (4 x 83 mg, 0.98 mmol). After another 60 min at room temperature the mixture

was diluted with EtOAc (100 ml) and washed with sat. aq. $NaHCO_3$ solution (2 x 25 ml) and brine (25 ml). The combined aq. phases were extracted with EtOAc (2 x 25 ml). The combined organic phases were dried ($MgSO_4$), filtered and concentrated *in vacuo*. The residue was purified by FC (silica gel, 1% Et_3N in hexane/EtOAc 6:4 → 4:6) to give the title compound **3** (365 mg, 0.57 mmol, 72%) as an orange foam. TLC (silica gel; hexane/EtOAc 6 :4): R_f = 0.3. ^{1}H-NMR (300 MHz, $CDCl_3$, δ(ppm)): 7.40-7.19 (m, 7H); 7.08 (s, 1H); 6.84 (d, 4H, J = 8.7); 6.34 (d, 2H, J = 0.8); 6.23 (d, 1H, J = 8.5); 4.20-4.08 (m, 1H); 3.98-3.89 (m, 1H); 3.79 (s, 6H); 3.74 (dd, 1H, J_1 = 4.2, J_2 = 9.8); 3.31 (dd, 1H, J_1 = 3.4, J_2 = 9.6); 2.93 (d, 1H, J = 2.4); 1.15 (d, 3H). ^{13}C-NMR (75 MHz, $CDCl_3$, δ(ppm)): 159.3, 158.70, 144.25, 135.32, 135.25, 131.44 (6s); 129.93, 129.91, 128.09, 127.91, 127.09, 126.65, 119.19, 118.90 (8d); 114.38 (s); 113.40 (d); 107.14 (s); 86.99 (s); 68.38 (d); 65.06 (t); 55.25 (q); 54.17 (d); 20.00 (q). HR-ESI$^+$-MS: found: 660.0995 $[M+Na]^+$; calc: 660.0982.

4'-{1-[Bis-(4-methoxyphenyl)phenyl-methoxymethyl]-2-[(2-cyanoethoxy)-diisopropylamino-phosphanyloxy]-propylcarbamoyl}-[2,2']bi[1,3]dithiolylidene]-4-carboxylic acid (4) - Compound **3** (100 mg, 0.16 mmol) and diisopropylammonium-1H-tetrazol-1-ide (60 mg, 0.35 mmol) were dried by co-evaporation with dry benzene (3 x 5 ml) and dissolved in dry CH_2Cl_2 (5 ml). N,N,N',N'-tetraisopropyl-phosphordiamidite (100 µl, 0.31 mmol) was added and the mixture was stirred at room temperature for 16 h. The mixture was concentrated to approximately 1 ml and directly purified on a short column (silica gel, hexane/EtOAc 1:1 + 1% Et_3N) to yield **4** (126 mg, 0.15 mmol, 93%) as an orange foam. TLC (silica gel; hexane/EtOAc 1:1 + 1% Et_3N): R_f = 0.5. ^{1}H-NMR (300 MHz, $CDCl_3$, δ(ppm)): 7.41 (d, 2H, J = 7.2); 7.33-7.16 (m, 7H); 7.10, 7.09 (2s, 1H); 6.86-6.79 (m, 4H); 6.32 (s, 2H); 6.14 (d, major isomer, J = 8.5); 5.85 (d, minor isomer, J = 8.9, -HNCO-); 4.42-4.10 (m, 2H); 3.83-3.45 (m, 4H); 3.79, 3.78 (2s, 6H, 2 x CH_3); 3.32-3.16 (m, 2H); 2.67-2.37 (m, 2H); 1.29-1.00 (m, 15H). ^{31}P-NMR (162 MHz, $CDCl_3$, δ(ppm)): 148.58; 148.06. HR-ESI$^+$-MS: found: 860.2045 $[M+Na]^+$; calc: 860.2061.

Oligodeoxynucleotides 5'd($AX_{TTF}G$) (**5**), 5'd($GATGACX_{TTF}GCTAG$) (**6**) and its antiparallel complement 5'd($CTAGCX_{TTF}GTCATC$) (**7**) were synthesized on the 1.0 µmol scale on

a Applied Biosystems Expedite 8900 DNA synthesizer using standard phosphoramidite chemistry. 5-(Ethylthio)-1H-tetrazole (0.25 M in CH_3CN) was used as a coupling reagent and the coupling time for the TTF-phosphoramidite **4** was extended to 6 min. Oligodeoxynucleotides were detached and deprotected in conc. aq. NH_3 (55°C, 16 h) and purified by RP-HPLC. ESI^- mass analysis was consistent with the structure of the three oligodeoxynucleotides sequences reported in this communication: (i) **5** calc: 977.9, found 977.5, (ii) **6** calc: 3778.7, found: 3778.0 and (iii) **7** calc: 3689.6, found: 3689.5.

Instrumentation

Thermal denaturation experiments were carried out on a Varian Cary 100 bio UV/Vis spectrophotometer. The absorbance was monitored at 260 nm and the heating rate was set to 0.5°C min^{-1}. Circular dichroism (CD) spectra were recorded on a Jasco J-715 spectropolarimeter equipped with a Jasco PFO-350S temperature controller. Electrochemical measurements were performed with an Autolab PGSTAT 30. The working electrode was an ITO slide masked with chemically inert adhesive Teflon tape (3 M) with an exposed area of 0.071 cm^2. Slides were cleaned in ultrasonic bath for 10 minutes each with acetone, ethanol and MilliQ water. This procedure was repeated twice. A Pt wire and MSE were employed as secondary and reference electrode. The supporting electrolyte was 0.05 M Na_2SO_4.