Interaction between a cationic bolaamphiphile and DNA: the route towards nanovectors for oligonucleotide antimicrobials

Supporting Information

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Anion exchange of [12-bis-THA]I_2 to obtain [12-bis-THA]Cl_2

We used the ion exchange resin Dowex 1x4 Chloride form, 50-100 mesh (strongly basic; 1 meq/mL wet resin; CAS 69011-19-4). The resin (9.993 g, about 15 mL) was introduced into an Erlenmeyer flask, and water was added up to 200 mL total volume. The mix was stirred overnight at room temperature, to allow for a complete swelling of the resin. The next day, the resin was washed several times on a Büchner funnel with filter paper (Whatman quantitative filter paper, ashless, 40) using 500 mL Milli-Q water, followed by 500 mL HCl 5 vol%, and again water, until neutral pH. Finally, the resin was washed with about 1 L methanol. The resin thereby conditioned was then transferred to another Erlenmeyer, and 100 mL methanol was added.

Finally [12-bis-THA]I_2 (190 mg) was introduced as a powder, and the mix was stirred during about 24 hours at room temperature. Once the reaction completed, the resin was separated from the mixture by filtration, and washed with methanol. The solvent was then eliminated by rotary evaporation.

The solid [12-bis-THA]Cl_2 was redissolved in Milli-Q water, filtered and freeze-dried. This procedure was repeated twice, thereby obtaining 132 mg of dry powder free of resin residue. ^{1}H NMR analysis of a 1 mg/mL solution of the chemical in deuterated methanol confirmed the purity of the product.

The success of the ion exchange procedure was assessed by determining the amount of residual iodine in an aqueous solution of the final product (0.85 mg/mL) by means of ICP-AES: the analysis revealed a 4% impurity of unreacted [12-bis-THA]I_2. Elemental analysis of the lyophilized powder yielded the following composition: 64.2% C, 7.21% H, 7.76% N. Considering the theoretical CHN composition of the pure compound (respectively: 71.8%, 8.24%, and 8.81%), this result is well in line with a product contaminated by 4% unreacted [12-bis-THA]I, and crystallized with 4 water molecules.

Molecular weights:

[12-bis-THA]I_2 = 818.66 g/mol

[12-bis-THA]Cl_2 = 635.75 g/mol

Physico-chemical characterization of [12-bis-THA]Cl_2

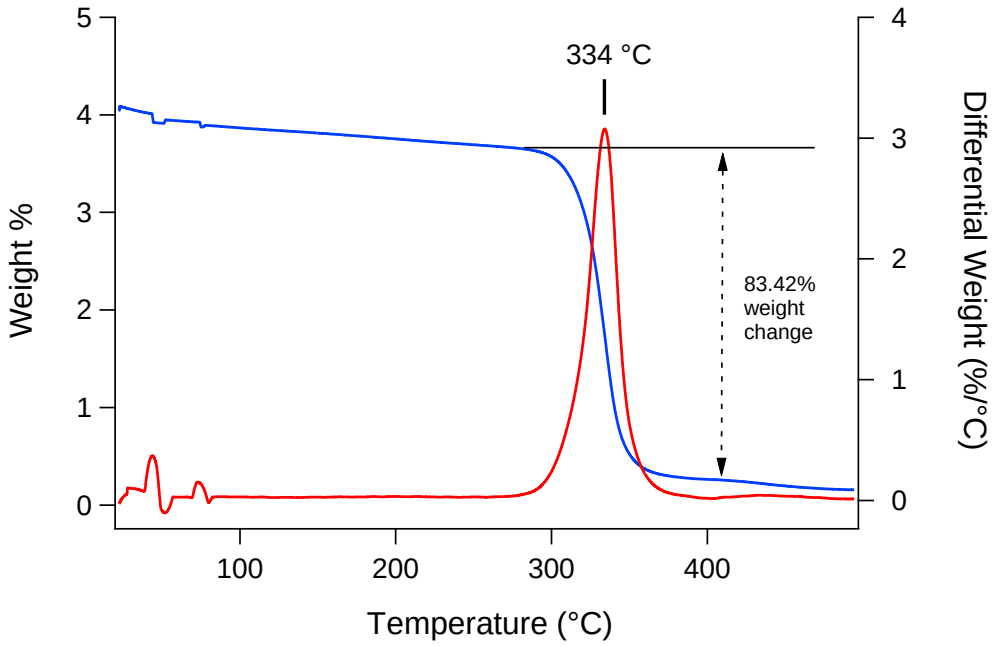

Figure S1. Thermogravimetric analysis of pure [12-bis-THA]Cl_2. The graph shows the percentage of weight loss (blue curve) and its 1st derivative. The percentage of weight loss (83.42%) and the temperature at which the phenomenon occur (334 °C) are determined. This result configures a decomposition of the molecule before any melting occurs.

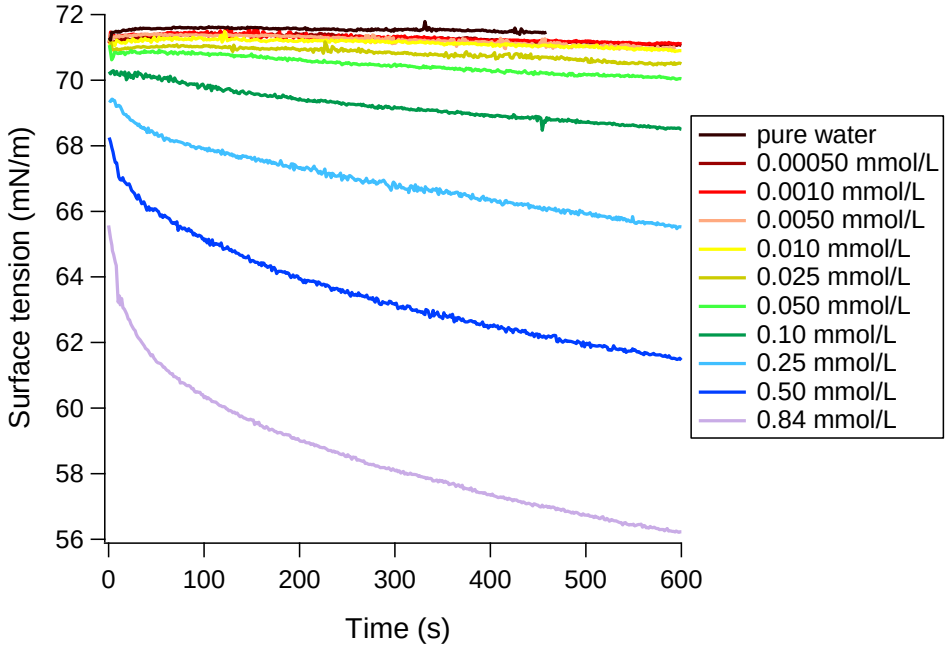

Figure S2. Surface tension (mN/m) *vs.* Time (s) curves for aqueous solutions of [12-bis-THA]Cl_2 at different concentrations. All measurements were carried out at 25 °C.

Fluorescence spectroscopy study of [12-bis-THA]Cl_2 aqueous solutions

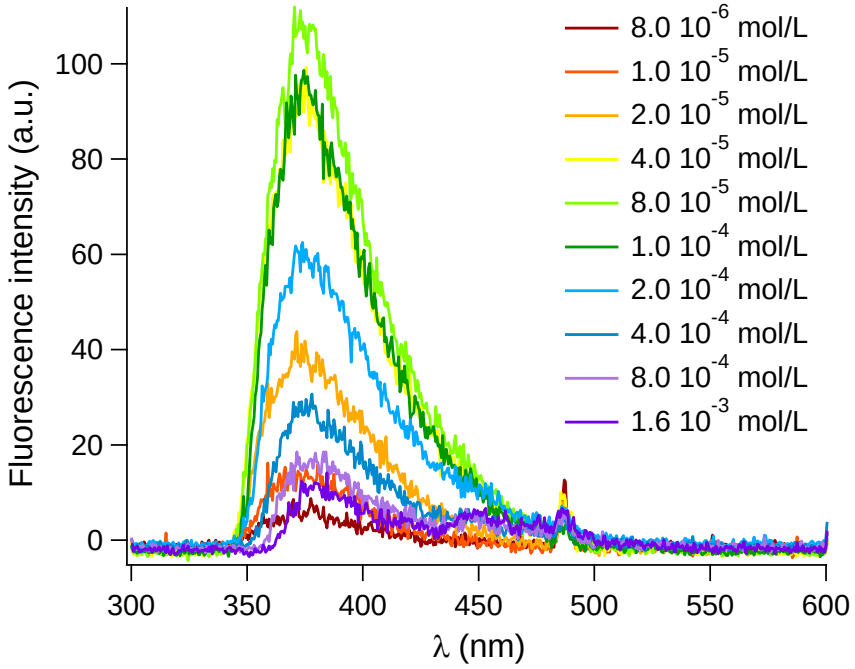

Figure S3. Steady-state fluorescence emission spectra for several aqueous solutions of [12-bis-THA]Cl_2. Spectra acquired in the corrected spectrum mode, with λ_{exc} = 244 nm, slits = 2.5/2.5, smoothing = 2.5.

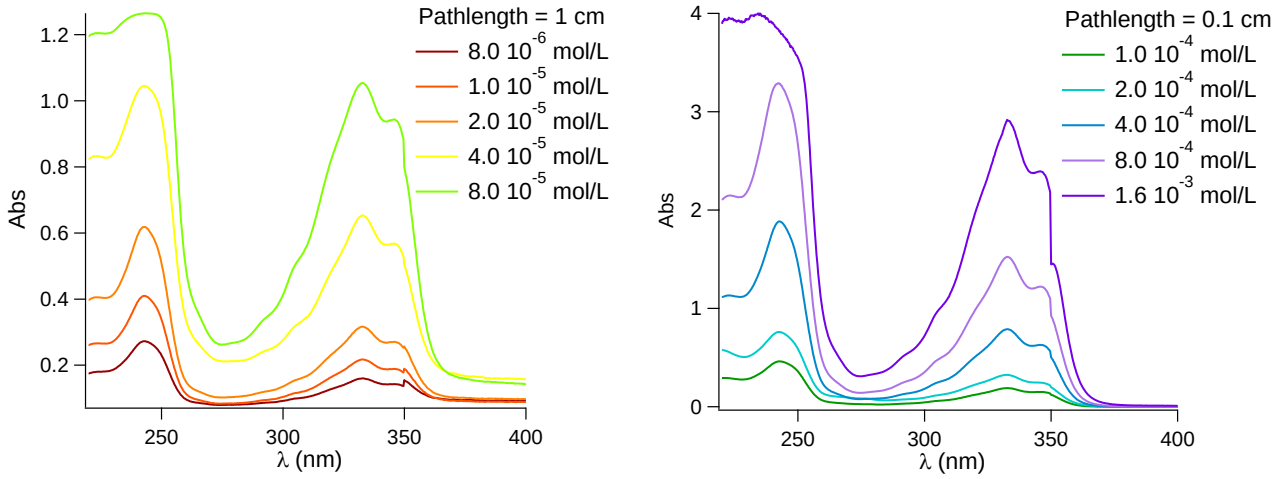

Figure S4. UV-vis absorption spectra of the same samples as Figure S3.

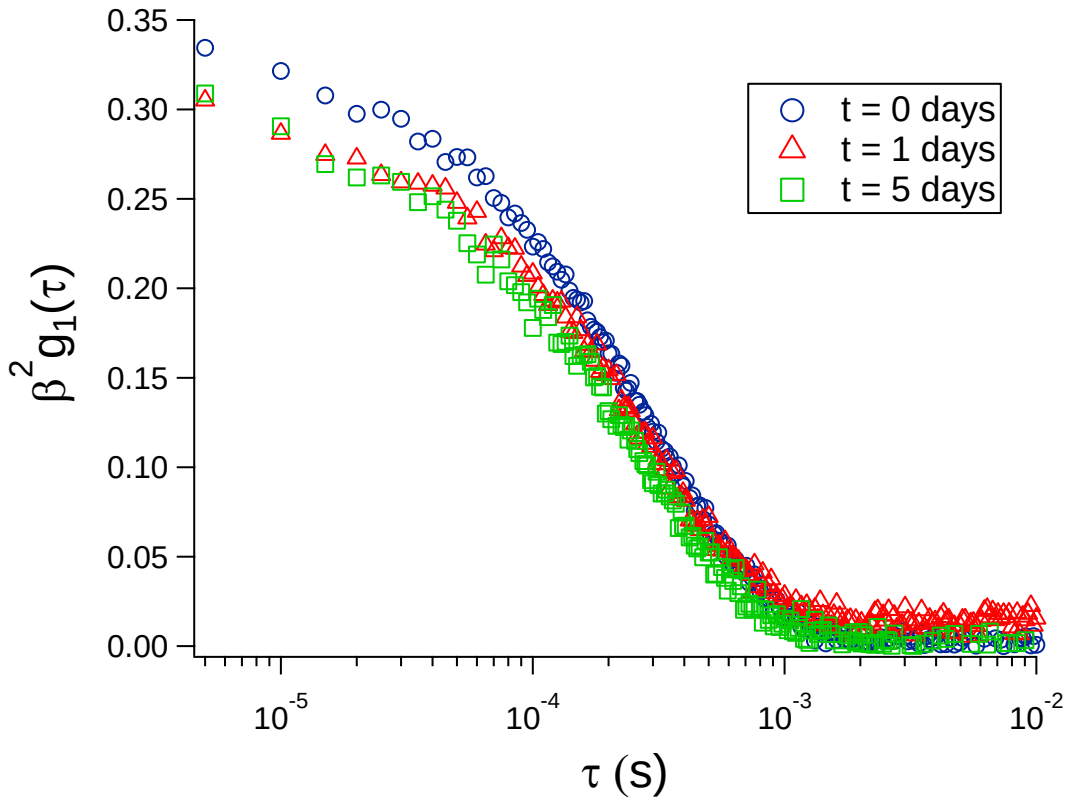

Figure S5. DLS autocorrelation function corresponding to a solution of 9.0 10^{-4} mol/L [12-bis-THA]Cl_2 measured at different time intervals.

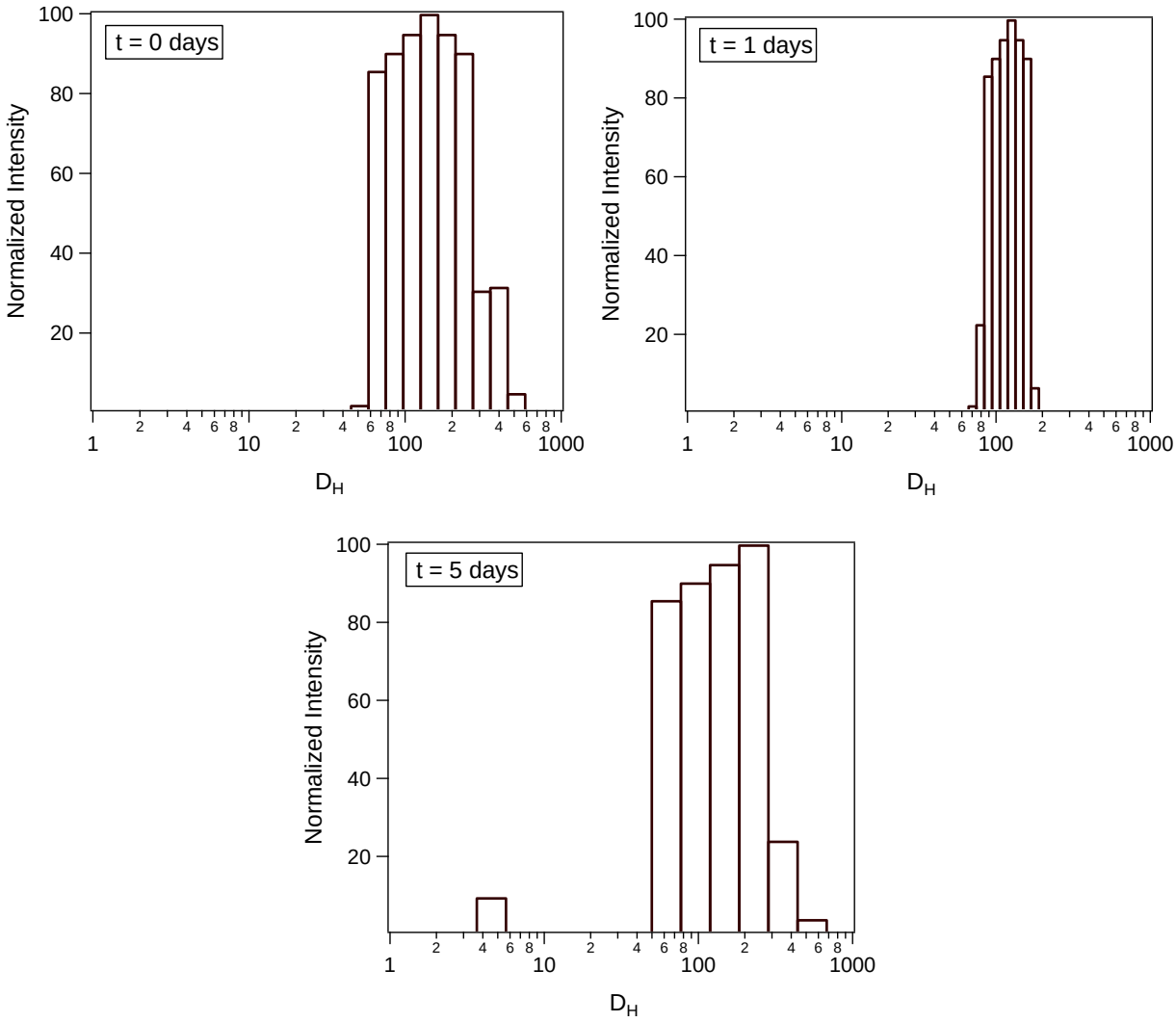

Figure S6. Intensity-weighed hydrodynamic size distribution obtained by CONTIN analysis of the autocorrelation functions in Figure S5.

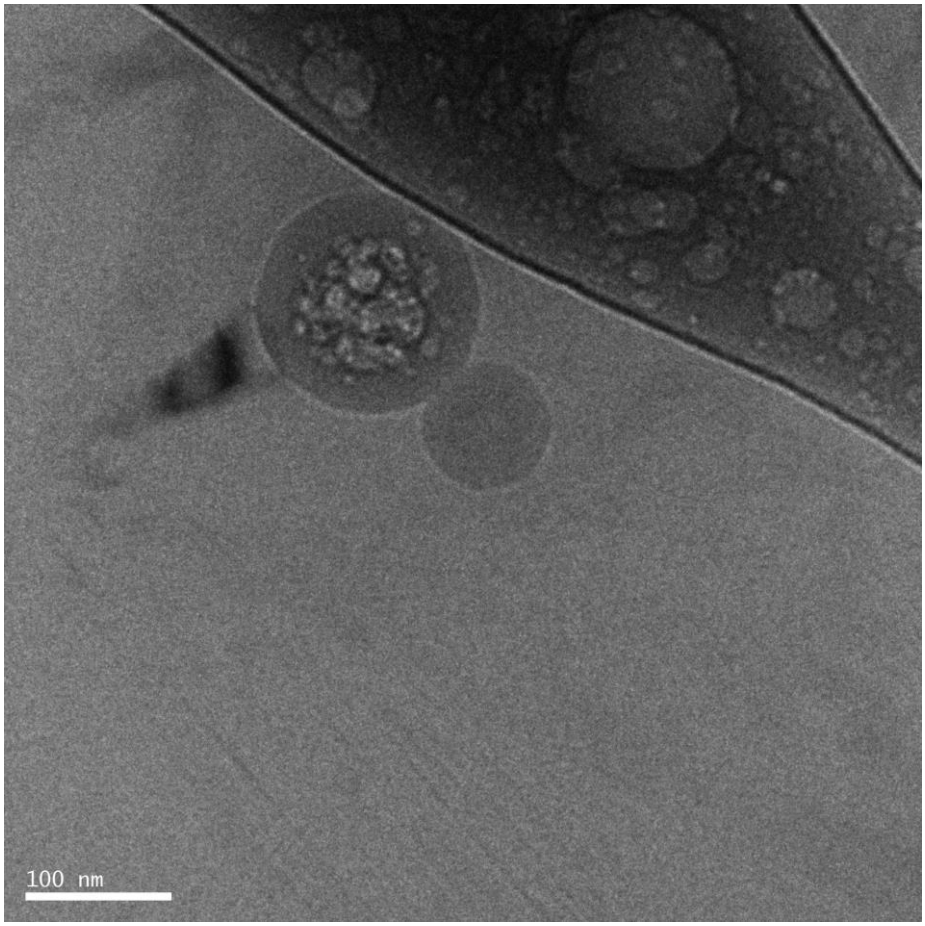

Figure S7. Cryo-TEM image of an aqueous solution of [12-bis-THA]Cl_2, 1.8 10^{-4} mol/L, and TFD in a 11:1 charge ratio.

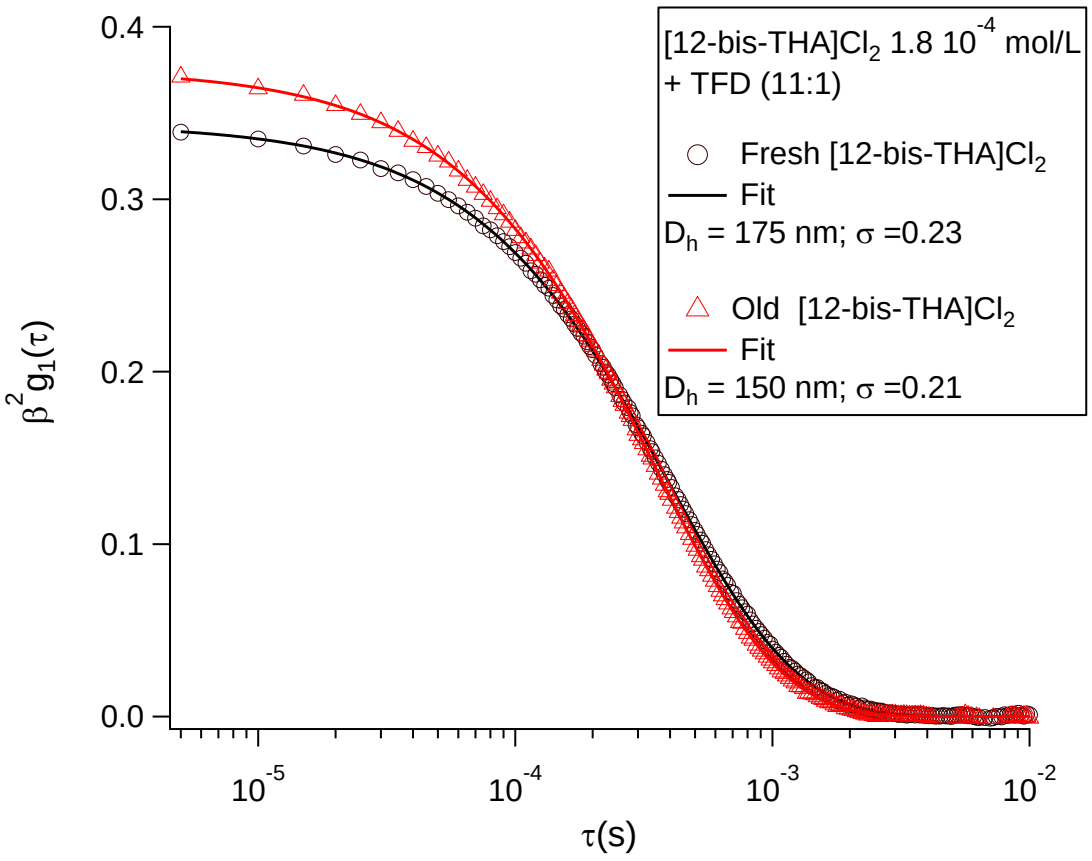

Figure S8. DLS autocorrelation function corresponding to solutions of 1.8 10^{-4} mol/L [12-bis-THA]Cl_2 (one freshly prepared, one about 1 month old) + TFD in a 11:1 charge ratio.

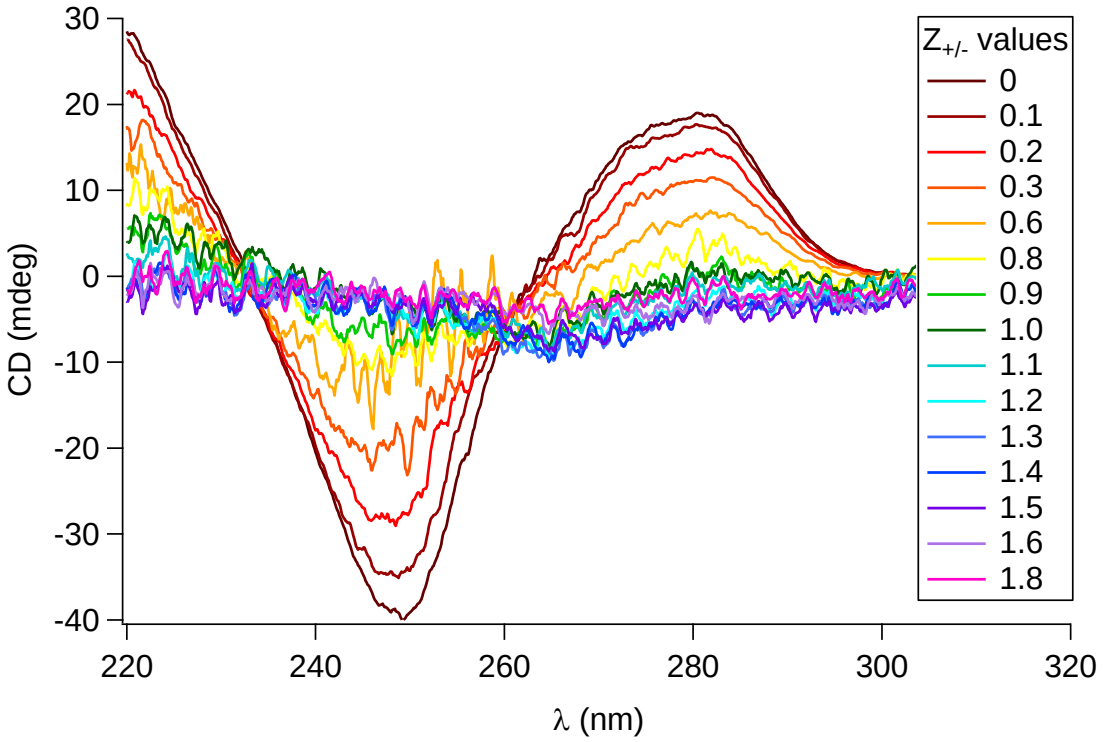

Figure S9. CD titration of a 77-base pairs oligonucleotide (90 µg/mL, or 1.9 10^{-6} mol/L) with [12-bis-THA]Cl_2. The legend reports the positive-to-negative charge ratios for every addition of bolaamphiphile.

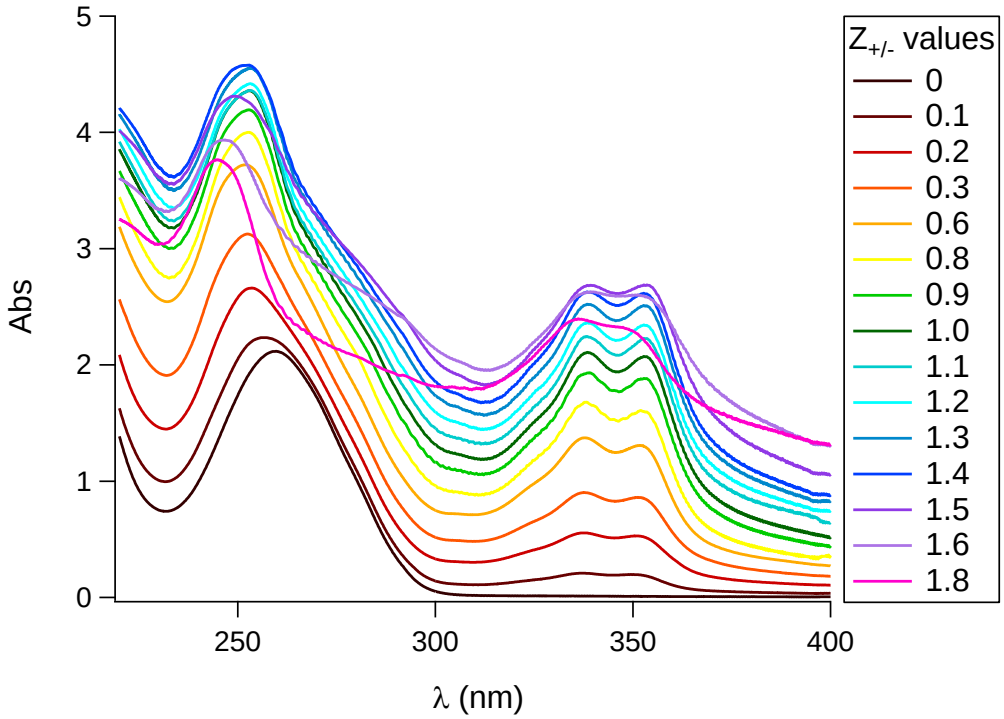

Figure S10. Absorption spectra corresponding to the CD spectra in Figure S9.

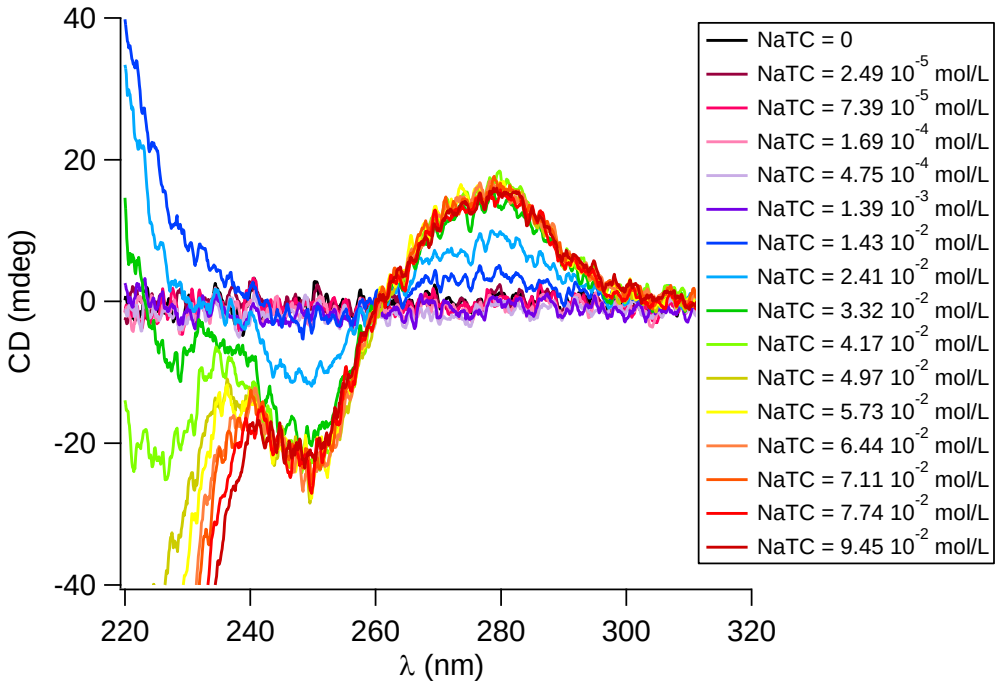

Figure S11. Circular dichroism titration of a DNA/[12-bis-THA]Cl_2 complex with sodium taurocholate (NaTC). The complex charge ratio is $Z_{+/-}$ = 1.5 (DNA: 90 µg/mL, or 1.9 10^{-6} mol/L; [12-bis-THA]Cl_2 = 2.5 10^{-4} mol/L).

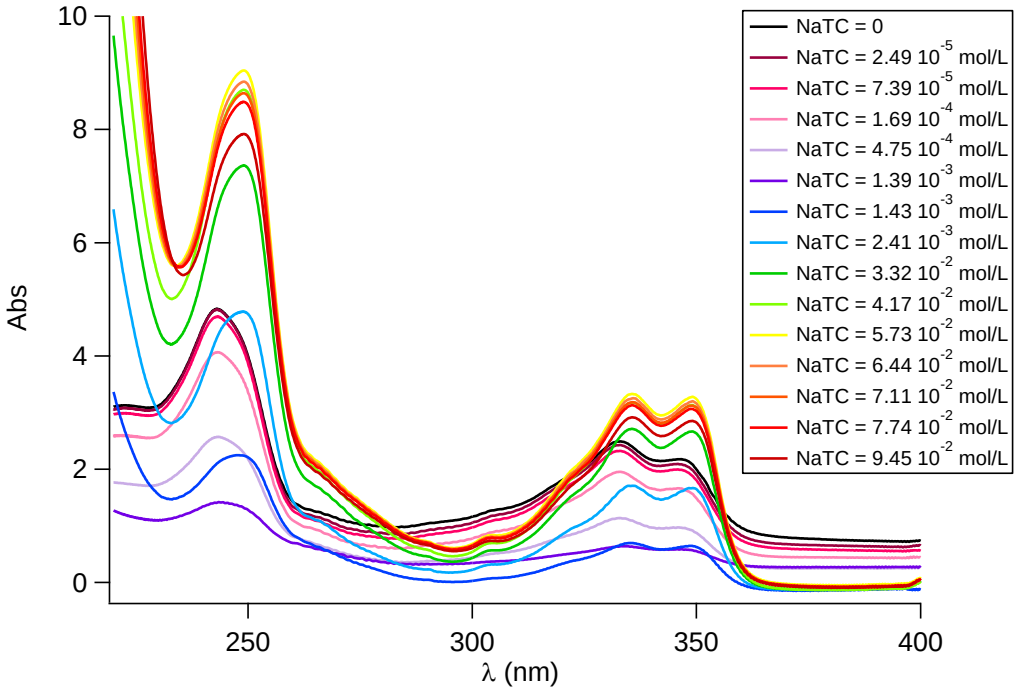

Figure S12. Absorption spectra corresponding to the CD spectra in Figure S11.