Electronic Supplementary Information

Synthesis of Fmc-AA

Fmc-A-OMe
To a DCM (15 ml) solution of 9-Fluorene acetic acid (340 mg, 1.52 mmol) was added HCl.L-alanine methyl ester (254 mg, 1.82 mmol), DIPEA (1.06 ml, 6.06 mmol), and Propylphosphonic anhydride solution 50 wt. % in EtOAc (1.08 ml, 1.82 mmol). The reaction mixture was then stirred at room temperature for an hour. The reaction mixture was diluted with DCM, then washed with 1 M HCl (x2), water (x2), and brine. The organic layer was isolated and concentrated via rotary evaporation, in order to afford the crude product. Purified via silica column chromatography, eluting with a 0-1% MeOH/DCM gradient, in order to afford the title compound (434 mg, 77.1 %yield).

Fmc-A
To a 1:1 THF/Water (15 ml) solution of Fmc-AOMe (434 mg, 1.40 mmol) was added LiOH (88.3 mg, 2.10 mmol), and the reaction mixture stirred at room temperature for 2 hours. The reaction mixture was diluted with DCM, washed with 1M HCl solution, dried over $MgSO_4$, and concentrated under vacuum in order to afford the title compound (381 mg, 91.9 %yield).

Fmc-AA-OMe
To a DCM (15 ml) solution of Fmc-A (381 mg, 1.29 mmol) was added HCl.L-alanine methyl ester (270 mg, 1.94 mmol), DIPEA (899 ml, 5.16 mmol), and Propylphosphonic anhydride solution 50 wt. % in EtOAc (1.15 ml, 1.94 mmol). The reaction mixture was diluted with DCM, then washed with 1 M HCl (x2), water (x2), and brine. The organic layer was isolated and concentrated via rotary evaporation, in order to afford the crude product. Purified via silica column chromatography, eluting with a 0-1% MeOH/DCM gradient, in order to afford the title compound (428 mg, 87.2 %yield).
^{1}H NMR ($CDCl_3$) δ 7.78 (d, 2H, ArH), 7.51 (dd, 2H, ArH), 7.40 (t, 2H, ArH), 7.31 (m, 2H, ArH), 6.65 (d, 1H, NH), 5.98 (d, 1H, NH), 4.57 (m, 2H, CHCO), 4.50 (t, 1H, ArCH), 3.77 (s, 3H, OCH_3), 2.71 (ddd, 2H, CH_2), 1.45 (d, 3H, CH_3), 1.34 (d, 3H, CH_3)

Fmc-AA
To a 1:1 THF/Water (15 ml) solution of Fmc-AAOMe (428 mg, 1.12 mmol) was added LiOH (70.8 mg, 1.69 mmol), and the reaction mixture stirred at room temperature for 2 hours. The reaction mixture was diluted with DCM, washed with 1M HCl solution, dried over $MgSO_4$, and concentrated under vacuum in order to afford the title compound (402 mg, 97.5 %yield).
ESI MS $[M+H]^+$ m/z 366.98, $[M+Na]^+$ m/z 389.13, $[M-H]^-$ m/z 365.05
^{1}H NMR (CD_3OD) δ 7.79 (d, 2H, ArH), 7.54 (d, 1H, ArH), 7.51 (d, 1H, ArH), 7.37 (t, 2H, ArH), 7.29 (q, 2H, ArH), 4.53 (q, 1H, CHCO), 4.46 (q, 1H, CHCO), 4.41 (t, 1H, ArCH), 2.66 (dd, 1H, CH_2), 2.60 (dd, 1H, CH_2), 1.47 (d, 3H, CH_3), 1.39 (d, 3H, CH_3)

Synthesis of labelled Fmoc-A(^{13}C)A

Fmoc-A(^{13}C)
To water (6 ml) was added alanine-1-^{13}C (250 mg, 2.78 mmol), and triethylamine (388 µl, 2.78 mmol). Separately, FmocOSu (941 mg, 2.78 mmol) was dissolved in MeCN (5 ml). The two solutions were mixed, and the pH raised to 9.0 via the dropwise addition of triethylamine. The reaction mixture was stirred at room temperature for 1.5 hours. The reaction mixture was acidified with 1M HCl and extracted with EtOAc. The organic layer was dried over $MgSO_4$ and concentrated under vacuum in order to afford the title compound (800 mg, 92.3 %yield).

Fmoc-A(^{13}C)AOtBu
To a DCM (20 ml) solution of Fmoc-A(^{13}C) (800 mg, 2.56 mmol 0.6 mmol) was added HCl.alanine tert butyl ester salt (698 mg, 3.84 mmol), DIPEA (1.86 ml, 10.7 mmol), and Propylphosphonic anhydride solution 50 wt. % in EtOAc (2.36 ml, 3.84 mmol). The

reaction mixture was stirred at room temperature for 1.5 hours. The reaction mixture was diluted with DCM, then washed with 1 M HCl (x2), water (x2), and brine. The organic layer was isolated and concentrated via rotary evaporation, in order to afford the crude product. Purified via silica column chromatography, eluting with a 0-1% MeOH/DCM gradient, in order to afford the title compound (1.03 g, 77.2 %yield).

Fmoc-A(^{13}C)A
A 1:1 TFA/DCM (15 ml) solution of Fmoc-A(^{13}C)AOtBu (1.03 g, 2.34 mmol) was stirred at room temperature for 3 hours. The reaction mixture was then concentrated via rotary evaporation. The residue was diluted with DCM, then washed with 1 M HCl (x2), water (x2), and brine. The organic layer was isolated, dried over $MgSO_4$, and concentrated via rotary evaporation, in order to afford the title compound (839 mg, 92.9 %yield).
ESI MS $[M+H]^+$ m/z 384.07, $[M+Na]^+$ m/z 406.20
^{13}C NMR (CD_3OD) δ 173 (^{13}C=O)
^{1}H NMR (CD_3OD) δ 7.81 (d, 2H, ArH), 7.68 (t, 2H, ArH), 7.40 (t, 2H, ArH), 7.33 (td, 2H, ArH), 4.39 (m, 3H, CHCO/CH_2O), 4.24 (t, 1H, ArCH), 4.20 (m, 1H, CHCO), 1.42 (d, 3H, CH_3), 1.37 (dd, 3H, CH_3)

HPLC

A Dionex P680 HPLC system equipped with a C18 column of 250 mm length, 4.6 mm internal diameter and 5mm particle size was also used to confirm >95% purity of final compounds. A gradient of 20% acetonitrile in water at 4 minutes to 80% acetonitrile at 31 minutes was used, with a flow rate of 1 ml/min and detection wavelength of 225 nm.

Additional Figures

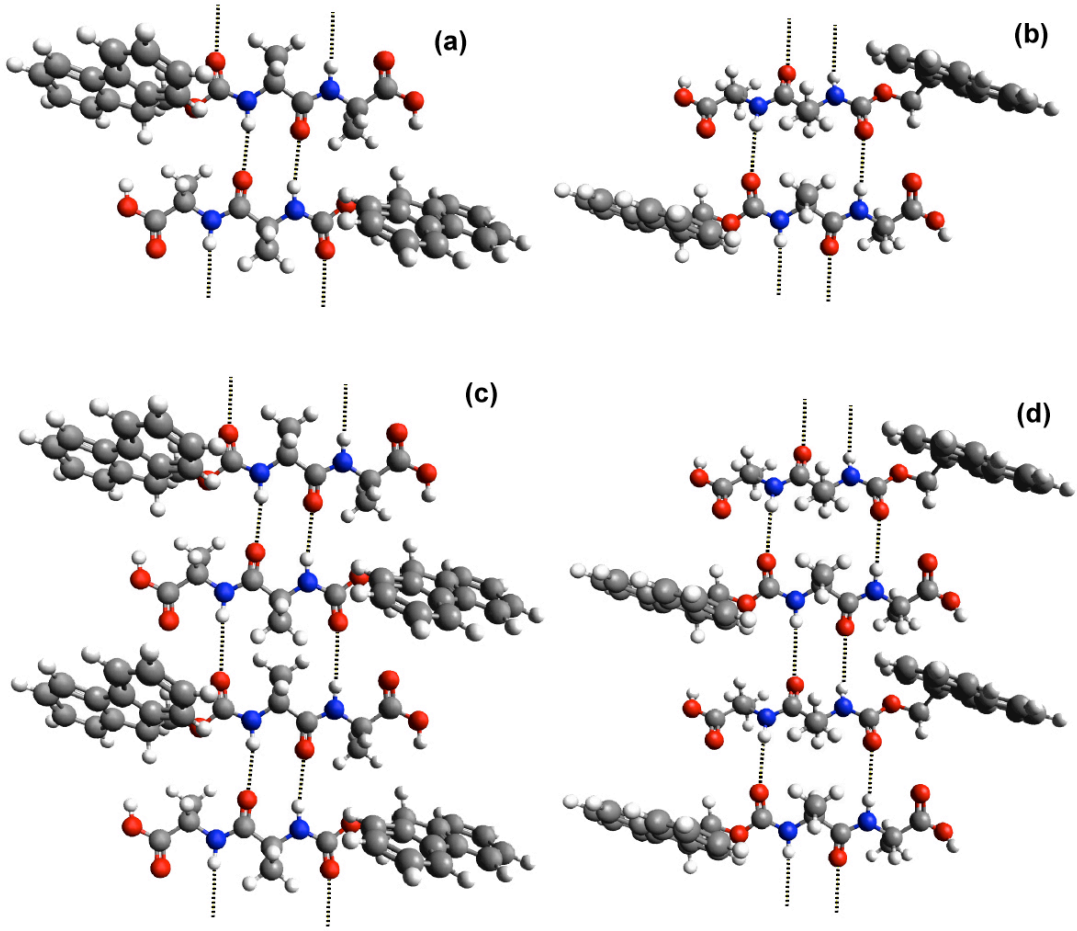

Figure S1. Additional antiparallel models for **Fmoc**: (a) ap2a dimer; (b) ap2b dimer; (c) ap2a tetramer; (d) ap2b tetramer. Note that models a and b are different segments of the same structure.

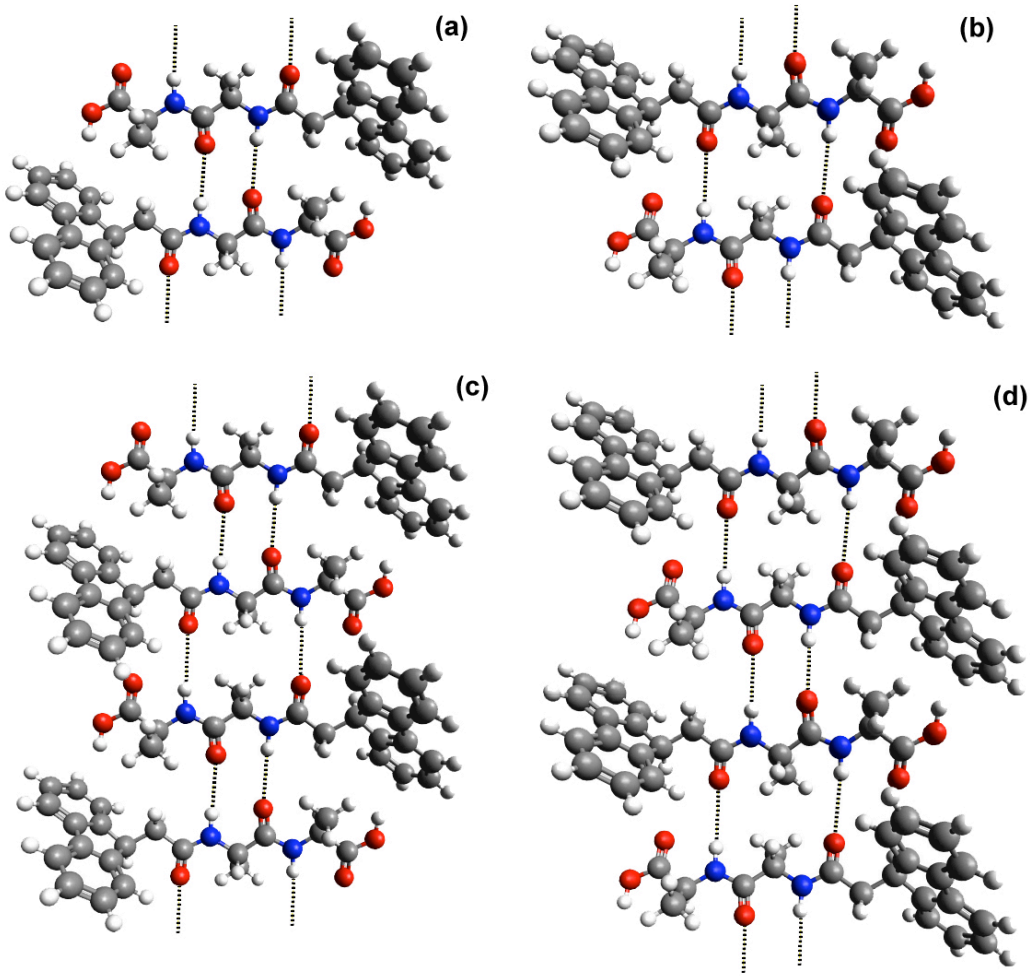

Figure S2. Additional antiparallel models for **Fmc**: (a) ap2a dimer; (b) ap2b dimer; (c) ap2a tetramer; (d) ap2b tetramer. Note that models a and b are different segments of the same structure.

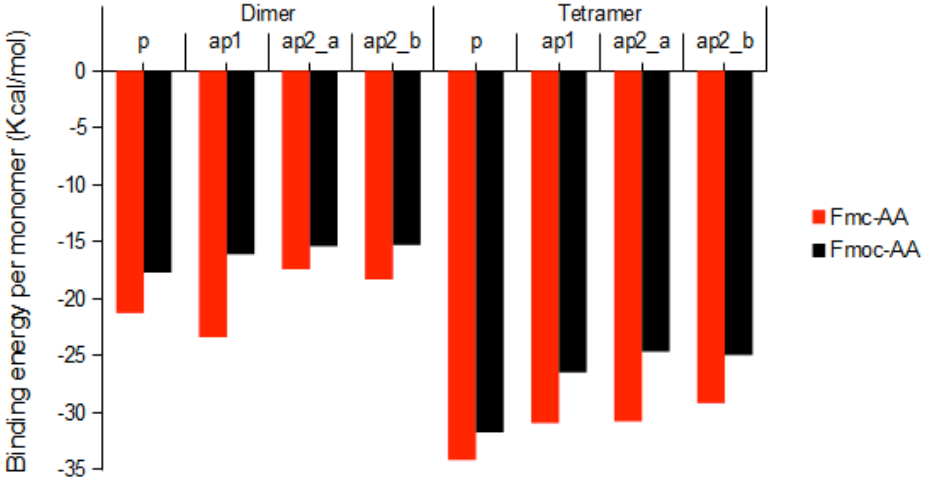

Figure S3. Binding energy calculation results. No structure can be ruled out on the basis of these binding energy calculations, because the parallel arrangement had an intrinsic advantage in that significant π-π stacking was present due to the imperfect intermolecular arrangement in these size-limited optimised structures. Much larger constructs would be necessary to be in a position to make any firm conclusions as a result of calculated binding energies.

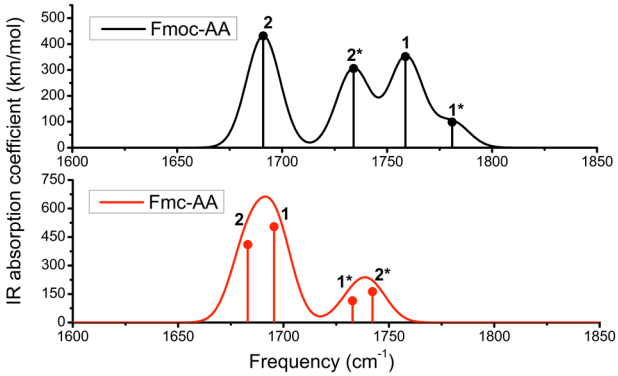

Figure S4. Simulated Amide I spectra for **Fmoc** and **Fmc** parallel dimers. Spectra are generated applying an 8 cm^{-1} linewidth Gaussian to the calculated normal modes (vertical droplines). Amide I modes arising from amide groups with their carbonyl group pointing out of the stack are indicated with an asterisk (*).

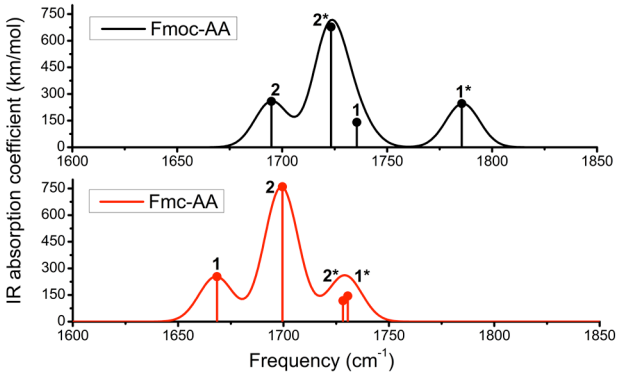

Figure S5. Simulated Amide I spectra for **Fmoc** and **Fmc** antiparallel (ap1) dimers. Spectra are generated applying an 8 cm^{-1} linewidth Gaussian to the calculated normal modes (vertical droplines). Amide I modes arising from amide groups with their carbonyl group pointing out of the stack are indicated with an asterisk (*).

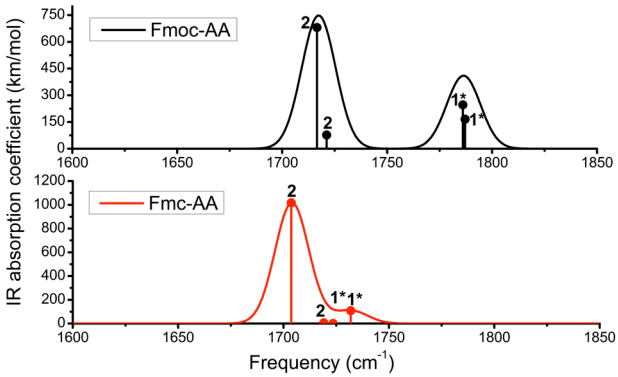

Figure S6. Simulated Amide I spectra for **Fmoc** and **Fmc** antiparallel (ap2a) dimers. Spectra are generated applying an 8 cm^{-1} linewidth Gaussian to the calculated normal modes (vertical droplines). Amide I modes arising from amide groups with their carbonyl group pointing out of the stack are indicated with an asterisk (*).

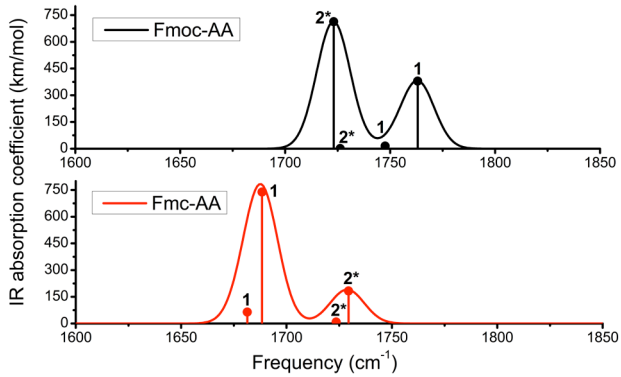

Figure S7. Simulated Amide I spectra for **Fmoc** and **Fmc** antiparallel (ap2b) dimers. Spectra are generated applying an 8 cm^{-1} linewidth Gaussian to the calculated normal modes (vertical droplines). Amide I modes arising from amide groups with their carbonyl group pointing out of the stack are indicated with an asterisk (*).

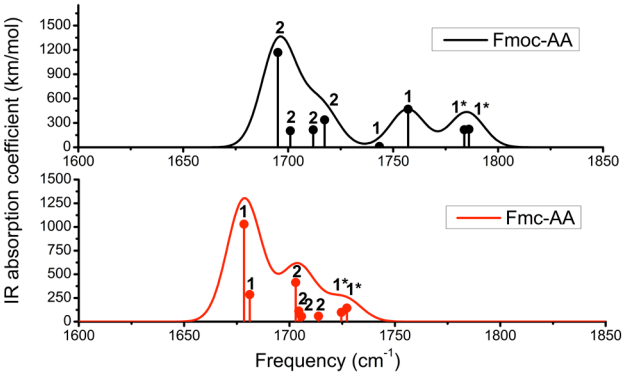

Figure S8. Simulated Amide I spectra for **Fmoc** and **Fmc** antiparallel (ap2a) tetramers. Spectra are generated applying an 8 cm^{-1} linewidth Gaussian to the calculated normal modes (vertical droplines). Amide I modes arising from amide groups with their carbonyl group pointing out of the stack are indicated with an asterisk (*).

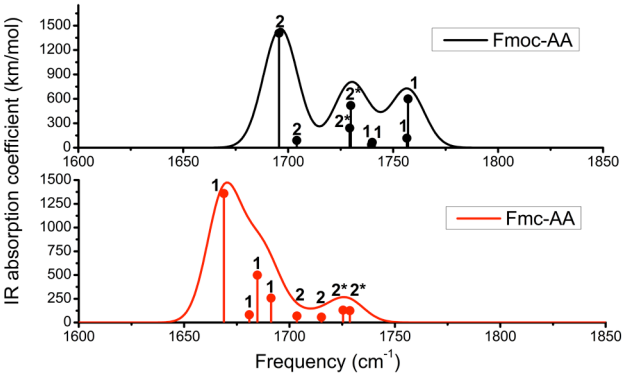

Figure S9. Simulated Amide I spectra for **Fmoc** and **Fmc** antiparallel (ap2b) tetramers. Spectra are generated applying an 8 cm^{-1} linewidth Gaussian to the calculated normal modes (vertical droplines). Amide I modes arising from amide groups with their carbonyl group pointing out of the stack are indicated with an asterisk (*).