Folding and Duplex Formation in Sequence-Defined Aniline Benzaldehyde Oligoarylacetylenes

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- [TEA-TFA] – 0 mM
- [TEA-TFA] – 1 mM
- [TEA-TFA] – 2 mM
- [TEA-TFA] – 4 mM
- [TEA-TFA] – 6 mM
- [TEA-TFA] – 8 mM
- [TEA-TFA] – 20 mM
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[TEA-TFA] – 0 mM

[TEA-TFA] – 1 mM

[TEA-TFA] – 2 mM

[TEA-TFA] – 4 mM

[TEA-TFA] – 6 mM

[TEA-TFA] – 8 mM

[TEA-TFA] – 20 mM
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$^1$H-$^1$H ROSEY correlations observed for $ds$-$ABA$.

$^1$H-$^1$H COSY correlations observed for $ds$-$ABA$.

$R = (\text{CH}_2\text{CH}_2\text{O})_2\text{CH}_3$
**Figure S12.** $^1$H NMR peak assignments and $^1$H-$^1$H ROSEY and $^1$H-$^1$H COSY correlations for ds-BAB. Chemical shifts in ppm are given in parenthesis next to the associated proton. Ambiguous peaks are given as a range where they appear. $^1$H-$^1$H correlations observed between protons are indicated by a double headed arrow. * denotes peaks where significant overlap occurs in the $^1$H NMR spectrum, peaks could be assigned with certainty from cross-peaks in the 2D spectra.

$^1$H-$^1$H ROSEY correlations observed for ds-BAB.

$^1$H-$^1$H COSY correlations observed for ds-BAB.

R = (CH$_2$CH$_2$O)$_2$CH$_3$
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$^1$H-$^1$H ROSEY correlations observed for ds-AAB.

$^1$H-$^1$H COSY correlations observed for ds-AAB.

$R = (\text{CH}_2\text{CH}_2\text{O})_2\text{CH}_3$
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$^1$H-$^1$H ROSEY correlations observed for ds-ABB.

$^1$H-$^1$H COSY correlations observed for ds-ABB.

$R = (\text{CH}_2\text{CH}_2\text{O})_2\text{CH}_3$
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$^1$H-$^1$H ROSEY correlations observed for fold-AAB.

$^1$H-$^1$H COSY correlations observed for fold-AAB.

$R = (\text{CH}_2\text{CH}_2\text{O})_2\text{CH}_3$
Figure S16. $^1$H NMR peak assignments and $^1$H-$^1$H ROSEY and $^1$H-$^1$H COSY correlations for fold-ABB. Chemical shifts in ppm are given in parenthesis next to the associated proton. Overlapping peaks are given as a range where they appear. $^1$H-$^1$H correlations observed between protons are indicated by a double headed arrow. *denotes peaks where significant overlap occurs in the $^1$H NMR spectrum, peaks could be assigned with certainty from cross-peaks in the 2D spectra.

$^1$H-$^1$H ROSEY correlations observed for fold-ABB.

$^1$H-$^1$H COSY correlations observed for fold-ABB.

$R = (CH_2CH_2O)_2CH_3$
Figure S17. ESI-TOF Mass spectra for ss-ABOs.

ss-AAA

M+Na/+1

2M+Na/+1

SS-BBB

M+Na/+1

2M+Na/+1

ss-ABA

M+Na/+1

2M+Na/+1

SS-BAB

M+Na/+1

2M+Na/+1

ss-AAB

M+Na/+1

2M+Na/+1

SS-ABB

M+Na/+1

2M+Na/+1
Figure S18. ESI-TOF Mass spectra for ds-, and fold-ABOs. a These peaks are distinguishable from the corresponding fold-ABOs by their isotopic ratios indicating a +2 charge state. b These peaks are not distinguishable from the M+Na/+1 ions of the corresponding ds-ABOs, however NMR data confirms these solutions do not contain significant amounts of ds-ABO and so it can be concluded that these peaks arise from 2M+Na/+1 ions of the fold-ABO.
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Figure S21. Relevant section of the $^1$H NMR spectra of ds-ABA-BAB in CDCl$_3$ over a dilution series from 383 uM to 3 uM. Spectra acquired at 50 °C.
Figure S22. Relevant section of the $^1$H NMR spectra of $ds$-$AAB$-$BBA$ in CDCl$_3$ over a dilution series from 259 uM to 2 uM. Spectra acquired at rt.
Figure S23. Relevant section of the $^1$H NMR spectra of ds-AAB-BBA in CDCl$_3$ over a dilution series from 259 uM to 2 uM. Spectra acquired at 50 °C.
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Figure S25. Concentration dependence of the $^1$H NMR chemical of shift of 3-rung duplexes in CDCl$_3$ at rt and 50 °C for three resonances: blue, the internal imine (NHC), red the terminal imines (NHC), and yellow the aromatic protons meta to the ester functional groups. Curves represent the line of best fit to the equal K model of indefinite association. The error is the standard error estimated from the variance-covariance matrix of the least-squares fitted parameters.
EXPERIMENTAL SECTION

General. All solvents and catalysts, as well as starting materials 3-ethynylbenzaldehyde 1 and 3-ethylaniline 4 were purchased from commercial sources and used without further treatment. Diiodide 2,[1] 3,5-diethynylbenzaldehyde,[2] and 3,5-diethylaniline[3] were prepared via previously reported methods. “Dry” CDCl₃ was prepared by treating and storing commercially available CDCl₃ over 4 Å molecular sieves. THF was purchased as a solution stabilized with 250 ppm BHT and fractionally distilled before use. Removal of peroxides from the THF was crucial to the solution stability of the ABOs. MM2 energy minimum calculations for 1,3-folded AAB and 1,2-folded AAB were accomplished using the Perkin Elmer Chem3D software package. ¹H NMR and ¹³C NMR spectra were recorded at 93.94 kG (¹H 400 MHz, ¹³C 100 MHz) at 25 °C. Hydrogen chemical shifts are expressed in parts per million (ppm) relative to the residual proto-solvent resonance: CDCl₃ δ 7.26. For ¹³C spectra, the centerline of the solvent signal was used as internal reference: CDCl₃ δ 77.16. Unless otherwise noted, each carbon resonance represents a single carbon (relative intensity).

ESI-TOF high resolution mass spectrometric data were obtained on a ToF (time-of-flight) Agilent Technologies system. Samples were injected as 10 uM solutions in 8:2 THF:H₂O with 20 uM sodium acetate. The MS settings were: capillary voltage 4500 V, desolvation temperature 300 °C, fragmentor voltage 450 V. Matrix-assisted laser desorption/ionization (MALDI) time-of-flight (TOF) mass spectrometry experiments were carried out as follows: 0.5 μL of a 100 μM solution of 2,5-dihydroxybenzoic acid matrix (Sigma) in methanol was deposited on a MTP 384 polished steel BC target plate (Bruker), and the solvent was allowed to evaporate. A single 0.5 μL aliquot of analyte in CDCl₃ was then added on top of the 2,5-dihydroxybenzoic acid film and the sample analyzed with an autolfextreme MALDI-TOF mass spectrometer (Bruker). For K₆ determination, a global fit of three protons to the equal K model of indefinite association was preformed using the MATLAB software package the multiple curve fitting with common parameters tool.[4]

![Reaction Scheme](image)

2-(2-methoxyethoxy)ethyl 3-((3-formylphenyl)ethynyl)-5-iodobenzoate (3).

To a 100 mL round bottom flask equipped with a stir bar 1 (65 mg, 0.5 mmol) was added then dissolved in anhydrous toluene (5 mL) and DIPEA (3 equiv. 1.5 mmol, 261 μL). Diiodide 2 was added (10 equiv., 5 mmol, 2.38 g) to the reaction vessel and the solution stirred until homogeneous (approx. 15 minutes). To the stirred solution Pd(PPh₃)₄ (0.05 equiv., 0.025 mmol, 29 mg) and
Cul (0.1 equiv., 0.05 mmol, 9.5 mg) were then added. The headspace of the reaction vessel was purged with argon and the flask sealed with a glass stopper. After stirring 2.5 h at room temperature dry silica was added. The mixture was then concentrated onto the silica gel using rotoevaporation and the resulting white powder used to dry load a silica gel column. Normal phase silica gel flash chromatography (40 g silica column, hexane with a 20-60% gradient of EtOAc over 18 minutes) gave product 3 (227 mg, 0.47 mmol, 95% yield) as a white solid and recovered unreacted 2 (2.05 g, 96%). 

**1H NMR** (400 MHz, CDCl₃) δ 10.03 (s, 1H), 8.36 (t, J = 1.6 Hz, 1H), 8.18 (t, J = 1.5 Hz, 1H), 8.06 (t, J = 1.6 Hz, 1H), 8.03 (t, J = 1.7 Hz, 1H), 7.88 (dt, J = 7.7, 1.4 Hz, 1H), 7.77 (dt, J = 7.8, 1.4 Hz, 1H), 7.55 (t, J = 7.7 Hz, 1H), 4.55 – 4.47 (m, 2H), 3.88 – 3.82 (m, 2H), 3.73 – 3.67 (m, 2H), 3.61 – 3.55 (m, 2H), 3.40 (s, 3H).

**13C NMR** (100 MHz, CDCl₃) δ 193.9, 166.9, 146.6, 141.0, 139.7, 139.1, 135.5, 134.6, 134.5, 132.1, 131.9, 127.5, 126.2, 96.0, 92.6, 90.8, 74.5, 73.1, 71.7, 67.3, 61.7. HRMS (ESI): m/z calcd for C₂₁H₁₉INO₅Na⁺ 501.0169 [M+Na⁺]; found 501.0145.

2-(2-methoxyethoxy)ethyl 3-((3-aminophenyl)ethynyl)-5-iodobenzoate (5).

To a 100 mL round bottom flask equipped with a stir bar 4 (56 µL, 0.5 mmol) was added then dissolved in anhydrous toluene (5 mL) and DIPEA (3 equiv. 1.5 mmol, 261 µL). Diiodide 2 was added (10 equiv., 5 mmol, 2.38 g) to the reaction vessel and the solution stirred until homogeneous (approx. 15 minutes). To the stirred solution Pd(PPh₃)₄ (0.05 equiv., 0.025 mmol, 29 mg) and Cul (0.1 equiv., 0.05 mmol, 9.5 mg) were then added. The headspace of the reaction vessel was purged with argon and the flask sealed with a glass stopper. After stirring 2.5 h at room temperature dry silica was added. The mixture was then concentrated onto the silica gel using rotoevaporation and the resulting white powder used to dry load a silica gel column. Normal phase silica gel flash chromatography (40 g silica column, hexane with a 30-70% gradient of EtOAc over 18 minutes) gave product 5 (219 mg, 0.47 mmol, 94% yield) as a white solid and recovered unreacted 2 (2.07 g, 96%).

**1H NMR** (400 MHz, CDCl₃) δ 8.29 (t, J = 1.6 Hz, 1H), 8.12 (t, J = 1.5 Hz, 1H), 8.00 (t, J = 1.6 Hz, 1H), 7.12 (t, J = 7.8 Hz, 1H), 6.91 (dt, J = 7.6, 1.2 Hz, 1H), 6.81 (dd, J = 2.4, 1.4 Hz, 1H), 6.66 (ddd, J = 8.0, 2.4, 1.0 Hz, 1H), 4.51 – 4.45 (m, 2H), 3.86 – 3.79 (m, 2H), 3.74 (br, 2NH), 3.71 – 3.64 (m, 2H), 3.59 – 3.53 (m, 2H), 3.38 (s, 3H). 

**13C NMR** (100 MHz, CDCl₃) δ 164.6, 146.5, 144.1, 137.9, 132.0, 131.9, 129.4, 125.7, 123.1, 122.1, 117.8, 115.9, 93.3, 92.1, 86.1, 71.9, 70.6, 69.1, 64.6, 59.2. HRMS (ESI): m/z calcd for C₂₀H₂₀INO₂⁺ 466.0510 [M+H⁺]; found 466.0531.
2-(2-methoxyethoxy)ethyl 3-((3-ethynyl-5-formylphenyl)ethynyl)-5-((3-formylphenyl)ethynyl)benzoate (6).

To a 20 mL scintillation vial AsPh$_3$ (0.04 mmol, 12 mg) and Pd$_2$(dba)$_3$ (0.01 mmol, 5.0 mg, 5.0 mol%) were added and dissolved in anhydrous toluene (1 mL). The head space of the vial was purged with argon then the vial sealed with a screw on cap. The purple solution was gently swirled until the Pd$_2$(dba)$_3$ dissolved and the color changed to bright yellow (approx. 10 min). In a separate vial equipped with a stir bar, 2,6-diethynylbenzaldehyde (308 mg, 2.0 mmol, 10 equiv.) and aryl-iodide 3 (1 equiv., 96 mg, 0.2 mmol) were dissolved in anhydrous toluene (1 mL) and DIPEA (12 equiv., 2.4 mmol, 414 uL). While stirring under a stream of argon the Pd catalyst solution was added dropwise (1 mL) to the solution containing the aldehyde and alkyne. The vessel was sealed with a screw on cap and heated to 40 °C. After stirring overnight, the reaction was cooled to rt transferred to a round bottom flask and diluted with DCM (approx. 50 mL). Silica gel was added to vessel and crude reaction mixture concentrated onto the silica gel. Silica gel flash chromatography (hexane with a 20-90% gradient of EtOAC over 18 minutes) gave pure 6 (86 mg, 0.17 mmol, 85%) as a white solid. $^1$H NMR (400 MHz, CDCl$_3$) δ 10.04 (s, 1H), 10.00 (s, 1H), 8.21 (d, $J$ = 1.6 Hz, 1H), 8.19 (t, $J$ = 1.6 Hz, 1H), 8.05 (t, $J$ = 1.7 Hz, 1H), 8.00 (t, $J$ = 1.6 Hz, 1H), 7.96 (t, $J$ = 1.6 Hz, 1H), 7.92 – 7.86 (overlap, 3H), 7.79 (dt, $J$ = 7.7, 1.5 Hz, 1H), 7.56 (t, $J$ = 7.7 Hz, 1H), 4.56 – 4.51 (m, 2H), 3.90 – 3.85 (m, 2H), 3.75 – 3.69 (m, 2H), 3.61 – 3.57 (m, 2H), 3.40 (s, 3H), 3.21 (s, 1H).

$^{13}$C NMR (100 MHz, CDCl$_3$) δ 191.5, 190.6, 165.1, 140.2, 138.5, 137.3, 136.8, 136.7, 133.2, 133.0, 132.9, 132.7, 131.2, 129.6, 129.4, 124.4, 124.0, 123.93, 123.89, 123.5, 89.75, 89.69, 89.0, 88.6, 81.4, 79.8, 72.1, 70.7, 69.3, 64.7, 59.3. HRMS (ESI): m/z calcd for C$_{32}$H$_{26}$O$_6$Na$: 527.1465 [M+Na]$^+$; found 527.1443.

2-(2-methoxyethoxy)ethyl 3-((3-amino-5-ethynylphenyl)ethynyl)-5-((3-aminophenyl)ethynyl)benzoate (7).
To a 20 mL scintillation vial AsPh$_3$ (0.046 mmol, 14.1 mg) and Pd$_2$(dba)$_3$ (0.011 mmol, 5.3 mg, 5.0 mol%) were added and dissolved in anhydrous toluene (1 mL). The head space of the vial was purged with argon then the vial sealed with a screw on cap. The purple solution was gently swirled until the Pd$_2$(dba)$_3$ dissolved and the color changed to bright yellow (approx. 10 min). In a separate vial equipped with a stir bar, 2,6-diethynylaniline (303 mg, 2.34 mmol, 10 equiv.) and aryl-iodide 5 (1 equiv., 109 mg, 0.23 mmol) were dissolved in anhydrous toluene (1 mL) and DIPEA (12 equiv., 2.76 mmol, 480 uL). While stirring under a stream of argon the catalyst solution was added dropwise to the solution containing the aldehyde and alkyne. The vessel was sealed with a screw on cap and heated to 40 °C. After stirring overnight, the reaction was cooled to rt transferred to a round bottom flask and diluted with DCM (approx. 50 mL). Silica gel was added to vessel and crude reaction mixture concentrated onto the silica gel. Silica gel flash chromatography (hexane with a 70-100% gradient of EtOAc over 5 minutes, then held at 100% EtOAc for 20 min) gave pure 7 (87 mg, 0.18 mmol, 79%) as a white solid. $^1$H NMR (400 MHz, CDCl$_3$) δ 8.12 (s, 1H), 8.10 (s, 1H), 7.79 (s, 1H), 7.13 (t, $J$ = 7.8 Hz, 1H), 7.06 (s, 1H), 6.93 (d, $J$ = 7.5 Hz, 1H), 6.84 (s, 1H), 6.80 (s, 1H), 6.77 (s, 1H), 6.67 (d, $J$ = 8.2 Hz, 1H), 4.53 – 4.47 (m, 2H), 3.87 – 3.81 (m, 2H), 3.78 (s, 2H), 3.75 (br, 2NH), 3.72 – 3.68 (br, 2NH), 3.60 – 3.55 (m, 2H), 3.39 (s, 3H), 3.05 (s, 1H). $^{13}$C NMR (100 MHz, CDCl$_3$) δ 165.3, 146.49, 146.48, 138.4, 132.4, 132.2, 130.8, 129.4, 125.6, 124.3, 123.9, 123.6, 123.3, 122.1, 118.8, 118.4, 117.9, 115.8, 91.3, 90.2, 87.6, 87.0, 83.1, 77.3, 71.9, 70.6, 69.2, 64.6, 59.2. HRMS (ESI): m/z calcd for C$_{38}$H$_{36}$N$_2$O$_4$+H$^+$ 479.1965 [M+H]$^+$; found 479.1946.

**ss-AAA.**

To a 20 mL scintillation vial AsPh$_3$ (0.026 mmol, 7.9 mg) and Pd$_2$(dba)$_3$ (0.0033 mmol, 3.0 mg, 10 mol%) were added and dissolved in anhydrous toluene (0.5 mL). The head space of the vial was purged with argon then the vial sealed with a screw on cap. The purple solution was gently swirled until the Pd$_2$(dba)$_3$ dissolved and the color changed to bright yellow (approx. 10 min). In a separate vial equipped with a stir bar, 2,6-diethynylaniline (9.2 mg, 0.065 mmol, 1 equiv.) and aryl-iodide 5 (2 equiv., 60 mg, 0.13 mmol) were dissolved in anhydrous toluene (1.3 mL) and DIPEA (12 equiv., 1.6 mmol, 271 uL). While stirring under a stream of argon the catalyst solution was added dropwise to the solution containing 2,6-diethynylaniline and 5. The vessel was sealed with a screw on cap and heated to 40 °C. After stirring overnight, the reaction was cooled to rt, transferred to a round bottom flask, and diluted with DCM (approx. 50 mL) and TEA (approx. 1 mL). Silica gel (approx. 2 g) was added to the vessel and the crude reaction mixture was concentrated onto the silica gel. Silica gel flash chromatography (hexane with a 70-100% gradient of EtOAc over 5 minutes, then held at 100% EtOAc for 25 min, both organic solvents were basified with 0.1 % TEA) gave ss-AAA (34 mg, 0.042 mmol, 65%) as a white solid after concentration in vacuo. $^1$H NMR (400 MHz, CDCl$_3$) δ 8.15 (t, $J$ = 1.6 Hz, 2H), 8.13 (t, $J$ = 1.6 Hz, 2H), 7.83 (t, $J$ = 1.6 Hz, 2H), 7.18 – 7.12 (overlap, 3H), 6.95 (ddd, $J$ = 7.6, 1.5, 1.0 Hz, 2H), 6.87 (ddd, $J$ = 2.4, 1.5, 0.5 Hz, 2H), 6.85 (d, $J$ = 1.4 Hz, 2H), 6.69 (ddd, $J$ = 8.1, 2.4, 1.0 Hz, 2H), 4.54 – 4.49 (m, 4H), 3.89 – 3.84 (m, 4H), 3.79 (br, 2NH), 3.74 – 3.70
(overlap, 8H), 3.62 – 3.56 (m, 4H), 3.40 (s, 6H). $^{13}$C NMR (100 MHz, CDCl$_3$) δ 165.4 (2C), 146.6, 146.5 (2C), 138.5 (2C), 132.5 (2C), 132.3 (2C), 130.9 (2C), 129.5 (2C), 125.5, 124.4 (2C), 124.0 (2C), 123.9 (2C), 123.4 (2C), 122.3 (2C), 118.4 (2C), 118.0 (2C), 115.9 (2C), 91.4 (2C), 90.3 (2C), 87.8 (2C), 87.1 (2C), 72.1 (2C), 70.7 (2C), 69.3 (2C), 64.6 (2C), 59.3 (2C). HRMS (ESI): m/z calcld for C$_{50}$H$_{45}$N$_{3}$O$_{8}$+Na$^+$: 838.3099 [M+Na]$^+$; found 838.3100.

ss-BBB.
To a 20 mL scintillation vial AsPh$_3$ (0.19 mmol, 19 mg) and Pd$_2$(dba)$_3$ (0.0075 mmol, 6.8 mg, 5 mol%) were added and dissolved in anhydrous toluene (1.0 mL). The head space of the vial was purged with argon then the vial sealed with a screw on cap. The purple solution was gently swirled until the Pd$_2$(dba)$_3$ dissolved and the color changed to bright yellow (approx. 10 min). In a separate vial equipped with a stir bar, 2,6-diethynylbenzaldehyde (19 mg, 0.12 mmol, 1.0 equiv.) and aryl-iodide 3 (2.5 equiv., 143 mg, 0.3 mmol) were dissolved in anhydrous toluene (3.0 mL) and DIPEA (12 equiv., 1.5 mmol, 261 µL). While stirring under a stream of argon the catalyst solution was added dropwise to the solution containing 2,6-diethynylbenzaldehyde and 3. The vessel was sealed with a screw on cap and stirred at rt. After stirring overnight, the crude reaction mixture was transferred to a round bottom flask and diluted with DCM (approx. 50 mL) and TEA (approx. 1 mL). Silica gel (approx. 5 g) was added to the vessel and the crude reaction mixture was concentrated onto the silica gel. Silica gel flash chromatography (hexane with a 20-90% gradient of EtOAC) gave pure ss-BBB (98 mg, 0.11 mmol, 94%) as a white solid after concentration in vacuo. $^1$H NMR (400 MHz, CDCl$_3$) δ 10.044 (s, 1H), 10.039 (s, 2H), 8.24 – 8.19 (overlap, 4H), 8.06 (t, $J$ = 1.6 Hz, 2H), 8.03 (d, $J$ = 1.6 Hz, 2H), 7.96 (t, $J$ = 1.6 Hz, 1H), 7.92 – 7.87 (overlap, 4H), 7.80 (dt, $J$ = 7.7, 1.5 Hz, 2H), 7.56 (t, $J$ = 7.7 Hz, 2H), 4.57 – 4.51 (m, 4H), 3.90 – 3.85 (m, 4H), 3.74 – 3.69 (m, 4H), 3.62 – 3.56 (m, 4H), 3.40 (s, 6H). $^{13}$C NMR (100 MHz, CDCl$_3$) δ 191.5 (2C), 190.6, 165.1 (2C), 139.7, 138.5 (2C), 137.3 (2C), 136.9, 136.7 (2C), 133.1 (2C), 133.0 (2C), 132.9 (2C), 132.5 (2C), 131.2 (2C), 129.6 (2C), 129.4 (2C), 124.5 (2C), 123.89 (2C), 123.86 (2C), 123.5 (2C), 89.8 (2C), 89.7 (2C), 88.9 (2C), 88.7 (2C), 72.1 (2C), 70.7 (2C), 69.3 (2C), 64.7 (2C), 59.3 (2C). HRMS (ESI): m/z calcld for C$_{53}$H$_{45}$O$_{11}$+Na$^+$: 877.2619 [M+Na]$^+$; found 877.2643.

ss-ABA.
To a 20 mL scintillation vial AsPh$_3$ (0.02 mmol, 6.2 mg) and Pd$_2$(dba)$_3$ (0.0025 mmol, 2.2 mg, 10 mol%) were added and dissolved in anhydrous toluene (0.5 mL). The head space of the vial was purged with argon then the vial sealed with a screw on cap. The purple solution was gently swirled until the Pd$_2$(dba)$_3$ dissolved and the color changed to bright yellow (approx. 10 min). In a separate vial equipped with a stir bar, 2,6-diethynylbenzaldehyde (7.7 mg, 0.05 mmol, 1 equiv.) and aryl-iodide 5 (2 equiv., 47 mg, 0.1 mmol) were dissolved in anhydrous toluene (1 mL) and DIPEA (12 equiv., 0.6 mmol, 104 µL). While stirring under a stream of argon the catalyst solution was added dropwise to the solution containing 2,6-diethynylbenzaldehyde and 5. The vessel was
sealed with a screw on cap and heated to 40 °C. After stirring at overnight, the reaction was cooled to rt, transferred to a round bottom flask, and diluted with DCM (approx. 50 mL) and TEA (approx. 1 mL). Silica gel (approx. 2 g) was added to the vessel and the crude reaction mixture was concentrated onto the silica gel. Silica gel flash chromatography (hexane with a 70-100% gradient of EtOAc over 5 minutes, then held at 100% EtOAc for 10 min, both organic solvents were basified with 0.1 % TEA) gave ss-ABA (31 mg, 0.037 mmol, 74%) as a white solid after concentration in vacuo. 1H NMR (400 MHz, CDCl3) δ 10.04 (s, 1H), 8.18 (t, J = 1.6 Hz, 2H), 8.17 (t, J = 1.6 Hz, 2H), 8.01 (d, J = 1.6 Hz, 2H), 7.95 (t, J = 1.6 Hz, 1H), 7.86 (t, J = 1.6 Hz, 2H), 7.16 (t, J = 7.8 Hz, 2H), 6.96 (dt, J = 7.6, 1.2 Hz, 2H), 6.87 (dd, J = 2.4, 1.5 Hz, 2H), 6.70 (ddd, J = 8.0, 2.5, 1.0 Hz, 2H), 4.55 – 4.50 (m, 4H), 3.90 – 3.85 (m, 4H), 3.77 – 3.68 (overlap, 8H), 3.62 – 3.57 (m, 4H), 3.40 (s, 6H). 13C NMR (100 MHz, CDCl3) δ 191.5 (2C), 165.3 (2C), 146.7, 138.5 (2C), 137.3 (2C), 136.7 (2C), 133.2 (2C), 124.8 (2C), 124.5 (2C), 123.8 (2C), 123.7 (2C), 122.3 (2C), 118.4 (2C), 116.0 (2C), 91.6 (2C), 90.0 (2C), 88.5 (2C), 86.9 (2C), 72.1 (2C), 70.7 (2C), 69.3 (2C), 64.7 (2C), 59.3 (2C). HRMS (ESI): m/z calcd for C31H46N2O8+Na+: 851.2939 [M+Na]+; found 851.2937.

ss-BAB.
To a 20 mL scintillation vial AsPh3 (0.017 mmol, 5.1 mg) and Pd2(dba)3 (0.0021 mmol, 1.9 mg, 10 mol%) were added and dissolved in anhydrous toluene (0.5 mL). The head space of the vial was purged with argon then the vial sealed with a screw on cap. The purple solution was gently swirled until the Pd2(dba)3 dissolved and the color changed to bright yellow (approx. 10 min). In a separate vial equipped with a stir bar, 2,6-diethynylaniline (5.6 mg, 0.042 mmol, 1 equiv.) and aryl-iodide 3 (2 equiv., 40.0 mg, 0.083 mmol) were dissolved in anhydrous toluene (700 μL) and DIPEA (12 equiv., 0.50 mmol, 82 μL). While stirring under a stream of argon, the catalyst solution was added dropwise dropwise to the solution containing 2,6-diethynylaniline and 3. The vessel was sealed with a screw on cap and heated to 40 °C. After stirring at overnight, the reaction was cooled to rt, transferred to a round bottom flask, and diluted with DCM (approx. 50 mL) and TEA (approx. 1 mL). Silica gel (approx. 2 g) was added to the vessel and the crude reaction mixture was mixture concentrated onto the silica gel. Silica gel flash chromatography (hexane with a 20-100% gradient of EtOAc over 10 minutes, then held at 100% EtOAc for 10 min, both organic solvents basified with 0.1 % TEA) gave ss-BAB (31 mg, 0.037 mmol, 87%) as a white solid after concentration in vacuo. 1H NMR (400 MHz, CDCl3) δ 10.03 (s, 2H), 8.18 – 8.15 (overlap, 4H), 8.04 (t, J = 1.6 Hz, 2H), 7.88 (dt, J = 7.8, 1.4 Hz, 2H), 7.85 (t, J = 1.6 Hz, 2H), 7.79 (dt, J = 7.7, 1.4 Hz, 2H), 7.55 (t, J = 7.7 Hz, 2H), 7.14 (t, J = 1.3 Hz, 1H), 6.85 (d, J = 1.4 Hz, 2H), 4.55 – 4.51 (m, 4H), 3.89 – 3.85 (m, 4H), 3.83 (s, 2H), 3.74 – 3.69 (m, 4H), 3.61 – 3.57 (m, 4H), 3.40 (s, 6H). 13C NMR (100 MHz, CDCl3) δ 191.5 (2C), 165.3 (2C), 146.7, 138.5 (2C), 137.3 (2C), 136.7 (2C), 133.2 (2C), 132.8 (2C), 132.5 (2C), 131.1 (2C), 129.5 (2C), 129.4 (2C), 125.5, 124.2 (2C), 124.0 (2C), 123.8 (2C), 123.7 (2C), 118.4 (2C), 90.6 (2C), 89.4 (2C), 89.2 (2C), 87.6 (2C), 72.1 (2C), 70.7 (2C), 69.3 (2C), 64.7 (2C), 59.3 (2C). HRMS (ESI): m/z calcd for C32H45N2O10+Na+: 864.2779 [M+Na]+; found 864.2791.
**ss-AAB.**

To a 20 mL scintillation vial AsPh₃ (0.02 mmol, 6.2 mg) and Pd₂(dba)₃ (0.0025 mmol, 2.2 mg, 10 mol%) were added and dissolved in anhydrous toluene (0.5 mL). The head space of the vial was purged with argon then the vial sealed with a screw on cap. The purple solution was gently swirled until the Pd₂(dba)₃ dissolved and the color changed to bright yellow (approx. 10 min). In a separate vial equipped with a stir bar, aryl-ynes 7 (57 mg, 0.12 mmol, 1.2 equiv.) and aryl-iodide 3 (1.0 equiv., 48 mg, 0.1 mmol) were dissolved in anhydrous toluene (0.5 mL) and DIPEA (24 equiv., 1.2 mmol, 200 µL). While stirring under a stream of argon the Pd catalyst solution was added dropwise to the solution containing 7 and 3. The vessel was sealed with a screw on cap and heated to 40 °C. After stirring overnight, the reaction was cooled to rt, transferred to a round bottom flask, and diluted with DCM (approx. 50 mL) and TEA (approx. 1 mL). Silica gel (approx. 2 g) was added to the vessel and the crude reaction mixture was concentrated onto the silica gel. Silica gel flash chromatography (hexane with a 70-100% gradient of EtOAC over 5 minutes, then held at 100% EtOAc for 20 min, both organic solvents were basified with 0.1% TEA) gave ss-AAB (74 mg, 0.09 mmol, 88%) as a white solid after concentration in vacuo. ¹H NMR (400 MHz, CDCl₃) δ 10.03 (s, 1H), 8.18 – 8.16 (overlap, 2H), 8.14 (t, J = 1.6 Hz, 1H), 8.12 (t, J = 1.6 Hz, 1H), 8.04 (t, J = 1.6 Hz, 1H), 7.88 (dt, J = 7.8, 1.4 Hz, 1H), 7.85 (t, J = 1.6 Hz, 1H), 7.82 (t, J = 1.6 Hz, 1H), 7.79 (dt, J = 7.7, 1.4 Hz, 1H), 7.55 (t, J = 7.7 Hz, 1H), 7.17 – 7.12 (overlap, 2H), 6.94 (dt, J = 7.6, 1.2 Hz, 1H), 6.87 – 6.83 (overlap, 3H), 6.68 (ddd, J = 8.0, 2.5, 1.0 Hz, 1H), 4.55 – 4.49 (overlap, 4H), 3.89 – 3.84 (overlap, 4H), 3.82 (br, 2NH), 3.75 – 3.68 (overlap, 6H), 3.61 – 3.56 (overlap, 4H), 3.40 (s, 3H), 3.40 (s, 3H). ¹³C NMR (100 MHz, CDCl₃) δ 191.5, 165.4, 165.3, 146.6, 146.5, 138.50, 138.46, 137.3, 136.7, 133.2, 132.8, 132.52, 132.48, 132.3, 131.1, 130.9, 129.5, 129.44, 129.36, 125.5, 124.4, 124.2, 124.02, 124.01, 123.9, 123.8, 123.7, 123.4, 122.3, 118.4, 118.3, 117.9, 115.9, 91.4, 90.6, 90.3, 89.4, 89.2, 87.8, 87.6, 87.1, 72.1 (2C), 70.7 (2C), 69.3 (2C), 64.7 (2C), 64.6, 59.3 (2C). HRMS (ESI): m/z calcd for C₅₃H₄₄N₂O₅Na+: 851.2939 [M+Na]+; found 851.2937.

**ss-ABB.**

To a 20 mL scintillation vial AsPh₃ (0.011 mmol, 3.3 mg) and Pd₂(dba)₃ (0.0013 mmol, 1.3 mg, 10 mol%) were added and dissolved in anhydrous toluene (0.4 mL). The head space of the vial was purged with argon then the vial sealed with a screw on cap. The purple solution was gently swirled until the Pd₂(dba)₃ dissolved and the color changed to bright yellow (approx. 10 min). In a separate vial equipped with a stir bar, aryl-ynes 6 (28 mg, 0.055 mmol, 1.0 equiv.) and aryl-iodide 5 (1.1 equiv., 26 mg, 0.061 mmol) were dissolved in anhydrous toluene (0.55 mL) and DIPEA (6 equiv., 0.33 mmol, 59 µL). While stirring under a stream of argon the catalyst solution was added dropwise to the solution containing 6 and 5. The vessel was sealed with a screw on cap and heated to 40 °C. After stirring overnight, the reaction was cooled to rt, transferred to a round bottom flask, and diluted with DCM (approx. 50 mL) and TEA (approx. 1 mL). Silica gel (approx. 2 g) was added to the vessel and the crude reaction mixture was concentrated onto the silica gel. Silica gel flash chromatography (hexane with a 70-100% gradient of EtOAC over 5 minutes, then
held at 100% EtOAc for 10 min, both organic solvents basified with 0.1 % TEA) gave ss-ABB (37 mg, 0.043 mmol, 79%) as a white solid after concentration in vacuo. 

$^1$H NMR (400 MHz, CDCl$_3$) δ 10.04 (s, 2H), 8.23 – 8.21 (overlap, 2H), 8.19 (t, J = 1.6 Hz, 1H), 8.17 (t, J = 1.6 Hz, 1H), 8.06 (td, J = 1.7, 0.6 Hz, 1H), 8.02 (d, J = 1.6 Hz, 2H), 7.96 (t, J = 1.6 Hz, 1H), 7.91 – 7.88 (overlap, 2H), 7.87 (t, J = 1.6 Hz, 1H), 7.80 (dt, J = 7.7, 1.4 Hz, 1H), 7.57 (t, J = 7.7 Hz, 1H), 7.16 (t, J = 7.8 Hz, 1H), 6.96 (dt, J = 7.6, 1.2 Hz, 1H), 6.87 (dd, J = 2.5, 1.4 Hz, 1H), 6.70 (ddd, J = 8.1, 2.4, 1.0 Hz, 1H), 4.56 – 4.52 (overlap, 4H), 3.90 – 3.85 (overlap, 4H), 3.74 – 3.70 (overlap, 6H), 3.61 – 3.57 (overlap, 4H), 3.41 (s, 3H), 3.40 (s, 3H).

$^{13}$C NMR (100 MHz, CDCl$_3$) δ 191.5, 190.7, 165.3, 165.2, 146.5, 139.8, 138.6, 138.5, 136.9, 136.7, 133.2, 133.1, 133.0, 132.9, 132.6, 132.43, 132.36, 131.2, 131.1, 129.58, 129.55, 129.4, 124.64, 124.62, 124.5, 123.94, 123.89, 123.5, 123.33, 123.30, 122.3, 118.0, 116.0, 91.7, 90.1, 89.8, 89.7, 89.0, 88.8, 88.5, 86.9, 72.1 (2C), 70.7 (2C), 69.3 (2C), 64.74, 64.68, 59.3 (2C).

HRMS (ESI): m/z calcd for C$_{52}$H$_{43}$N$_{10}$O$_{10}$+Na+: 864.5799 [M+Na]+; found 864.2786.

ds-ABA.

A 7.5 mM solution of ss-ABA (3.7 mg, 4.5 µmol) in dry CDCl$_3$ (600 uL) was prepared in an NMR tube. An initial $^1$H NMR spectrum of ss-ABA was acquired and then 10 uL of a solution of 1% TFA in CDCl$_3$ (v/v) was added. The capped NMR tube was immediately inverted several times to mix, and then the solvent evaporated under a stream of Ar. Dry CDCl$_3$ (600 uL) was added to the NMR tube and the yellow residue allowed to dissolve (approx. 5 min). Another $^1$H NMR spectrum was acquired, and then the acidic solution was quenched by adding TEA (0.5 uL) directly to the NMR tube. Another $^1$H NMR spectrum was acquired showing complete conversion to ds-ABA. Using DCM (~4 mL) the solution was transferred to a test tube and the organic layer washed with water (4 mL) 3 times. The cloudy organic layer was then concentrated in vacuo to give ds-ABA (3.7 mg, 2.3 µmol, 100%) as a white solid. $^1$H NMR (400 MHz, CDCl$_3$) δ 8.52 (s, 2H), 8.16 – 8.12 (overlap, 6H), 8.10 (t, J = 1.6 Hz, 2H), 8.03 (d, J = 1.6 Hz, 4H), 7.86 (t, J = 1.6 Hz, 2H), 7.83 (t, J = 1.6 Hz, 2H), 7.76 (t, J = 1.5 Hz, 2H), 7.49 (s, 2H), 7.41 (dt, J = 7.3, 1.7 Hz, 2H), 7.37 (t, J = 7.4 Hz, 2H), 7.32 (d, J = 7.4, 1.9 Hz, 2H), 7.15 (t, J = 7.8 Hz, 2H), 6.96 (dt, J = 7.7, 1.1 Hz, 2H), 6.87 (dd, J = 2.5, 1.5 Hz, 2H), 6.69 (ddd, J = 8.1, 2.4, 1.0 Hz, 2H), 4.56 – 4.48 (overlap, 8H), 3.92 – 3.84 (overlap, 8H), 3.77 – 3.69 (overlap, 12H), 3.63 – 3.57 (overlap, 8H), 3.42 (s, 6H), 3.41 (s, 6H).

$^{13}$C NMR (100 MHz, CDCl$_3$) δ 165.3 (2C), 165.2 (2C), 157.8 (2C), 150.1 (2C), 146.6 (2C), 139.0 (2C), 138.5 (2C), 136.9 (2C), 136.8 (2C), 132.7 (2C), 132.9 (2C), 132.29 (4C), 131.2 (2C), 131.7 (2C), 130.9 (4C), 130.1 (2C), 129.52 (2C), 129.47 (2C), 125.0 (2C), 124.5 (2C), 124.2 (2C), 124.0 (2C), 123.9 (2C), 123.7 (2C), 123.7 (2C), 123.6 (2C), 123.5 (2C), 122.3 (2C), 122.0 (2C), 118.0 (2C), 115.9 (2C), 91.5 (2C), 89.0 (2C), 89.5 (2C), 89.3 (2C), 89.3 (2C), 88.1 (2C), 87.1 (2C), 72.1 (2C), 72.1 (2C), 70.8 (2C), 70.7 (2C), 69.33 (2C), 69.32 (2C), 64.6 (4C), 59.31 (2C), 59.29 (2C).

HRMS (ESI): m/z calcd for C$_{102}$H$_{84}$N$_{4}$O$_{16}$+Na+: 1644.5808 [M+Na]+; found 1644.5810.
ds-BAB.

A 7.5 mM solution of ss-BAB (7.6 mg, 9 µmol) in dry CDCl₃ (1.2 mL) was prepared in an NMR tube. An initial ¹H NMR spectrum of ss-BAB was acquired and then 10 µL of a solution of 1% TFA in CDCl₃ (v/v) was added. The capped NMR tube was immediately inverted several times to mix, and then the solvent evaporated under a stream of Ar. Dry CDCl₃ (1.2 mL) was added to the NMR tube and the yellow residue allowed to dissolve (approx. 5 min). Another ¹H NMR spectrum was acquired, and then the acidic solution was quenched by adding TEA (1 µL) directly to the NMR tube. Another ¹H NMR spectrum was acquired showing nearly complete conversion to ds-BAB. Using DCM (~4 mL) the solution was transferred to a test tube and the organic layer washed with water (4 mL) 3 times. The cloudy organic layer was then concentrated in vacuo to give ds-BAB (7.3 mg, 4.4 µmol, 98%) as a white solid. ¹H NMR (400 MHz, CDCl₃) δ 10.04 (s, 2H), 8.59 (s, 2H), 8.20 (t, J = 1.6 Hz, 2H), 8.18 (t, J = 1.6 Hz, 2H), 8.17 (t, J = 1.6 Hz, 2H), 8.16 – 8.14 (overlap, 4H), 8.05 (t, J = 1.7 Hz, 2H), 7.92 – 7.86 (overlap, 8H), 7.79 (dt, J = 7.7, 1.4 Hz, 2H), 7.65 (dt, J = 7.8, 1.4 Hz, 2H), 7.61 (t, J = 1.5 Hz, 2H), 7.56 (t, J = 1.7 Hz, 2H), 7.53 – 7.46 (overlap, 6H), 4.57 – 4.51 (overlap, 8H), 3.92 – 3.85 (overlap, 8H), 3.76 – 3.70 (overlap, 8H), 3.63 – 3.58 (overlap, 8H), 3.42 (s, 6H), 3.41 (s, 6H). ¹³C NMR (100 MHz, CDCl₃) δ 191.4 (2C), 165.04 (2C), 164.99 (2C), 159.0 (2C), 150.2 (2C), 138.7 (2C), 138.4 (2C), 137.3 (2C), 136.6 (2C), 136.1 (2C), 134.2 (2C), 133.2 (2C), 132.05 (2C), 132.02 (2C), 132.00 (2C), 129.3 (2C), 128.8 (2C), 128.0 (2C), 124.3 (2C), 124.00 (2C), 123.98 (2C), 123.94 (2C), 123.91 (2C), 123.64 (2C), 123.55 (2C), 123.4 (2C), 90.4 (2C), 90.2 (2C), 89.9 (2C), 89.4 (2C), 89.2 (2C), 88.7 (2C), 88.6 (2C), 88.5 (2C), 72.13 (2C), 72.09 (2C), 70.72 (2C), 70.70 (2C), 69.29 (2C), 69.26 (2C), 64.6 (2C), 64.5 (2C), 59.28 (2C), 59.26 (2C). HRMS (ESI): m/z calcd for C₁₀₄H₈₂N₂O₁₈+Na⁺: 1670.5488 [M+Na⁺]; found 1670.5469.

ds-AAB.

A 7.5 mM solution of ss-AAB (3.7 mg, 4.5 µmol) in dry CDCl₃ (600 µL) was prepared in an NMR tube. An initial ¹H NMR spectrum of ss-AAB was acquired and then TFA was added (2 µL). The capped NMR tube was immediately inverted several times to mix. Another ¹H NMR spectrum was acquired, and then the acidic solution was quenched by adding TEA (6 µL) directly to the NMR tube. Another ¹H NMR spectrum was acquired showing nearly complete conversion to ds-AAB. Using DCM (~4 mL) the solution was transferred to a test tube and the organic layer washed with water (4 mL) 3 times. The cloudy organic layer was then concentrated in vacuo to give ds-AAB (3.7 mg, 2.3 µmol, 100%) as a white solid. ¹H NMR (400 MHz, CDCl₃) δ 8.45 (s, 2H), 8.10 (t, J = 1.6 Hz, 2H), 8.08 (t, J = 1.6 Hz, 2H), 8.01 (t, J = 1.6 Hz, 2H), 8.00 – 7.97 (overlap, 4H), 7.78 – 7.72 (overlap, 6H), 7.50 (dt, J = 7.7, 1.4 Hz, 2H), 7.46 (t, J = 1.4 Hz, 2H), 7.40 – 7.37 (overlap, 4H), 7.34 (t, J = 7.6 Hz, 2H), 7.14 (t, J = 7.8 Hz, 2H), 6.94 (dt, J = 7.5, 1.2 Hz, 2H), 6.85 (dd, J = 2.4, 1.5 Hz, 2H), 6.68 (ddd, J = 8.1, 2.4, 1.0 Hz, 2H), 4.53 – 4.45 (overlap, 8H), 3.90 – 3.82 (overlap, 8H), 3.78 – 3.68 (overlap, 12H), 3.63 – 3.57 (overlap, 8H), 3.42 (s, 6H), 3.40 (s, 6H). ¹³C NMR (100 MHz, CDCl₃) δ 165.3 (2C), 165.2 (2C), 159.4...
(2C), 150.5 (2C), 146.6 (2C), 139.0 (2C), 138.4 (2C), 136.2 (2C), 134.3 (2C), 132.6 (2C), 132.5 (2C), 132.4 (2C), 132.3 (2C), 132.2
(2C), 132.1 (2C), 130.9 (2C), 130.8 (2C), 129.5 (2C), 129.1 (2C), 129.0 (2C), 125.8 (2C), 124.42 (2C), 124.36 (2C), 124.12 (2C), 124.05
(2C), 124.0 (2C), 123.8 (4C), 123.5 (2C), 123.4 (2C), 122.2 (2C), 118.0 (2C), 115.9 (2C), 91.5 (2C), 90.4 (2C), 89.94 (2C), 89.88 (2C),
88.75 (2C), 88.69 (2C), 88.6 (2C), 87.1 (2C), 72.12 (2C), 72.09 (2C), 70.74 (2C), 70.72 (2C), 69.3 (4C), 66.4 (4C), 59.29 (2C), 59.27
(2C). HRMS (ESI): m/z calcd for C_{102}H_{84}N_{4}O_{16}^+Na+: 1644.5808 [M+Na]^+; found 1644.5868.

ds-ABB.

A 7.5 mM solution of ss-ABB (7.6 mg, 9 µmol) in dry CDCl₃ (1.2 mL) was prepared in an NMR tube. An initial ¹H NMR spectrum of
ss-ABA was acquired and then 10 µL of a solution of 1% TFA in CDCl₃ (v/v) was added. The capped NMR tube was immediately
inverted several times to mix, and then the solvent evaporated under a stream of Ar. Dry CDCl₃ (600 µL) was added to the NMR
tube, 5 µL of a solution of 1% TFA in CDCl₃ (v/v) was added, and the yellow residue allowed to dissolve (approx. 5 min). Another
¹H NMR spectrum was acquired, and then the acidic solution was quenched by adding TEA (1 µL) directly to the NMR tube.
Another ¹H NMR spectrum was acquired showing a mix of fold-ABB and ds-ABB, 2:8 respectively. The solution was loaded directly
onto a silica gel column for purification. Silica gel flash chromatography (DCM with a 0-50% gradient of THF, both organic solvents
basified with 0.1% TEA) gave ds-ABB (5.0 mg, 3.0 µmol, 66%) as a white solid after concentration in vacuo. ¹H NMR (400 MHz,
CDCl₃) δ 10.04 (s, 2H), 8.59 (s, 2H), 8.23 – 8.19 (overlap, 6H), 8.18 (t, J = 1.6 Hz, 2H), 8.13 – 8.09 (overlap, 4H), 8.06 (s, 2H), 7.94 (t,
J = 1.5 Hz, 2H), 7.92 – 7.87 (overlap, 4H), 7.87 – 7.77 (overlap, 2H), 7.80 (dt, J = 7.8, 1.6 Hz, 2H), 7.60 – 7.53 (overlap, 4H), 7.50 –
7.41 (overlap, 4H), 7.37 (dt, J = 7.4, 1.6 Hz, 2H), 4.57 – 4.52 (overlap, 8H), 3.91 – 3.86 (overlap, 8H), 3.75 – 3.70 (overlap, 8H), 3.63
– 3.58 (overlap, 8H), 3.42 (s, 6H), 3.41 (s, 6H). ¹³C NMR (100 MHz, CDCl₃) δ 191.5 (2C), 165.2 (2C), 165.1 (2C), 157.8 (2C), 150.2
(2C), 139.0 (2C), 138.5 (2C), 137.3 (2C), 136.9 (2C), 136.77 (2C), 136.75 (2C), 136.7 (2C), 133.2 (2C), 132.81 (2C), 132.75 (2C),
132.41 (2C), 132.38 (2C), 132.1 (2C), 131.6 (2C), 131.1 (2C), 131.0 (2C), 129.51 (2C), 129.46 (2C), 129.4 (2C), 125.0 (2C),
124.2 (2C), 124.02 (2C), 123.96 (4C), 123.9 (2C), 123.8 (2C), 123.6 (2C), 122.1 (2C), 90.9 (2C), 89.7 (2C), 89.6 (2C), 89.4 (2C), 89.3
(2C), 89.2 (2C), 89.1 (2C), 88.1 (2C), 72.14 (2C), 72.12 (2C), 70.8 (4C), 69.33 (2C), 69.31 (2C), 64.7 (2C), 64.6, (2C), 59.3 (4C). HRMS
(ESI): m/z calcd for C_{104}H_{86}N_{4}O_{18}^+Na+: 1670.5488 [M+Na]^+; found 1670.5450.

fold-ABB.

A 3.9 mM solution of ss-ABB (6.4 mg, 7.7 umol) in dry CDCl₃ (2 mL) was prepared in a 100 mL flask, and then a 5 µL of a solution
of 1% TFA in CDCl₃ (v/v) was added. The solvent was evaporated under a stream of Ar, then the residue was dissolved in 80 mL
dry CDCl₃ (100 uM AAB), and then 5 µL of a solution of 1% TFA in CDCl₃ (v/v) was added. The solution was allowed to stand for 5
min and then the acid was quenched with 6 µL TEA. An ¹H NMR spectrum of an aliquot of the solution showed complete
consumption of ss-AAB and a 9:1 mixture of fold-AAB to ds-AAB. The solution was concentrated to approx. 400 uL and loaded onto a silica gel column for purification. Silica gel flash chromatography (DCM with a 0-50% gradient of THF, both organic solvents basified with 0.1% TEA) gave fold-ABB (5.0 mg, 6.2 umol, 79%) as a white solid after concentration in vacuo. $^1$H NMR (400 MHz, CDCl$_3$) δ 8.74 (s, 1H), 8.34 (t, $J = 1.7$ Hz, 1H), 8.13 – 8.07 (overlap, 6H), 7.87 (dt, $J = 7.9$, 1.3 Hz, 1H), 7.74 (s, 1H), 7.59 (dt, $J = 7.7$, 1.4 Hz, 1H), 7.48 (t, $J = 7.7$ Hz, 1H), 7.44 – 7.37 (overlap, 4H), 6.79 (d, $J = 1.4$ Hz, 2H), 4.56 – 4.50 (overlap, 4H), 4.30 – 3.86 (overlap, 4H), 3.82 (s, 2H), 3.76 – 3.71 (overlap, 4H), 3.43 (s, 6H). $^{13}$C NMR (100 MHz, CDCl$_3$) δ 165.5, 165.4, 158.7, 150.0, 146.9, 142.0, 141.9, 136.7, 134.5, 132.7, 131.0 (2C), 130.9, 130.8, 130.64, 130.61, 129.5, 129.1, 128.5 (2C), 128.4, 128.1, 124.2, 124.1, 123.9, 123.8, 123.6, 123.5, 123.4, 120.7, 91.8, 91.4, 90.54, 90.48, 89.27, 89.26, 89.2, 88.9, 72.1 (2C), 70.8 (2C), 69.3 (2C), 64.7 (2C), 59.3 (2C). HRMS (ESI): m/z calcld for C$_{51}$H$_{42}$N$_2$O$_8$+Na$: 833.2833$ [M+Na]$^+$; found 833.2827.

fold-ABB.

A 7.5 mM solution of ss-ABB (3.8 mg, 4.5 umol) in dry CDCl$_3$ (600 uL) was prepared in an NMR tube. An initial $^1$H NMR spectrum of ss-ABB was acquired and then TFA (2 uL) was added. The capped NMR tube was immediately inverted several times to mix. Another $^1$H NMR spectrum was acquired, and then the acidic solution was quenched by adding TEA (6 uL) directly to the NMR tube. Another $^1$H NMR spectrum was acquired showing complete conversion to fold-ABB. Using DCM (~4 mL) the solution was transferred to a test tube and the organic layer washed with water (4 mL) 3 times. The cloudy organic layer was then concentrated in vacuo to give fold-ABB (3.7 mg, 4.5 umol, 100%) as a white solid. $^1$H NMR (400 MHz, CDCl$_3$) δ 10.02 (s, 1H), 8.72 (s, 1H), 8.16 (t, $J = 1.6$ Hz, 1H), 8.15 – 8.11 (overlap, 5H), 8.10 (t, $J = 1.6$ Hz, 1H), 7.94 (d, $J = 1.6$ Hz, 2H), 7.83 (dt, $J = 7.7$, 1.4 Hz, 1H), 7.73 (s, 1H), 7.58 (dt, $J = 7.7$, 1.4 Hz, 1H), 7.48 (t, $J = 7.7$ Hz, 1H), 7.44 – 7.36 (overlap, 3H), 4.56 – 4.51 (overlap, 4H), 3.91 – 3.86 (m, 4H), 3.76 – 3.71 (overlap, 4H), 3.63 – 3.59 (overlap, 4H), 3.42 (s, 6H). $^{13}$C NMR (100 MHz, CDCl$_3$) δ 190.7, 165.2, 165.1, 158.5, 149.9, 142.7, 142.0, 141.9, 137.1, 136.7, 134.2, 132.8, 131.33, 131.30, 131.22, 131.19, 131.1 (3C), 129.6 (2C), 129.2, 128.7, 128.60, 128.57, 124.6 (2C), 124.4, 124.3, 123.9, 123.6, 123.5, 123.4, 120.7, 91.8, 91.4, 90.54, 90.48, 89.27, 89.26, 89.2, 88.9, 72.1 (2C), 70.8 (2C), 69.3 (2C), 64.7 (2C), 59.3 (2C). HRMS (ESI): m/z calcld for C$_{52}$H$_{41}$NO$_9$+Na$: 846.2674$ [M+Na]$^+$; found 846.2718.

ds-AAA-BBB.

Solutions of AAA and BBB in CDCl$_3$ were combined in an NMR tube to give equimolar amounts of each trimer, then the solution was diluted with CDCl$_3$ to a final concentration of 0.80 mM trimer and total volume of 600 uL. An initial $^1$H NMR spectrum was acquired to verify the 1:1 sociometry of AAA and BBB and then 5 uL of a solution of 1% TFA in CDCl$_3$ (v/v) was added. The capped NMR tube was immediately inverted several times to mix, and then concentrated to dryness under a stream of Ar. The residue
was dissolved in dry CDCl₃ (600 uL) and the acidic solution was quenched by adding TEA (6 uL) directly to the NMR tube. DCM (~4 mL) the solution was transferred to a test tube and the organic layer washed with water (4 mL) 3 times. The cloudy organic layer was then concentrated in vacuo to give ds-AAA-BBB as a white solid. ¹H NMR (400 MHz, CDCl₃ with 0.1 % v/v TEA, 50 °C) δ 8.64 (s, 1H), 8.52 (s, 2H), 8.19 – 8.13 (overlap, 8H), 8.13 – 8.07 (overlap, 4H), 7.94 – 7.87 (overlap, 6H), 7.83 (s, 1H), 7.65 (s, 1H), 7.63 (d, J = 7.6 Hz, 2H), 7.56 (s, 2H), 7.51 – 7.35 (overlap, 8H), 7.31 (d, J = 7.6 Hz, 2H), 4.57 – 4.52 (overlap, 8H), 3.92 – 3.87 (overlap, 8H), 3.77 – 3.73 (overlap, 8H), 3.65 – 3.60 (overlap, 8H), 3.43 (s, 12H). HRMS (MALDI-TOF): m/z calcd for C₁₁₃H₂₁N₂O₁₆+Na⁺: 1639.554 [M+Na⁺]; found 1639.559.

ds-ABA-BAB

Solutions of ABA and BAB (as mixtures of ss-ABO and ds-ABO) in CDCl₃ were combined in an NMR tube to give equimolar amounts of each trimer, then the solution was diluted with CDCl₃ to a final concentration of 0.40 mM trimer and total volume of 600 uL. An initial ¹H NMR spectrum was acquired to verify the 1:1 sociometry of ABA and BAB and then 5 uL of a solution of 1% TFA in CDCl₃ (v/v) was added. The capped NMR tube was immediately inverted several times to mix, and then concentrated to dryness under a stream of Ar. The residue was dissolved in dry CDCl₃ (600 uL) and the acidic solution was quenched by adding TEA (6 uL) directly to the NMR tube. DCM (~4 mL) the solution was transferred to a test tube and the organic layer washed with water (4 mL) 3 times. The cloudy organic layer was then concentrated in vacuo to give ds-ABA-BAB as a white solid. ¹H NMR (400 MHz, CDCl₃ with 0.1 % v/v TEA, 50 °C) δ 8.62 (s, 1H), 8.49 (s, 2H), 8.17 – 8.11 (overlap, 8H), 8.07 (d, J = 12.2 Hz, 4H), 7.91 – 7.86 (overlap, 6H), 7.82 (s, 1H), 7.64 – 7.59 (overlap, 3H), 7.55 (s, 2H), 7.51 – 7.35 (overlap, 8H), 7.30 (d, J = 7.6 Hz, 2H), 4.57 – 4.51 (overlap, 8H), 3.92 – 3.87 (overlap, 8H), 3.78 – 3.73 (overlap, 8H), 3.65 – 3.60 (overlap, 8H), 3.44 (s, 12H). HRMS (MALDI-TOF): m/z calcd for C₁₁₃H₂₁N₂O₁₆+Na⁺: 1639.554 [M+Na⁺]; found 1639.563.

ds-AAB-BBA

Solutions of AAB and BBA (as mixtures of ss-ABO and ds-ABO) in CDCl₃ were combined in an NMR tube to give equimolar amounts of each trimer, then the solution was diluted with CDCl₃ to a final concentration of 0.26 mM trimer and total volume of 600 uL. An initial ¹H NMR spectrum was acquired to verify the 1:1 sociometry of AAB and BBA and then 5 uL of a solution of 1% TFA in CDCl₃ (v/v) was added. The capped NMR tube was immediately inverted several times to mix, and then concentrated to dryness under a stream of Ar. The residue was dissolved in dry CDCl₃ (600 uL) and the acidic solution was quenched by adding TEA (6 uL) directly to the NMR tube. DCM (~4 mL) the solution was transferred to a test tube and the organic layer washed with water (4 mL) 3 times. The cloudy organic layer was then concentrated in vacuo to give ds-AAB-BBA as a white solid. ¹H NMR (400 MHz, CDCl₃ with 0.01 % v/v TEA, 50 °C) δ 8.65 (s, 1H), 8.53 (s, 2H), 8.20 – 8.14 (overlap, 8H), 8.14 – 8.05 (overlap, 4H), 7.94 – 7.87
(overlap, 6H), 7.84 (s, 1H), 7.68 – 7.61 (overlap, 3H), 7.57 (s, 2H), 7.51 – 7.36 (overlap, 8H), 7.32 (d, J = 7.8 Hz, 2H), 4.58 – 4.51 (overlap, 8H), 3.93 – 3.87 (overlap, 8H), 3.78 – 3.73 (overlap, 8H), 3.64 – 3.60 (overlap, 8H), 3.43 (s, 12H). HRMS (MALDI-TOF):
m/z calcd for C_{103}H_{81}N_{3}O_{16}+Na^+: 1639.554 [M+Na]^+; found 1639.561.

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$^1$H NMR (400 MHz, CDCl$_3$)
$^{13}$C NMR (100 MHz, CDCl$_3$)

![Chemical Structure Image]

3
$^1$H NMR (400 MHz, CDCl$_3$)
$^{13}$C NMR (100 MHz, CDCl$_3$)

\[ \text{Diagram of chemical structure} \]

CDCl$_3$
$^1$H NMR (400 MHz, CDCl$_3$)
$^{13}$C NMR (100 MHz, CDCl$_3$)
$^1$H NMR (400 MHz, CDCl$_3$)
$^{13}$C NMR (100 MHz, CDCl₃)
$^1$H NMR (400 MHz, CDCl$_3$)
$^{13}$C NMR (100 MHz, CDCl$_3$)
$^1$H NMR (400 MHz, CDCl₃)

ss-BBB

![NMR Spectrum](image_url)
$^{13}$C NMR (100 MHz, CDCl$_3$)

ss-BBB
$^1$H NMR (400 MHz, CDCl$_3$ w/ 0.1% TEA)

ss-ABA
$^{13}$C NMR (100 MHz, CDCl$_3$ w/ 0.1% TEA)

ss-ABA

C DCl$_3$

13.5 133.0 132.5 132.0 131.5 131.0 130.5 130.0 129.5 129.0

125.0 124.5 124.0 123.5 123.0 122.5 122.0

190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10

TEA

TEA

SS3
\(^1\)H NMR (400 MHz, CDCl\(_3\))

ss-BAB
$^{13}$C NMR (100 MHz, CDCl$_3$)

ss-BAB
$^1$H NMR (400 MHz, CDCl$_3$ w/ 0.1% TEA)
$^{13}$C NMR (100 MHz, CDCl$_3$ w/ 0.1% TEA)
$^1$H NMR (400 MHz, CDCl$_3$ w/ 0.1% TEA)
$^{13}$C NMR (100 MHz, CDCl$_3$ w/ 0.1% TEA)
$^1$H NMR (400 MHz, CDCl$_3$ w/ 0.1% TEA)
$^{13}$C NMR (100 MHz, CDCl$_3$ w/ 0.1% TEA)
$^1$H-$^1$H ROSEY NMR (400 MHz, CDCl$_3$ w/ 0.1% TEA)
$^1$H$^1$H COSY NMR (400 MHz, CDCl$_3$ w/ 0.1% TEA)

ds-ABA
$^1$H NMR (400 MHz, CDCl$_3$ w/ 0.1% TEA)
$^{13}$C NMR (100 MHz, CDCl$_3$ w/ 0.1% TEA)
$^1$H-$^1$H ROSEY NMR (400 MHz, CDCl$_3$ w/ 0.1% TEA)

ds-BAB
$^1$H-$^1$H COSY NMR (400 MHz, CDCl$_3$ w/ 0.1% TEA)
$^1$H NMR (400 MHz, CDCl$_3$ w/ 0.1% TEA)
$^{13}$C NMR (100 MHz, CDCl$_3$ w/ 0.1% TEA)
$^1$H-$^1$H ROSEY NMR (400 MHz, CDCl$_3$ w/ 0.1% TEA)
$^1$H-$^1$H COSY NMR (400 MHz, CDCl$_3$ w/ 0.1% TEA)
$^1$H NMR (400 MHz, CDCl$_3$ w/ 0.1% TEA)
$^{13}$C NMR (100 MHz, CDCl$_3$ w/ 0.1% TEA)
$^1$H-$^1$H ROSEY NMR (400 MHz, CDCl$_3$ w/ 0.1% TEA)
$^1\text{H} - ^1\text{H}$ COSY NMR (400 MHz, CDCl$_3$ w/ 0.1% TEA)
$^1$H NMR (400 MHz, CDCl$_3$ w/ 0.1% TEA)
$^{13}$C NMR (100 MHz, CDCl$_3$ w/ 0.1% TEA)
$^1$H-$^1$H ROSEY NMR (400 MHz, CDCl$_3$ w/ 0.1% TEA)
$^1$H-$^1$H COSY NMR (400 MHz, CDCl$_3$ w/ 0.1% TEA)
$^1$H NMR (400 MHz, CDCl$_3$ w/ 0.1% TEA)
$^{13}$C NMR (100 MHz, CDCl$_3$ w/ 0.1% TEA)

fold-AAB
$^1$H-$^1$H ROSEY NMR (400 MHz, CDCl$_3$ w/ 0.1% TEA)
$^1$H-$^1$H COSY NMR (400 MHz, CDCl$_3$ w/ 0.1% TEA)
$^1$H NMR (400 MHz, CDCl$_3$ w/ 0.1% TEA, 50 °C)

ds-AAA·BBB
$^1$H NMR (400 MHz, CDCl$_3$ w/ 0.1% TEA, 50 °C)

d$^5$-ABA$^\cdot$ BAB

$^3$CHCl$_3$
$^{1}$H NMR (400 MHz, CDCl$_3$ w/ 0.01% TEA, 50 °C)

ds-AAB-ABB

[Chemical structure image]

[Graph of NMR spectra showing peaks at various ppm values for CHCl$_3$, H$_2$O, and TMS]