Cross-Reactive Conjugated Polymers: Analyte Specific Aggregative Response for Structurally Similar Diamines

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SUPPORTING INFORMATION

Materials

Chemicals for the synthesis of the polymer **1** were purchased from Acros and Aldrich and were used without further purification. All solvents were obtained from solvent purification systems from Innovative Technologies. The amines used in the assays were obtained from Sigma-Aldrich and used without further purification.

Instrumentation

Absorbance studies were performed using a Beckman Coulter 640 DU spectrophotometer and quartz cuvets from Starna. ^{1}H and ^{13}C spectra were recorded on a Varian Mercury 300 spectrometer operating at 300 and 75MHz, respectively. MALDI-TOF MS was performed using a Bruker Ultraflex TOF/TQF mass spectrometer. 2, 2':5', 2''-Terthiophene (Aldrich) was used as the matrix.

Assay Conditions

Note: All measurements were carried out in a Peltier thermostated sample holder maintained at 25 ^{o}C.

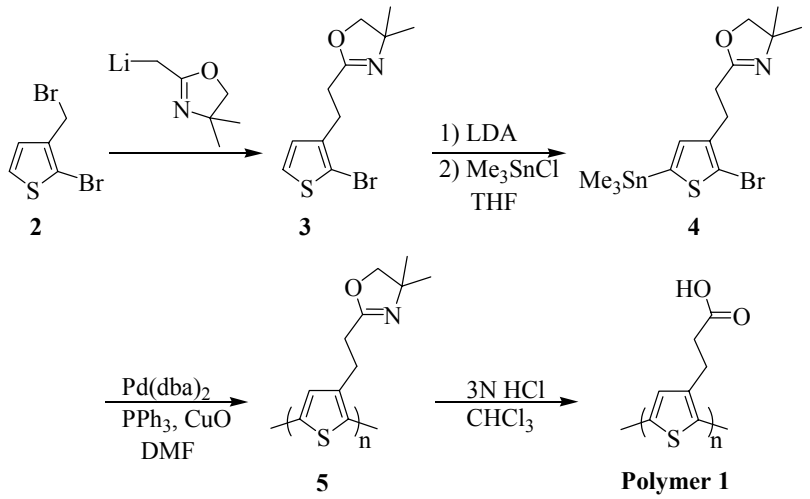
The polymer solution was prepared by adding 16 mg of **1** to N,N-dimethylformamide (1 mL) then sonicated for one hour. The resulting mixture was diluted with 1,4-dioxane (9 mL) and again sonicated for one hour. Subsequently, the mixture was filtered thru a 0.45 micron telfon disk to remove undissolved polymer. The orange filtrate (1mL) was added to a mixture of acetonitrile (5 mL) and deionized water (250 μL). This preparation produces 6.25mL of the purple working polymer solution. The 100 mM amine solutions (1,2-ethylenediamine, 1,3-propylenediamine, 1,4-butylenediamine, histamine, 1,5-pentylenediamine and 1,6-hexylenediamine) were prepared by adding 1,4-dioxane to the appropriate amount of amine. For each assay, the amine solution (50 μL) was added to polymer solution (1mL) in a quartz cuvet and then shaken for 30 seconds before the absorbance was measured. Each amine was measured at five different concentrations: 1.5 and 3.5 mM, in triplicate and 0.5, 2.5, and 5.0 mM all with six replicates for a total of 24 measurements for each amine and 144 measurements overall. Each experiment was measured from 300-750nm.

Data Anaylsis

Absorbance data was analyzed using commercially available feature selection algorithms such as linear discriminant analysis (LDA) and principal component analysis (PCA). Systat was used to obtain the general and leave-one-out cross validation classification

accuracies; whereas, Statistica was used mainly as a graphical program. For the linear discriminant analysis, each spectrum was pre-processed by dividing each spectral intensity by the sum of all the spectral intensity in that spectrum. This normalization made the area under the curve equal to one. Since one of the analytes (histamine) had an absorbance above 300 nm, the acetonitrile mixed assay was analyzed using nine wavelengths between 420-740 nm chosen every 40 nm from the spectral response for each diamine at each concentration. Classification accuracies were based on leave-one-out cross validation because it challenges the LDA model by removing each sample from the data set and recomputing discriminant functions based on the remaining samples.[1] Thus, the estimates of the classification for each sample are independent of the discriminant model.

Synthesis



Polymer **1** has been previously synthesized by the scheme outlined above.[2] Below are specific modifications to the published procedure that were used to synthesize the polymer for these studies.

HT-2,5-poly(3-(2-(4,5-dihydro-4,4 dimethyl-2-oxazolyl)ethyl)thiophene (5). 2-(2-(2-bromo-5-(trimethylstannyl)thiophen-3-yl)ethyl)-4,5-dihydro-4,4dimethyloxazole **4** (7.0 g, 15.5 mmol) was weighed in 100 mL Schlenk flask followed by 30 mL dry DMF then purged with nitrogen for 15 min. To this mixture, copper (II) oxide (1.24 g, 15.5 mmol, 1 eq.), triphenylphosphine (814 mg, 0.031 mmol, 0.20 eq.) and bis(dibenzylidene acetone)palladium(0) (446 mg, 0.776 mmol, 0.05 eq) was added all at once. The greenish-brown suspension solution was purged with nitrogen for 15 min then heated to 100^0C and stirred for 18 hrs under argon atmosphere. The reaction mixture was filtered thru celite and the purple precipitate was extracted with chloroform. The chloroform extract was concentrated and the resulting solid was soxhlet-extracted with hexanes then extracted with chloroform. The solvent was removed to afford a purple solid (2.1 g, 66%

yield). ^{1}H NMR (300MHz, $CDCl_3$): δ = 7.06 (s, 1H), 3.94 (s, 2H), 3.14 (d, 2H), 2.66 (d, 2H), 1.28 (s, 6H); ^{13}C NMR (75 MHz, $CDCl_3$): δ = 166.7, 138.4, 134.4, 132.4, 129.8, 80.0, 68.0, 29.6, 29.2, 26.4.

Polymer (1). HT-2,5-poly(3-(2-(4,5-dihydro-4,4 dimethyl-2-oxazolyl)ethyl)thiophene **5** (1.9 g, 10.1 mmol) was dissolved in 50 mL chloroform then 50 mL 3 N HCl was added to the mixture. The reaction was refluxed overnight. The resulting dark purple polymer was filtered, washed with water and chloroform and dried to give the product (1.05 g, 67% yield). ^{1}H NMR (300MHz, CD_3OD) (characterized as the cesium salt): δ = 7.16 (s, 1H), 3.11 (t, 2H), 2.54 (t, 2H).

Molecular weights and distribution of polymer **1** were determined as the butyl ester using MALDI-TOF MS. The ester was obtained by acid-catalyzed esterification of polymer **5** with sulfuric acid in refluxing n-butanol.[3] ^{1}H NMR (300MHz, $CDCl_3$): δ = 7.02 (s, 1H), 4.11 (t, 2H), 3.14 (t, 2H), 2.70 (t, 2H), 1.62 (m, 2H), 1.35 (m, 2H), 0.92 (t, 3H); MALDI-TOF MS: M_n = 3170, M_w = 3230, PDI = 1.02.

References for the supporting information

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