Design, synthesis, linear and nonlinear photophysical properties of novel pyrimidine-based imidazole derivatives

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2-methoxyethyl 4-methylbenzenesulfonate (M1)

A catalytic amount of Tetrabutyl ammonium bromide (TBAB) and a solution of 12.30 g (0.16 mol) of 2-methoxyethanol dissolved in CH_2Cl_2 were added into a round-bottom flask. Another molar amount of NaOH (65.00 g, 23%) was added into the preceding reaction system with stirring. Then a solution of 0.60 g (2 mmol) of 4-methylbenzene-1-sulfonyl chloride dissolved in CH_2Cl_2 was added dropwise. The reaction mixture was stirred at room temperature for 24h and was monitored by TLC. After the completion of the reaction, the solution was washed three times with water. The organic phase was dried with anhydrous $MgSO_4$, filtered, and concentrated. Light yellow oil (32.78 g) was collected. Yield: 95%. ^{1}H-NMR: (400 MHz, CD_3COCD_3), δ (ppm): 3.20 (s, 3H), 3.47~3.49 (t, J = 4.6 Hz, 2H), 4.06~4.09 (t, J = 4.6 Hz, 2H), 7.71 (d, J = 8.4 Hz, 2H), 7.27 (d, J =8.4 Hz, 2H), 2.357 (s, 3H).

2,2'-(phenylazanediyl)diethanol (M2)

4.75 g (50 mmol) of aniline and 12.00 g (150 mmol) of 2-chloroethanol were added into a three-necked flask with a magnetic stirrer, a reflux condenser. The reaction mixture was heated at 120^{o}C. 4.40 g (110 mmol) of NaOH was added into the solution slowly and the reaction was monitored by TLC (petroleum/ethyl acetate 2:1

v/v) for 72h. After the reaction was completed, the mixture was dispersed in a little mount of distilled water and was extracted with CH_2Cl_2 several times. The organic phase was dried with anhydrous $MgSO_4$, filtered, and concentrated. The crude product was purified by chromatography on a silica gel with petroleum (bp 60-90^{o}C) / ethyl acetate (4:1 by volume) as eluent to yield 4.85g of white solid. Yield: 50%. ^{1}H-NMR: (CD_3COCD_3, 400MHz), δ (ppm): 4.20~4.23 (t, J = 5.2 Hz, 2H), 3.54~3.57 (t, J = 5.8 Hz, 4H), 3.73~3.77 (q, J = 5.6 Hz, 4H), 6.74 (d, J = 8.0 Hz, 2H), 7.13~7.17 (t, J =7.6 Hz, 2H), 6.58~6.6182 (t, J =7.2 Hz, 1H).

N,N-bis(2-(2-methoxyethoxy)ethyl)aniline (M3)

N,N-bis(2-(2-methoxyethoxy)ethyl)aniline was prepared referring the literature [1] using 4-toluene sulfochloride (MSDS) instead of methylsufonyl chloride. Yield: 80%. ^{1}H-NMR: (400 MHz, CD_3COCD_3), δ (ppm): 3.32 (s, 6H), 3.58~3.60 (t, J = 5.2 Hz, 8H), 3.49~3.51 (t, J = 4.6 Hz, 4H), 3.63~3.66 (t, J = 6 Hz, 4H), 6.75 (d, J = 8.4 Hz, 2H), 7.16~7.20 (t, J =8.0 Hz, 2H), 6.61~6.65 (t, J =7.2 Hz, 1H).

4-(bis(2-(2-methoxyethoxy)ethyl)amino)benzaldehyde (M4)

0.73g (10mmol) DMF was added into a round-bottom flask in an ice-bath and cooled under 0℃. A solution of $POCl_3$ (1.84 g, 12 mmol) was added dropwise. Then a solution of 0.60 g (2 mmol) of N, N-bis(2-(2-methoxyethoxy)ethyl)aniline **M3** dissolved in $CHCl_3$ was added dropwise. The reaction mixture was refluxed at 65^{o}C for 15 h and monitored by TLC with petroleum (bp 60-90^{o}C)/ethyl acetate (8:1 by volume), then the remain was poured into ice water slowly. The NaOH solution was added to adjust the pH of the solution. After the pH in the solution had reached 8.0, the solution was extracted with CH_2Cl_2 four times. The organic phase was dried with anhydrous $MgSO_4$, filtered, and concentrated. The crude product was purified by chromatography on a silica gel with petroleum (bp 60-90^{o}C)/ethyl acetate (4:1 by volume) as eluent to yield 0.55 g of yellow oil. Yield：85%. IR (KBr,cm^{-1}) selected bands: 3493(w), 2876 (s), 2733 (w), 1669 (s), 1596 (s), 1556 (s), 1525 (s), 1454 (s), 1436 (s), 1401 (s), 1353 (s), 1316 (s), 1283 (m), 1239 (s), 1170 (s), 1112 (s), 1027 (s), 1001 (m), 818 (s),730 (m), 711 (w), 608 (w), 512 (m). ^{1}H-NMR: (400 MHz,

CD_3COCD_3), δ (ppm): 3.30 (s, 6H), 3.70~3.72 (t, J = 3.6 Hz, 8H), 3.48~3.50 (q, J = 3.8 Hz, 4H), 3.58~3.60 (q, J = 3.8 Hz, 4H), 6.88 (d, J = 9.2 Hz, 2H), 7.71 (d, J =8.4Hz, 2H), 9.72 (s, 1H).

2-(1H-imidazol-1-yl)-4-methylpyrimidine (M5)

0.19 g (1.0 mmol) of cuprous iodide, 0.30 g (1.5 mmol) of phenanthroline, 1.12 g (10 mmol) of t-BuOK, and 5 mL of DMF under nitrogen was added into a three-necked flask equipped with a magnetic stirrer, a reflux condenser, and a nitrogen input tube. The reaction mixture was stirred at room temperature for 10 min. Another molar amount of imidazole (1.36 g, 20 mmol) was added into the preceding reaction system and was stirred for about 6 min. Then 0.44g (2.0 mmol) of 2-iodo-4-dimethylpyrimidine and a catalytic amount of 18-crown-6 were added orderly. The reaction mixture was heated to about 150^{o}C and was monitored by TLC. After the completion of the reaction, appropriate amount of CH_2Cl_2 was added with stirring and the solution was washed three times with water. The organic phase was dried with anhydrous $MgSO_4$, filtered, and concentrated. The crude product was purified by chromatography on a silica gel with petroleum (bp 60-90^{o}C) / ethyl acetate (2:1 by volume) as eluent to yield White powder solid. Yield: 62 %. ^{1}H-NMR: (400 MHz, CD_3COCD_3), δ (ppm): 2.57 (s, 3H), 7.09 (s, 1H), 7.30 (d, J = 5.2 Hz, 1H), 7.91 (s, 1 H), 8.52 (s, 1 H), 8.4(d, J = 5.2 Hz, 1H).

2-(1H-imidazol-1-yl)-4,6-dimethylpyrimidine (M6)

The white powder **M6** was prepared according to a similar procedure of **M5** using 2-iodo-4,6-dimethylpyrimidine (0.46 g, 2.0 mmol) instead of 2-iodo-4-dimethylpyrimidine (0.44 g, 2.0 mmol). 0.20 g of white crystals was obtained. Yield：60%. ^{1}H-NMR: (400 MHz, CD_3COCD_3), δ (ppm): 8.52 (s, 1H), 7.19 (s, 1H), 7.92 (s, 1H), 7.09 (s, 1H), 2.52 (s, 6H).

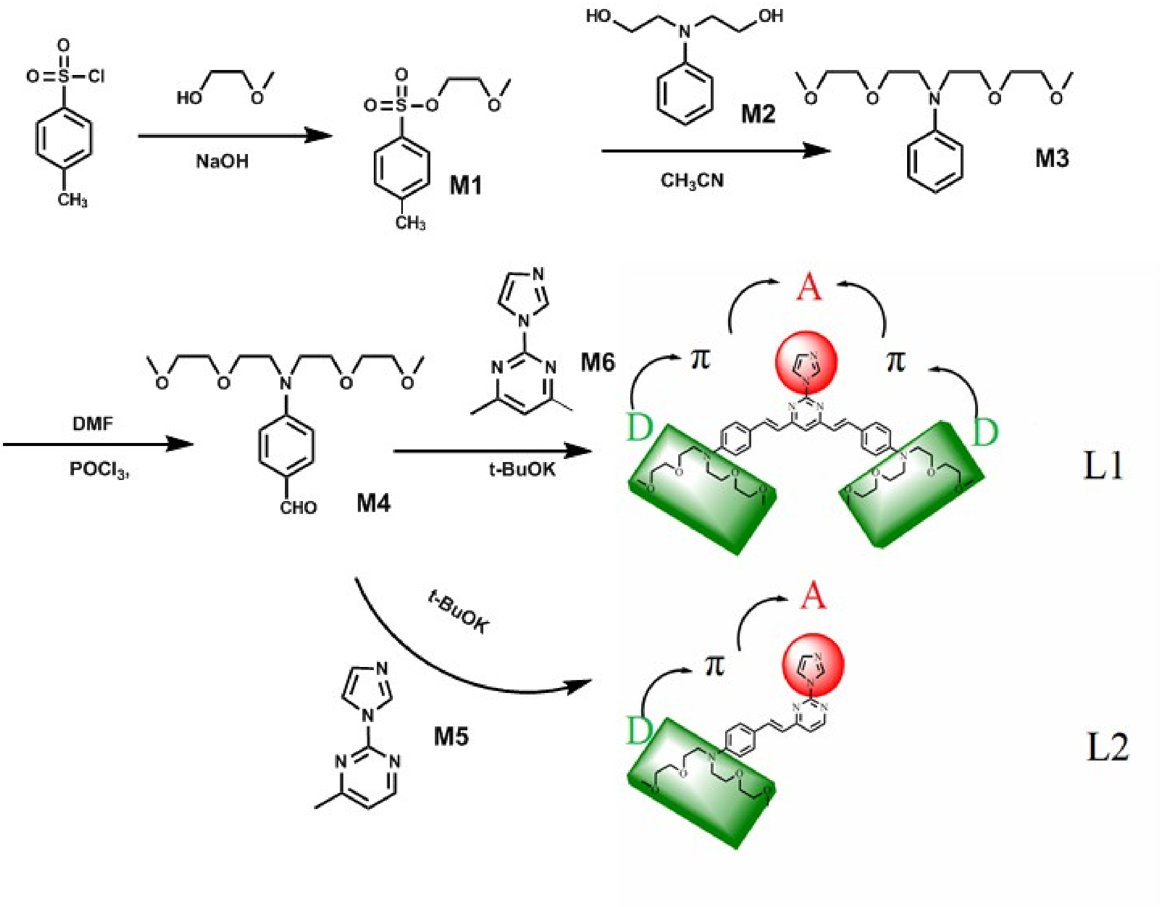

Fig. S1. The synthetic routes to target compounds L1 and L2.

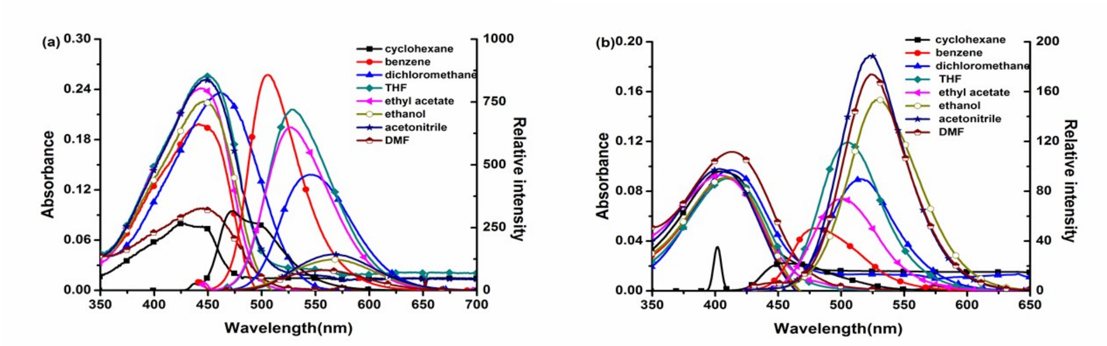

Fig. S2 (a) Single-photon absorption and Single-photon excited fluorescence spectrum of L1 in several solvents with differing polarit. (b) Single-photon absorption and Single-photon excited fluorescence spectrum of L2 in several solvents with differing polarit

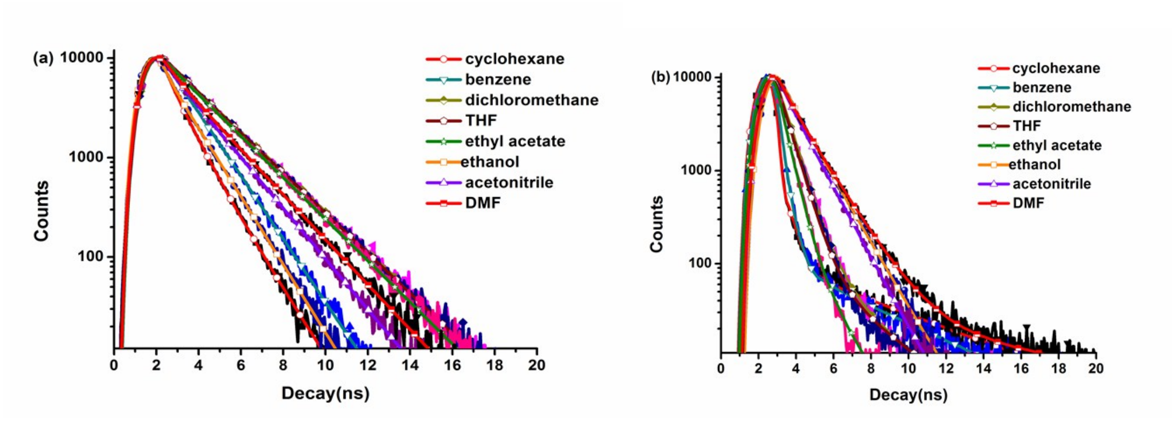

Fig. S3 (a) Decay curves of L1 in several solvents and the fitting result of the corresponding lifetimes ($c=1\times10^{-6}$mol L^{-1}). (b) Decay curves of L2 in several solvents and the fitting result of the corresponding lifetimes ($c=1\times10^{-6}$mol L^{-1}).

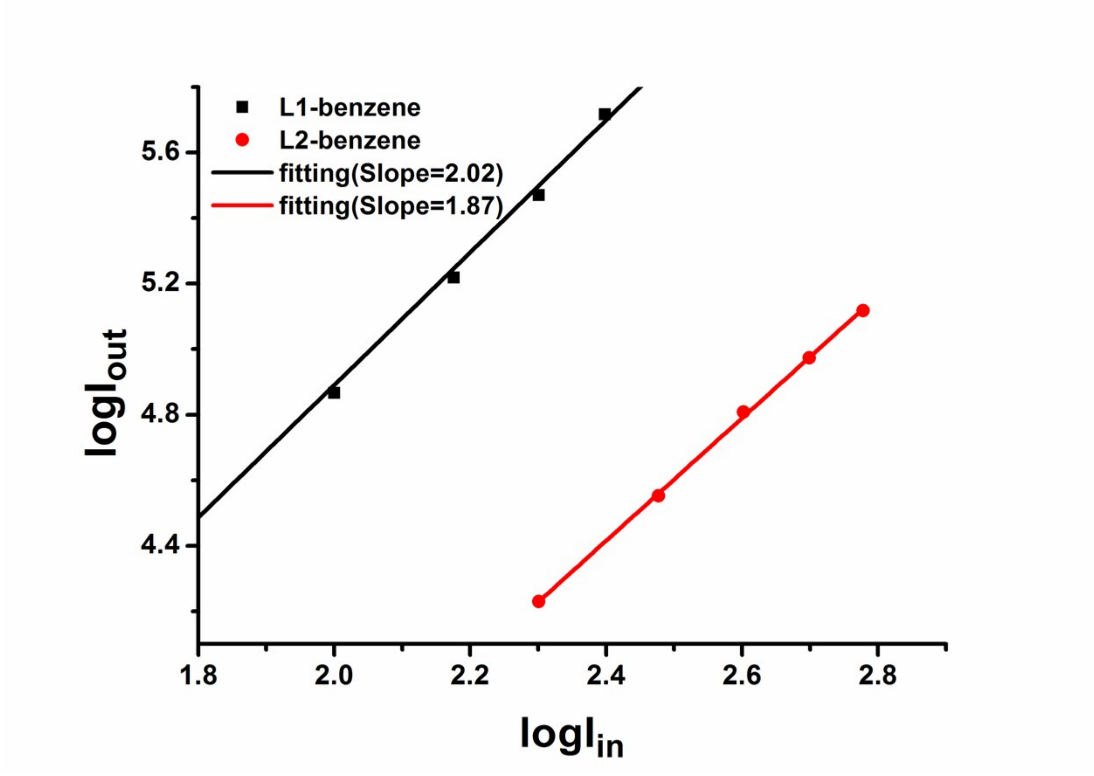

Fig. S4 Output fluorescence intensity (I_{out}) vs. the square of input laser power $(I_{in})^2$ for L1 and L2 in benzene. Excitation carried out at 800 nm, with $c = 1.0\times10^{-3}$mol L^{-1} in benzene.

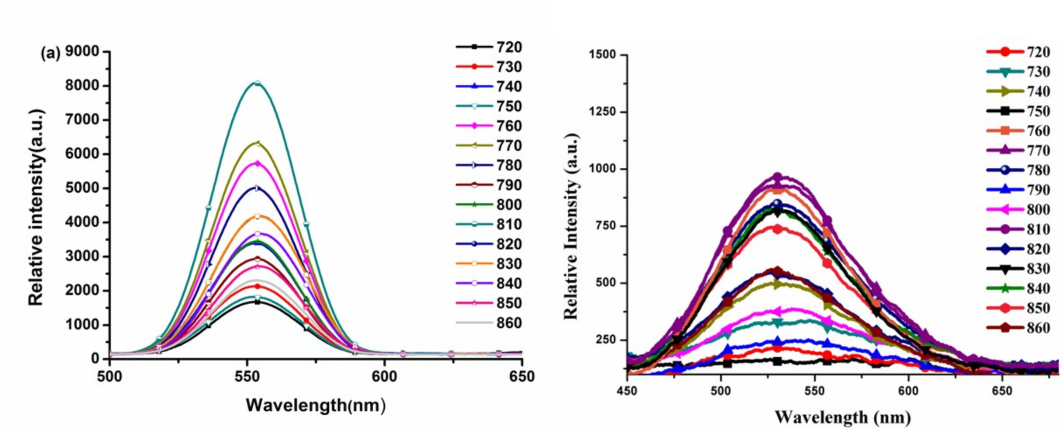

Fig.S5 (a) The two-photon excited fluorescence spectra of L1 in dichloromethane, with $c=1\times10^{-3}$mol L^{-1}. (b) The two-photon excited fluorescence spectra of L2 in dichloromethane, with $c=1\times10^{-3}$mol L^{-1}.

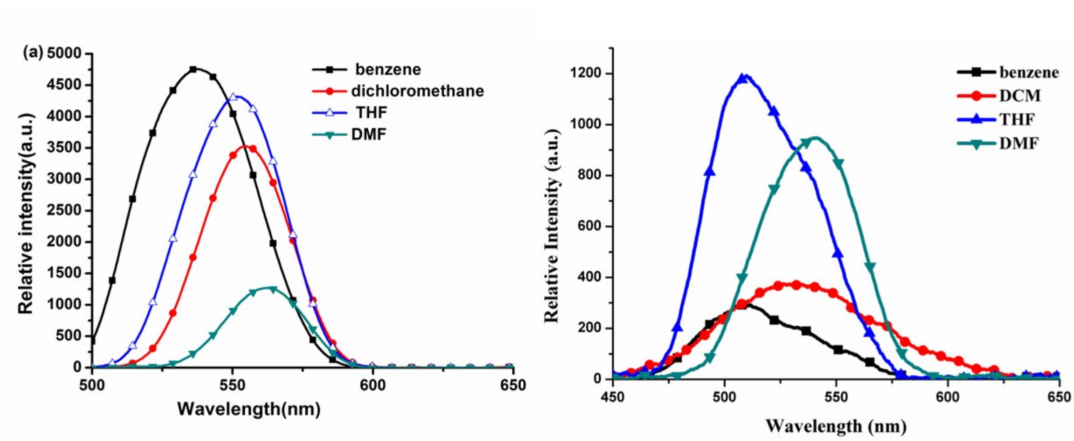

Fig.S6 (a)The two-photon excited fluorescence spectra of L1 in different solvents ($c=1\times10^{-3}$mol L^{-1}). (b)The two-photon excited fluorescence spectra of L2 in different solvents ($c=1\times10^{-3}$mol L^{-1}).

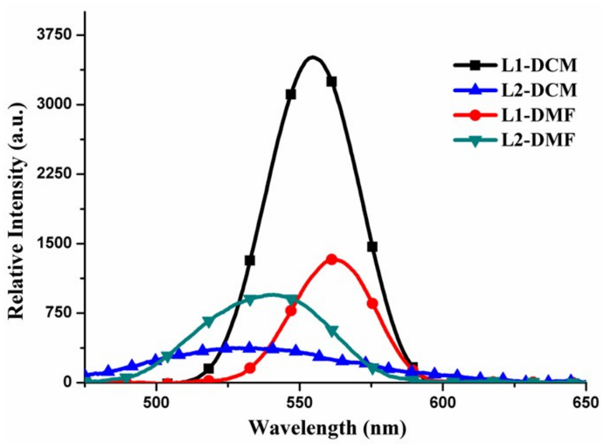

Fig.S7 The two-photon excited fluorescence spectra of L1 and L2 in dichloromethane and DMF($c=1\times10^{-3}$mol L^{-1}).

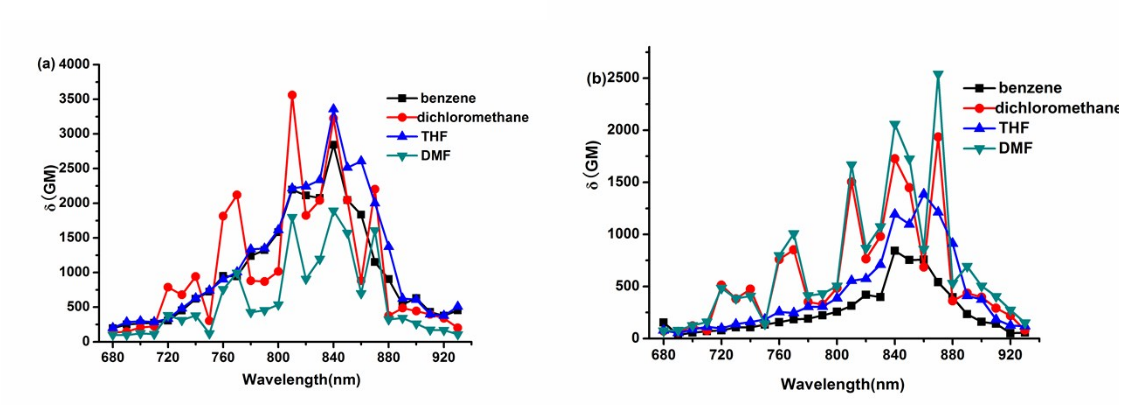

Fig.S8 (a) TPA cross-section of L1 in four solvents versus excitation wavelengths. (b) TPA cross-section of L2 in four solvents versus excitation wavelengths.

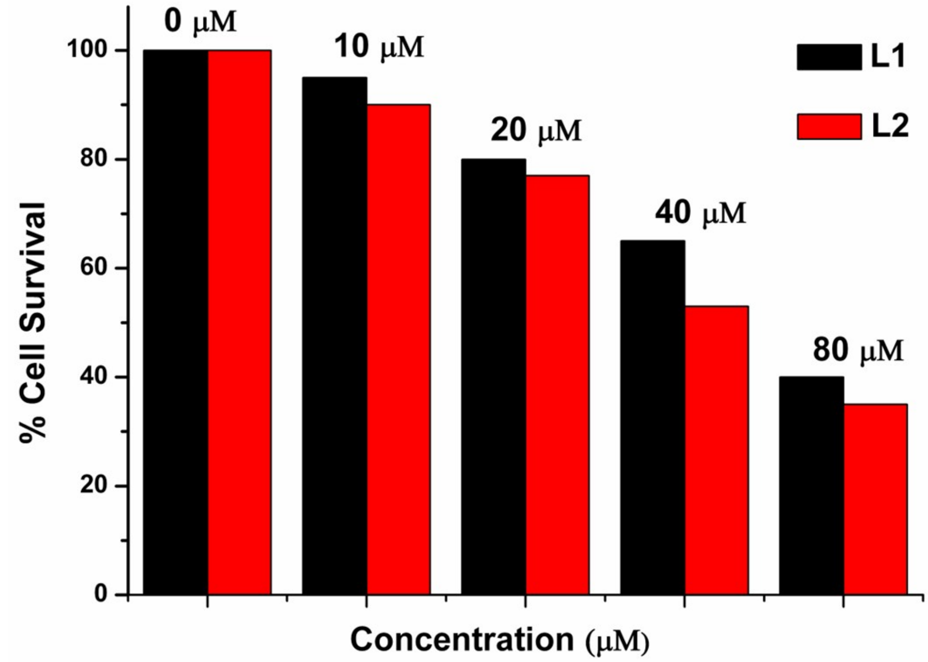

Fig. S9. Cytotoxicity data results obtained from the MTT assay.

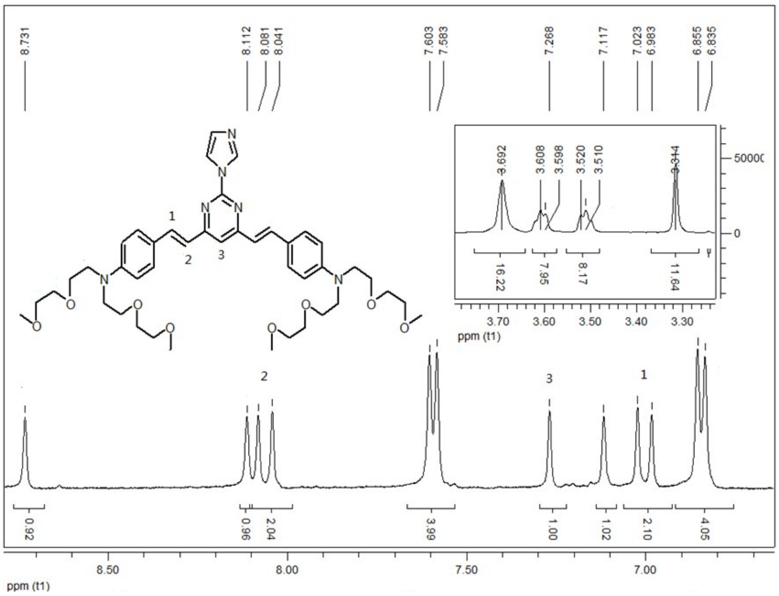

Fig. S10 [1]H-NMR spectrum of compound L1.

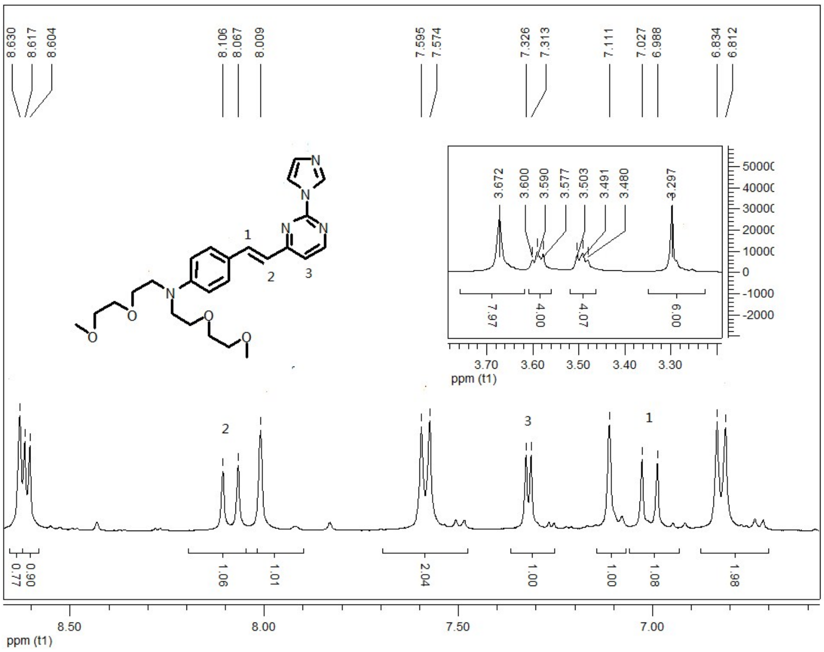

Fig. S11 [1]H-NMR spectrum of compound L2.

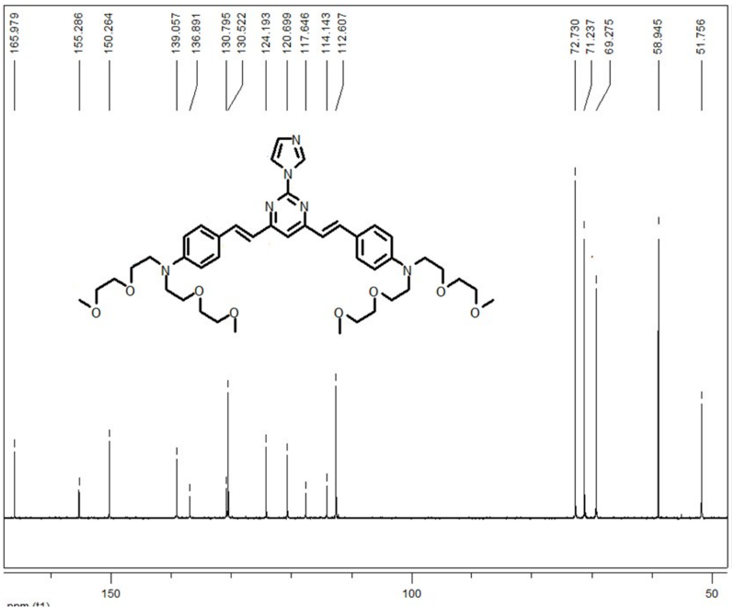

Fig. S12 ^{13}C -NMR spectrum of compound L1.

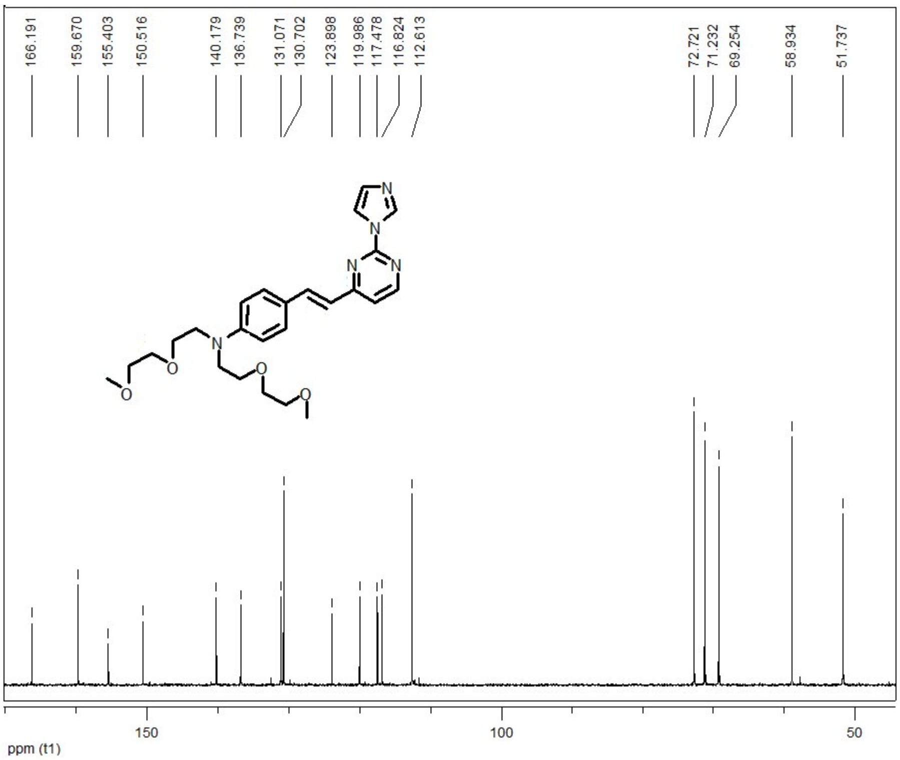

Fig. S13 ^{13}C -NMR spectrum of compound L2.

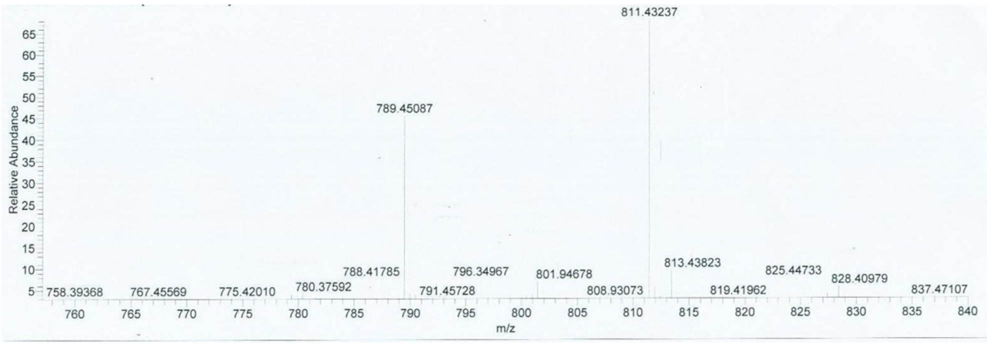

Fig S14 HRMS (GTC-MS) spectrum of L1

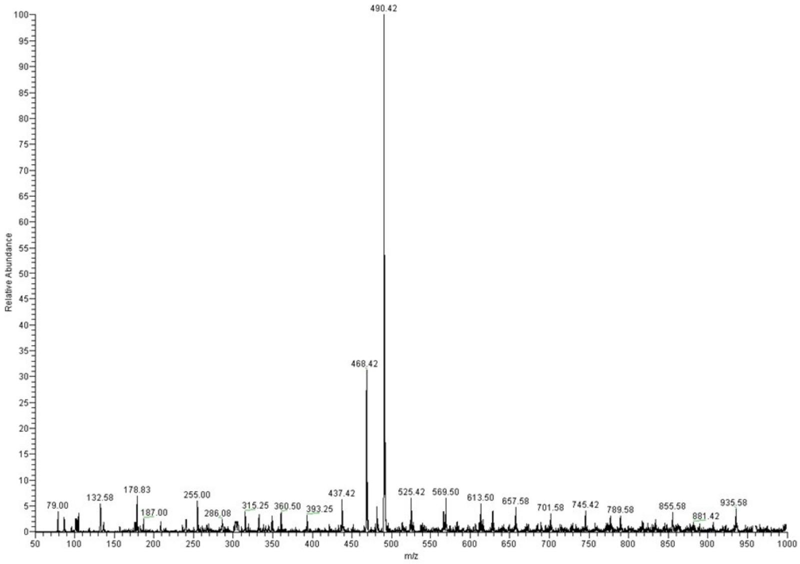

Fig S15 HRMS (GTC-MS) spectrum of L1

Table S1 Calculated absorption spectrum properties of compounds L1 and L2.

compd	λ_{cal}/nm	E_{cal} /eV	*f(a.u)*	Composition
L1	433.4	2.86	1.0420	(212)HOMO→(213)LUMO
L2	424.5	2.92	0.9848	(125)HOMO→(126)LUMO

Reference

[1] J. V. Ros-Lis, B. Garcia, D. Jiménez, R. Martínez-Máñez , F. Sancenón, J. Soto, *et al.*, *J. Am. Chem. Soc.,* **2004**, 129, 4064-4065.