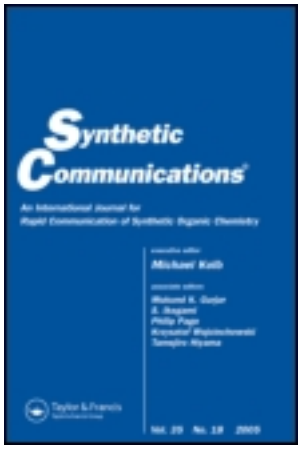

Synthetic Communications: An International Journal for Rapid Communication of Synthetic Organic Chemistry

Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/lsyc20

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Published online: 09 Dec 2009.

To cite this article: Mingxin Yu , Haiyan Fang , Youfeng Yue , Yenchun Chen & Showan Chen (2009) Synthesis of a Novel Ligand Containing Phenyl Pyridine, Synthetic Communications: An International Journal for Rapid Communication of Synthetic Organic Chemistry, 40:1, 58-63, DOI: 10.1080/00397910902923540

To link to this article: http://dx.doi.org/10.1080/00397910902923540

Synthetic Communications®, 40: 58–63, 2010

ISSN: 0039-7911 print/1532-2432 online
DOI: 10.1080/00397910902923540

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SYNTHESIS OF A NOVEL LIGAND CONTAINING PHENYL PYRIDINE

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In this article, we provide a new, efficient route to synthesize 2-[3-(3, 4-bis(2-ethylhexyloxy)phenyl]phenyl pyridine ligand from readily available starting materials. The target compound was obtained by a condensation reaction and Suzuki coupling reaction. Structures of compounds were demonstrated by ^{1}H NMR, ^{13}C NMR, and high-resolution mass spectrometry. The advantages of this synthetic route are simple operation, mild reaction conditions, and good yields.

Keywords: 2-[3-(3,4-Bis(2-ethylhexyloxy)phenyl] phenyl pyridine; ligand; phenylboronic acid compounds; Suzuki coupling reaction; synthesis

Among the heterocyclic compounds exhibiting high physiological activity, nitrogen-containing substances, many of which belong to the class of materials exhibiting analgesic action, are of particular interest. The phenyl pyridine compounds are known as compounds with antibacterial and antifungal properties.[1,2] Anticancer activity is more efficient using phenyl pyridine structures with lateral catena.[2,3]

They are of interest not only as medicinal products but also as ligands for the preparation of coordination compounds exhibiting valuable specific properties, such as high photoluminescence. Initiated by the pioneering work of Baldo et al.,[4] enormous advances[5–14] in metal complexes have been made in pursuit of highly efficient electrophosphorescent organic light-emitting diodes (OLEDs). It has been well demonstrated that structural changes in the skeleton as well as the substituent groups of the cyclometalating ligand afford significant color tuning of electrophosphorescence. Therefore, the design and synthesis of novel cyclometalating ligands have been enthusiastically investigated.[15–19]

In recent years, many derivatives of pyridine have been prepared. Paulose et al.[15] synthesized a series of 2-alkenyl pyridines in 2004. This was the first example

Received January 16, 2009.

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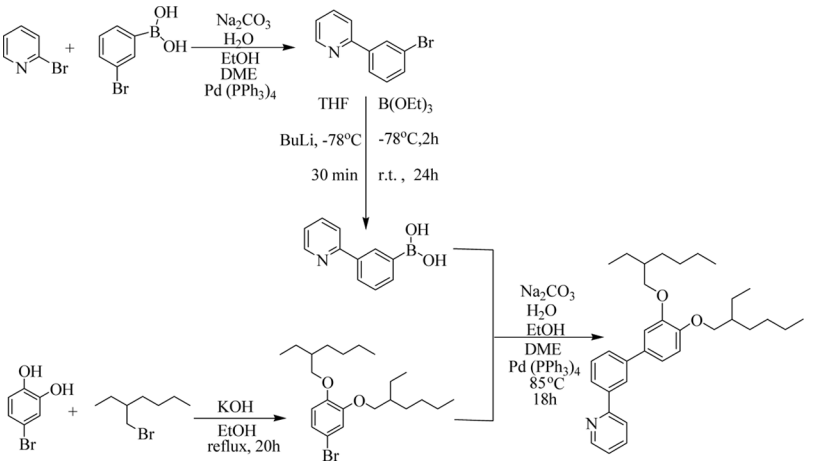

Scheme 1. Synthesis of BEPPP.

of alkenyl pyridines as organic ligands for phosphorescent iridium complexes. You[19] designed and synthesized ligands by changing the fused ring conjugation of pyridine- and pyrazine-based ligand structures. Herein, we prepared 2-[3-(3, 4-bis(2-ethylhexyloxy)phenyl]phenyl pyridine (BEPPP) as a novel ligand.

BEPPP can be used as electron transporter and luminescence host material for phenyl pyridine, and it also leads to fine solubility because it is connected to the hydrocarbon chain. We chose 1-bromo-3,4-dihydroxy benzene, 1-bromo-2-ethylhexane, 2-bromopyridine, and 3-bromophenylboronic acid as the basic raw materials. The target compound was obtained by the condensation reaction and Suzuki coupling reaction (Scheme 1). Synthetic procedures are described in the Experimental section. Structures of compounds were demonstrated by ^{1}H NMR, ^{13}C NMR and high-resolution mass spectrometry (HRMS). The advantages of this synthetic route are simple operation, mild reaction conditions, and good yields.

In conclusion, we provide a new, efficient route to the BEPPP ligand in good yields from readily available starting materials. BEPPP can be used as electron transporter and luminescence host material for metal complexes, and it also leads to fine solubility because it is connected to the hydrocarbon chain.

EXPERIMENTAL

All chemicals were used as supplied. All melting points were determined with a WRS-1A melting-point apparatus and were uncorrected. ^{1}H NMR and ^{13}C NMR spectra were recorded using a Bruker AV-500 NMR instrument in $CDCl_3$ with tetramethylsilane (TMS) as internal standard. Mass spectra (MS) were obtained on a Jeol JMS-S $\times$ 102A HRGC/LC/MS instrument operating in EI mode at 70 eV.

Synthesis of 1,2-Bis(2-ethylhexyloxy)-4-bromobenzen

A mixture of 1-bromo-2-ethyl-hexane (6.2 g, 32.0 mmol), 1-bromo-3,4-dihydroxy benzene (2.26 g, 12.0 mmol), and potassium hydroxide (1.7 g, 30 mmol) in ethanol (EtOH, 60 mL) was heated under reflux at 80°C for 16 h. The reaction mixture was allowed to cool to room temperature, and the inorganic material was filtered off. The filtrate was concentrated under reduced pressure, and crude oil was chromatographed on silica gel using ethyl acetate and hexane as eluent to yield 3.38 g (85%) of colorless oil.

Colorless oil; ^{1}H NMR (500 MHz, $CDCl_3$): 6.97–6.95 (m, 2H), 6.71 (d, 1H, $J = 9.0$ Hz), 3.83 (s, 2H), 3.80 (s, 2H), 1.76–1.70 (m, 2H), 1.54–1.25 (m, 16H), 0.93–0.86(m, 12H); ^{13}C NMR (500 MHz, $CDCl_3$): 150.34 (C), 148.68 (C), 123.17 (CH), 116.54 (CH), 114.75 (CH), 112.56 (C), 71.76 (CH_2), 71.55 (CH_2), 39.45 (CH), 39.44 (CH), 30.52 ($2CH_2$), 29.07 (CH_2), 29.06 (CH_2), 23.85 ($2CH_2$), 23.03 ($2CH_2$), 14.05 ($2CH_3$), 11.12 ($2CH_3$). HRMS (m/z): Calcd. for $C_{22}H_{37}BrO_2$, 412.1977, found 412.1982.

Synthesis of 2-(3-Bromophenyl)pyridine

A degassed mixture of 2-bromopyridine (1.92 mL, 20 mmol), Na_2CO_3 (4.6 g, 44 mmol), water (22 mL), EtOH (16 mL), dimethoxyethane (50 mL), 3-bromophenylboronic acid (4.0 g, 20 mmol), and $Pd(PPh_3)_4$ (230 mg, 0.2 mmol) was heated at reflux for 18 h. The reaction mixture was allowed to cool to room temperature, and the inorganic material was filtered off. The filtrate was concentrated under reduced pressure, and crude oil was chromatographed on silica gel to afford 3.21 g (68.6%) of 2-(3-bromophenyl) pyridine (eluent: ethyl acetate and hexane).

Colorless oil[20]; ^{1}H NMR (500 MHz, $CDCl_3$): 8.67 (d, 1H, $J = 5.0$ Hz), 8.15 (s, 1H), 7.88 (d, 1H, $J = 7.0$ Hz), 7.73 (dd, 1H, $J = 8.5$, 6.5 Hz), 7.66 (d, 1H, $J = 8.5$ Hz), 7.51 (d, 1H, $J = 7.0$ Hz), 7.31 (dd, 1H, $J = 7.0$, 7.5 Hz), 7.23 (dd, 1H, $J = 6.0$, 7.0 Hz); ^{13}C NMR (500 MHz, $CDCl_3$): 155.57 (C), 149.59 (CH), 141.21 (C), 136.75 (CH), 131.69 (CH), 130.10 (CH), 129.84 (CH), 125.23 (CH), 112.90 (C), 122.53 (CH), 120.40 (CH).

Synthesis of 3-(Pyridine-2-yl)phenylboronic Acid

A 2.5 M solution of n-butyllithiium in hexane (4.8 ml, 6 mmol) was added dropwise to a solution of 2-(3-bromophenyl)pyridine (2.34 g, 10.0 mmol) in tetrahydrofuran (THF, 50 mL) at -78°C. The mixture was maintained at this temperature for 1 h before trimethylborate (8.6 mL, 50 mmol) was added slowly to the mixture. The reaction mixture was stirred for 1 h at -60°C and allowed to warm to room temperature overnight. After addition of aqueous 3 M hydrochloric acid (40 mL), the mixture was stirred for 30 min. The organic layer was concentrated under reduced pressure. The residue was recrystallized from hexane to yield 1.0 g (50.2%) of a white solid.

Mp 77–78°C[21]; ^{1}H NMR (500 MHz, $CDCl_3$): 8.54–8.39 (m, 2H), 8.00–7.10 (m, 6H), 5.78 (s,b, 2H); ^{13}C NMR (500 MHz, $CDCl_3$): 155.12 (C), 149.58 (CH),

138.84 (C), 138.30 (CH), 135.48 (CH), 132.80 (CH), 128.96 (CH), 128.74 (CH), 128.09 (C), 126.92 (CH), 122.27 (CH).

Synthesis of 2-[3-(3,4-Bis(2-ethylhexyloxy)phenyl]phenyl Pyridine

A degassed mixture of 1,2-Bis(2-ethylhexyloxy)-4-bromobenzen (0.413 g, 1.0 mmol), Na_2CO_3 (0.233 g, 2.2 mmol), water (1.1 mL), EtOH (0.8 mL), dimethoxyethane (2.5 mL), 3-(pyridine-2-yl)phenylboronic acid (0.2 g, 1.0 mmol), and $Pd(PPh_3)_4$ (11.5 mg, 0.01 mmol) was heated at reflux for 18 h.The reaction mixture was allowed to cool to room temperature, and the inorganic material was filtered off. The filtrate was concentrated under reduced pressure, and crude oil was chromatographed on silica gel to afford 0.34 g (69.8%) of 2-[3-(3,4-bis (2-ethylhexyloxy)phenyl]phenyl pyridine (eluent: ethyl acetate and hexane).

Colorless oil; ^{1}H NMR (500 MHz, $CDCl_3$): 8.71 (d, 1H, $J = 5.0$ Hz), 8.16 (s, 1H), 7.90 (d, 1H, $J = 7.5$ Hz), 7.76–7.75 (m, 2H), 7.60 (d, 1H, $J = 7.5$ Hz), 7.51 (dd, 1H, $J = 7.5$, 7.5 Hz), 7.25–7.22 (m, 1H), 7.20–7.17 (m, 2H), 6.95 (d, 1H, $J = 8.5$ Hz), 3.95 (s, 2H), 3.92 (s, 2H), 1.82–1.78 (m, 2H), 1.59–1.25 (m, 16H), 0.92–0.86 (m, 12H);^{13}C NMR (500 MHz, $CDCl_3$): 157.54 (C), 149.64 (CH), 149.28 (C), 141.77 (C), 139.82 (C), 136.72 (CHmic), 133.92 (C), 129.04 (CH), 128.71 (C), 127.48 (CH), 125.47 (CH), 125.28 (CH), 122.13 (CH), 120.74 (CH), 119.61 (CH), 113.72 (CH), 112.93 (CH), 71.76 (CH_2), 71.64 (CH_2), 39.63 (CH), 39.55 (CH), 30.57 ($2CH_2$), 29.13 (CH_2), 29.10 (CH_2), 23.89 ($2CH_2$), 23.06 ($2CH_2$), 14.08 ($2CH_2$), 11.18 (CH_3), 11.16 (CH_3); HRMS (m/z): calcd. for $C_{33}H_{45}NO_2$ 487.3450; found 487.3456.

ACKNOWLEDGMENT

We thank the Key Industrial Catalysis Subject of Zhejiang Province, China, for financial support.

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