Electronic Supplementary Material (ESI) for RSC Advances.

Nitrogen and sulphur functionalized graphene oxide-palladium nanoparticle hybrid catalyst for an efficient Heck coupling

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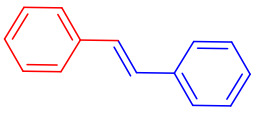
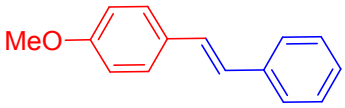
Spectral data

(E)-1,2-diphenylethene (3a)[1]: White Solid



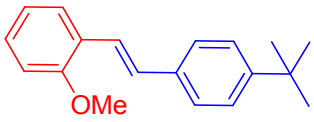
^{1}H NMR (300 MHz, $CDCl_3$) δ = 7.38 (d, 4H, J=7.5 Hz), 7.23 (t, 4H, J=7.2 Hz), 7.13 (t, 2H, J=7.2 Hz), 6.99 (s, 2H); ^{13}C NMR (75 MHz, $CDCl_3$) δ = 137.41, 128.79, 127.76, 127.73, 126.64. $C_{14}H_{12,}$ EI-MS: 180

(E)-1-methoxy-4-styrylbenzene (3b)[1]: White Solid



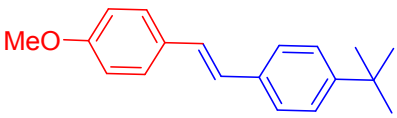
^{1}H NMR (300 MHz, $CDCl_3$) δ = 7.55 (t, 2H, J=7.8 Hz), 7.51 (t, 1H, J=9 Hz), 7.30 (d, 1H, J=6 Hz), 7.09 (d, 2H, J=15 Hz), 6.96 (d, 2H, J=6 Hz),3.98 (s, 3H); ^{13}C NMR (75 MHz, CDCl3, δ (ppm) 159.01, 137.35, 129.82, 128.33, 127.92, 127.43, 126.86, 126.29, 125.96, 113.83, 54.94. $C_{15}H_{14}O$, EI-MS: 210

(E)-1-(4-(tert-butyl)styryl)-2-methoxybenzene (3c)[2]: White Solid



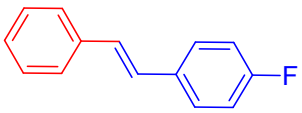
^{1}H NMR (300 MHz, $CDCl_3$) δ = 7.45 (d, 1H, J=7.5 Hz), 7.34 (dd, 3H, J1=5.4 Hz, J2=16.8 Hz), 7.22 (d, 2H, J=10.5 Hz), 7.09 (dd, 1H, J1=6.6, J2=13.8 Hz), 7.01 (d, 1H, J=16.2 Hz), 6.76 (dd, 2H, J1=7.5 Hz, J2=17.4 Hz), 3.72 (s, 3H), 1.21 (s, 9H); ^{13}C NMR (75 MHz, $CDCl_3$) δ = 156.95, 150.51, 136.70, 135.33, 128.95, 128.58, 126.41, 126.05, 125.60, 122.86, 120.83, 111.05, 55.59, 34.67, 31.43. $C_{19}H_{22}O$, EI-MS: 266

(E)-1-(tert-butyl)-4-(4-methoxystyryl)benzene (3d)[2]: White Solid



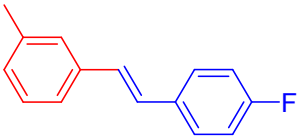
^{1}H NMR (300 MHz, $CDCl_3$) δ = 7.66 (t, 1 H, J=8.1 Hz), 7.49 (dd, 4H, J1= 7.5 Hz, J2=20.1 Hz), 7.35 (dd, 3H, J1=6 Hz, J2=22.8 Hz), 7.01 (dd, 2H, J1=7.5 Hz, J2=20.4 Hz) 3.85 (s, 3H), 1.29 (s, 9H); ^{13}C NMR (75 MHz, $CDCl_3$) δ =159.98, 136.19, 134.02, 132.15, 128.64, 128.22, 127.72, 127.21, 126.62, 126.25, 114.16, 55.53, 34.13, 31.34. $C_{19}H_{22}O$, EI-MS: 266

(E)-1-fluoro-4-styrylbenzene (3e)[3]: White Solid



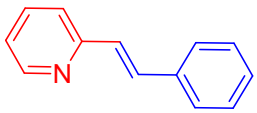
^{1}H NMR (300 MHz, $CDCl_3$) δ = 7.78 (dd, 1H, J1=7.5 Hz, J2=11.1 Hz), 7.54 (m, 4H), 7.42 (t, 2H, J=6.9 Hz), 7.35 (d, 1H, J1=7.2 Hz,), 7.11 (m, 3H);^{13}C NMR (75 MHz, $CDCl_3$) δ =164.06, 137.24, 132.05, 128.78, 128.42, 128.12, 127.74, 127.52, 126.53, 115.51. $C_{14}H_{11}F$, EI-MS: 198

(E)-1-(4-fluorostyryl)-2-methylbenzene (3f)[3]: White Solid



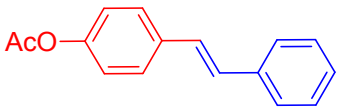
^{1}H NMR (300 MHz, $CDCl_3$) δ = 7.67 (dd, 2H, J1=6.3 Hz, J2=16.2 Hz), 7.45 (dd, 4H, J1=5.4 Hz, J2=12.6 Hz), 7.16 (m, 2H), 7.02 (dd, 2H, J1=5.4 Hz, J2=14.7 Hz), 2.40 (s, 3H); ^{13}C NMR (75 MHz, $CDCl_3$) δ = 160.74, 135.78, 132.02, 128.83, 128.64, 128.48, 128.03, 127.65, 126.28, 125.35. $C_{15}H_{13}F$, EI-MS: 212

(E)-2-styrylpyridine (3g)[1]: Solid



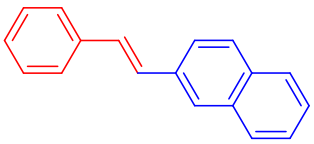
^{1}H NMR (300 MHz, $CDCl_3$) δ = 8.51 (s, 1H), 8.27 (d, 1H, J=8.1 Hz), 7.60 (m, 4H), 7.27 (m, 3H), 7.10 (dd, 2H, J1=3.9 Hz, J2=7.2 Hz); ^{13}C NMR (75 MHz, $CDCl_3$) δ = 156.03, 149.08, 136.82, 132.05, 131.92, 128.55, 128.39, 123.65, 121.01. $C_{13}H_{11}N$, ESI-MS= 180.09

(E)-4-styrylphenyl acetate (3h)[3]: White Solid



^{1}H NMR (300 MHz, $CDCl_3$) δ = 7.75 (m, 2H), 7.54 (m, 1H), 7.42 (dd, 1H, J1=2.1 Hz, J2=7.2 Hz), 7.35 (d, 1H, J=6.9 Hz), 7.26 (dd, 2H, J1=3.9 Hz, J2=12 Hz), 7.10 (m, 2H), 6.90 (dd, 2H, J1=1.8 Hz, J2=8.4 Hz), 2.93 (s, 3H); ^{13}C NMR (75 MHz, $CDCl_3$) δ = 163.45, 156.36, 142.01, 132.51 129.52, 128.93, 128.77, 128.58, 128.39, 125.93, 115.44, 28.07. $C_{16}H_{14}O_2$, EI-MS: 238

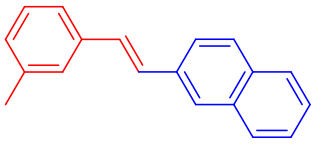
(E)-2-styrylnaphthalene (3i)[1]: White crystalline solid



^{1}H NMR (300 MHz, $CDCl_3$) δ = 8.40 (d, 1H, J=9 Hz), 8.11 (d, 1H, J=15 Hz), 7.88 (dd, 3H, J1=6 Hz, J2=21 Hz), 7.79 (d, 2H, J=9 Hz), 7.58 (m, 3H), 7.42 (t, 2H, J=6 Hz), 7.33 (m, 2H); ^{13}C NMR (75 MHz, $CDCl_3$) δ = 137.03, 134.64, 133.26, 132.56, 128.95, 128.73, 128.40, 128.18, 127.83,

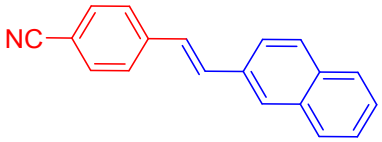
127.70, 127.57, 126.51, 126.45, 126.34, 125.98, 123.60. $C_{18}H_{14}$, EI-MS: 230

(E)-2-(2-methylstyryl)naphthalene (3j)[4]: White crystalline solid



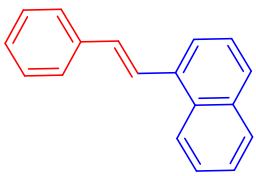
^{1}H NMR (300 MHz, $CDCl_3$) δ = 7.73 (d, 4H, J=9 Hz), 7.62 (d, 2H, J=9 Hz), 7.55 (d, 2H, J=6 Hz), 7.31(m, 3H), 7.10 (m, 3H), 2.36 (s, 3H); ^{13}C NMR (75 MHz, $CDCl_3$) δ = 136.47, 135.94, 135.23, 133.80, 133.10, 130.55, 130.55, 130.13, 128.38, 128.09, 127.79, 127.69, 126.87, 126.71, 126.42, 126.34, 125.97, 125.41, 123.68, 20.07. $C_{19}H_{16}$, EI-MS: 244

(E)-4-(2-(naphthalen-2-yl)vinyl)benzonitrile (3k)[4]: White crystalline solid



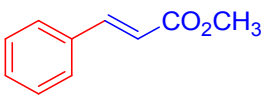
^{1}H NMR (300 MHz, $CDCl_3$) δ = 7.79 (t, 4H, J=9 Hz), 7.65 (d, 1H, J=6 Hz), 7.53 (d, 3H, J=9 Hz), 7.41 (t, 2H, J=6 Hz), 7.31 (d, 1H, J=18 Hz), 7.17 (d, 1H, J=12 Hz); ^{13}C NMR (75 MHz, $CDCl_3$) δ = 141.88, 133.78, 133.58, 133.47, 132.54, 132.50, 128.60, 128.19, 127.77, 126.99, 126.88, 126.62, 126.52, 123.29, 119.07, 110.60. $C_{19}H_{13}N$, EI-MS: 256 (M+1).

(E)-1-styrylnaphthalene (3l)[1]: White crystalline solid



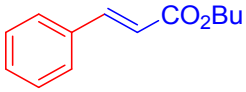
^{1}H NMR (300 MHz, $CDCl_3$) δ = 8.23 (d, 1H, J=6 Hz), 7.86 (d, 1H, J=9 Hz), 7.82 (dd, 2H, J1=9 Hz, J2=18), 7.62 (d, 1H, J=6 Hz), 7.52 (m, 3H), 7.41 (t, 2H, J= 9Hz), 7.32 (d, 2H, J=6 Hz), 7.18 (d, 2H, J=15 Hz); ^{13}C NMR (75 MHz, $CDCl_3$) δ = 137.61, 135.02, 133.72, 131.76, 131.39, 128.77, 128.61, 128.03, 128.77, 126.08, 126.81, 125.68. $C_{18}H_{14}$, EI-MS: 230

methyl cinnamate (5a)[5]: Colourless oil



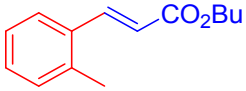
^{1}H NMR (300 MHz, $CDCl_3$) δ = 7.53 (d, 1H, J=18 Hz), 7.26 (t, 2H, J=3 Hz), 7.13 (t, 3H, J=3 Hz), 6.27 (d, 1H, J=15 Hz), 3.57 (s, 3H); ^{13}C NMR (75 MHz, $CDCl_3$) δ =167.07, 144.65, 134.32, 130.17, 128.78, 128.02, 117.76, 15.40. $C_{10}H_{10}O_2$, EI-MS: 162

butyl cinnamate (5b)[4]: Colourless oil



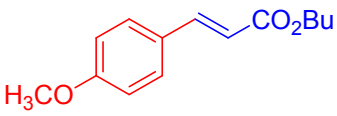
^{1}H NMR (300 MHz, $CDCl_3$) δ =7.60 (d, 2H, J=18), 7.39 (dd, 2H, J1=3 Hz, J2=9 Hz), 7.23 (t, 3H, J=3 Hz), 6.34 (d, 1H, 15.9 Hz), 4.09 (t, 2H, J=6 Hz), 1.57 (qt, 2H, J=6.7 Hz), 1.33 (sext, 2H, J=7.8 Hz), 0.85 (t, 3H, J=15 Hz) ; ^{13}C NMR (75 MHz, $CDCl_3$) δ = 166.90, 144.51, 134.49, 130.18, 128.85, 128.04, 118.31, 64.35, 30.67, 19.22, 13.75. $C_{13}H_{16}O_2$, EI-MS: 204

(E)butyl 3-(o-tolyl)acrylate (5c)[4]: Colourless oil



^{1}H NMR (300 MHz, $CDCl_3$) δ = 7.84 (d, 1H, J=15 Hz), 7.36 (d, 1H, J=9 Hz), 7.05 (m, 3H), 6.21 (d, 1H, J= 15 Hz), 4.07 (t, 2H, 6.9 Hz), 2.22 (s, 3H), 1.53 (qt, 2H, J= 6.7 Hz), 1.29 (sext, 2H, J=7.8 Hz), 0.81 (t, 3H, J=6 Hz); ^{13}C NMR (75 MHz, $CDCl_3$) δ = 166.84, 142.06, 137.44, 133.37, 130.70, 129.88, 126.32, 119.21, 64.21, 30.81, 19.58, 19.21, 13.71 $C_{14}H_{18}O_2$, EI-MS: 218

(E)-butyl 3-(4-methoxyphenyl)acrylate (5d)[6]: Colourless oil



^{1}H NMR (300MHz, $CDCl_3$) δ = 7.51 (m, 1 H), 7.43 (m, 2H), 7.31 (m, 1H), 6.81 (dd, 1H, J1=3.6 Hz, J2=8.7 Hz), 4.09 (t, 2H, J=6.6 Hz), 3.73 (s, 3H), 1.60 (qt, 2H, J=3.6 Hz), 1.36 (sext, 2H, J=6.6 Hz), 0.865 (t, 3H, J=7.2 Hz); ^{13}CNMR (75 MHz, $CDCl_3$) δ=167.50, 161.35, 144.27, 132.08, 129.69, 128.72, 114.32, 64.27, 55.50, 30.80, 19.21, 14.13. $C_{14}H_{18}O_3$, EI-MS: 234

References:

1 A. K. Jha, S. Kishor and Nidhi Jain, *RSC Adv*., 2015, **5**, 55218–55226.

2 S. Kumar, *New J. Chem.*, 2015, **39**, 2042-2051.

3 Z. Chen, *Org. Lett.,* 2014, **16**, 3020-3023.

4 A. K. Jha, R. K. Shahni and N. Jain, *Synlett,* 2015, **26**, 259–264.

5 S. Rostamnia and T. Rahmani, *Appl. Organometal. Chem.*, 2015, **29**, 471-474.

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