Supporting Information

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I. Characterization results of catalysts

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Figure S2. Energy dispersive X-ray spectroscopy (EDX) elemental line scans over different catalysts.
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Figure S4. (SAED) patterns of catalyst samples.

Figure S5. Typical XPS survey scans of catalyst samples.
Figure S6. Characterization data of Pd/C-py-R catalyst sample.
II. NMR peaks and MS-EI of all products

![Structure c1]

White solid; Mp = 124~126 °C; \(^1\)H NMR (400 MHz, CDCl\(_3\) \(\delta\) 7.36 – 7.31 (m, 6H), 7.22 – 7.15 (m, 6H), 7.11 (m, \(J = 9.2, 4.7, 3.1\) Hz, 3H). \(^{13}\)C NMR (101 MHz, CDCl\(_3\) \(\delta\) 147.99, 129.31, 124.28, 122.78.

MS-EI calculated for 245.1204, found 245.1226

![Structure c2]

Yellowish solid; Mp = 65~67 °C; \(^1\)H NMR (400 MHz, CDCl\(_3\) \(\delta\) 7.30 (t, \(J = 7.7\) Hz, 4H), 7.15 (d, \(J = 7.8\) Hz, 6H), 7.12 – 7.02 (m, 4H), 2.40 (s, 3H). \(^{13}\)C NMR (101 MHz, CDCl\(_3\) \(\delta\) 148.13, 145.36, 132.79, 130.01, 129.20, 125.03, 123.70, 122.31, 20.91. MS-EI calculated for 259.1361, found 259.1338

![Structure c3]

White solid; Mp = 128~131 °C; \(^1\)H NMR (400 MHz, CDCl\(_3\) \(\delta\) 7.33 (m, \(J = 7.2, 1.9\) Hz, 4H), 7.26 – 7.14 (m, 5H), 7.14 – 6.98 (m, 4H), 6.95 (t, \(J = 6.0\) Hz, 1H), 2.37 (d, \(J = 5.8\) Hz, 3H). \(^{13}\)C NMR (101 MHz, CDCl\(_3\) \(\delta\) 148.11, 147.94, 139.15, 129.27, 129.17, 125.12, 124.20, 123.82, 122.61, 121.69, 21.53. MS-EI calculated for 259.1361, found 259.1327

![Structure c4]

White solid; Mp = 53~55 °C; \(^1\)H NMR (400 MHz, CDCl\(_3\) \(\delta\) 7.29 – 7.19 (m, 7H), 7.17 – 7.14 (m, 1H), 7.01 (d, \(J = 7.7\) Hz, 4H), 6.95 (t, \(J = 7.3\) Hz, 2H), 2.07 (s, 3H). \(^{13}\)C NMR (101 MHz, CDCl\(_3\) \(\delta\) 147.53,
Yellowish solid; Mp = 127~129 °C; $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 7.42 – 7.31 (m, 7H), 7.15 – 7.11 (m, 6H), 1.44 (s, 18H). $^{13}$C NMR (101 MHz, CDCl$_3$) $\delta$ 148.30, 145.53, 145.33, 129.39, 126.21, 123.91, 123.51, 120.51, 34.27, 31.60. MS-EI calculated for 357.2457, found 357.2434

White solid; Mp = 106~109 °C; $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 7.09 – 7.05 (m, 2H), 6.93 (m, $J$ = 4.7, 3.6 Hz, 6H), 6.87 (d, $J$ = 8.5 Hz, 4H), 6.81 (t, $J$ = 7.3 Hz, 1H), 2.18 (s, 6H). $^{13}$C NMR (101 MHz, CDCl$_3$) $\delta$ 148.40, 145.60, 132.35, 129.94, 129.13, 124.57, 123.08, 121.83, 20.89. MS-EI calculated for 273.1517, found 273.1541

Yellowish solid; Mp = 114~116 °C; $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 7.01 (d, $J$ = 8.3 Hz, 6H), 6.94 (d, $J$ = 8.4 Hz, 6H), 2.27 (s, 9H). $^{13}$C NMR (101 MHz, CDCl$_3$) $\delta$ 145.82, 130.62, 129.04, 123.15, 20.24. MS-EI calculated for 287.1674, found 287.1703

S5
Yellowish solid; Mp = 51~53 °C; \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 7.08 – 6.94 (m, 9H), 6.88 – 6.72 (m, 3H), 2.28 (s, 6H), 2.21 (s, 3H). \(^{13}\)C NMR (101 MHz, CDCl\(_3\)) \(\delta\) 148.36, 145.73, 138.93, 132.18, 129.91, 128.99, 124.51, 123.93, 122.90, 120.54, 21.55, 20.91. MS-EI calculated for 287.1674, found 287.1681

Yellow solid; Mp = 104~106 °C; \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 7.66 (t, \(J = 7.3\) Hz, 2H), 7.61 – 7.54 (m, 2H), 7.52 – 7.45 (m, 2H), 7.44 – 7.30 (m, 5H), 7.30 – 7.17 (m, 6H), 7.17 – 7.07 (m, 2H). \(^{13}\)C NMR (101 MHz, CDCl\(_3\)) \(\delta\) 147.81, 147.29, 140.75, 135.25, 129.39, 128.84, 127.88, 126.90, 126.75, 124.52, 124.04, 123.03. MS-EI calculated for 321.1517, found 321.1532

Yellow solid; Mp = 144~147 °C; \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 7.70 (m, \(J = 7.1, 1.1\) Hz, 2H), 7.64 – 7.49 (m, 4H), 7.42 (m, \(J = 7.4, 5.8\) Hz, 1H), 7.36 – 7.00 (m, 10H), 2.47 (m, \(J = 8.3, 3.4\) Hz, 6H). \(^{13}\)C NMR (101 MHz, CDCl\(_3\)) \(\delta\) 147.77, 145.43, 140.92, 134.33, 132.67, 130.07, 128.84, 127.75, 126.71, 124.84, 122.87, 20.98. MS-EI calculated for 349.1830, found 349.1853

White solid; Mp = 145~147 °C; \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 6.94 (d, \(J = 8.4\) Hz, 5H), 6.88 (t, \(J = 6.4\) Hz, 5H), 6.84 – 6.78 (m, 2H), 2.20 (s, 6H), 2.16 (s, 3H). \(^{13}\)C NMR (101 MHz, CDCl\(_3\)) \(\delta\) 169.76, 145.99, 145.42, 132.48, 129.94, 124.45, 123.59, 122.03, 21.14, 20.83. MS-EI calculated for 331.1572, found 331.1549
White solid; Mp = 52~54 °C; $^1$H NMR (400 MHz, CDCl$_3$) δ 7.34 (m, $J = 8.5, 3.2, 1.4$ Hz, 4H), 7.16 – 7.12 (m, 4H), 7.03 – 6.98 (m, 2H), 5.75 (s, 1H). $^{13}$C NMR (101 MHz, CDCl$_3$) δ 143.21, 129.41, 121.09, 117.93. MS-EI calculated for 169.0891, found 169.0872

Yellowish solid; Mp = 87~88 °C; $^1$H NMR (400 MHz, CDCl$_3$) δ 7.31 (m, $J = 4.7, 2.8, 1.0$ Hz, 2H), 7.16 (d, $J = 8.0$ Hz, 2H), 7.10 – 7.06 (m, 4H), 6.96 (m, $J = 7.3, 2.6, 1.1$ Hz, 1H), 5.65 (s, 1H), 2.38 (s, 3H). $^{13}$C NMR (101 MHz, CDCl$_3$) δ 144.05, 140.39, 130.98, 129.92, 129.37, 120.37, 119.00, 116.96, 20.74. MS-EI calculated for 183.1048, found 183.1021

Yellow oil; $^1$H NMR (400 MHz, CDCl$_3$) δ 7.33 (m, $J = 11.8, 4.0$ Hz, 2H), 7.21 (d, $J = 8.3$ Hz, 1H), 7.15 – 7.11 (m, 2H), 7.02 – 6.93 (m, 3H), 6.83 (d, $J = 7.5$ Hz, 1H), 5.70 (s, 1H), 2.38 (s, 3H). $^{13}$C NMR (101 MHz, CDCl$_3$) δ 143.32, 143.15, 139.27, 129.37, 129.23, 121.95, 120.93, 118.60, 117.90, 115.01, 21.58. MS-EI calculated for 183.1048, found 183.1026

White solid; Mp = 134~137 °C; $^1$H NMR (400 MHz, CDCl$_3$) δ 7.34 (t, $J = 7.4$ Hz, 3H), 7.29 (d, $J = 7.3$ Hz, 1H), 7.23 (t, $J = 7.6$ Hz, 1H), 7.06 – 6.97 (m, 4H), 5.45 (s, 1H), 2.34 (s, 3H). $^{13}$C NMR (101 MHz, CDCl$_3$) δ 144.11, 141.30, 131.03, 129.38, 126.85, 122.12, 120.53, 119.00, 117.52, 17.96. MS-EI calculated for 183.1048, found 183.1068
White solid; Mp = 55°~57 °C; $^1$H NMR (400 MHz, CDCl$_3$) δ 7.22 (m, $J = 16.2, 7.9$ Hz, 5H), 7.03 (m, $J = 22.2, 8.2$ Hz, 4H), 5.35 (s, 1H), 1.30 (s, 9H). $^{13}$C NMR (101 MHz, CDCl$_3$) δ 145.45, 145.20, 129.02, 125.97, 123.78, 123.40, 121.89, 34.27, 31.46. MS-EI calculated for 225.1517, found 225.1508

White solid; Mp = 76°~79 °C; $^1$H NMR (400 MHz, CDCl$_3$) δ 6.95 (t, $J = 9.7$ Hz, 4H), 6.86 (t, $J = 7.7$ Hz, 4H), 5.29 (s, 1H), 2.20 (s, 6H). $^{13}$C NMR (101 MHz, CDCl$_3$) δ 141.22, 129.85, 123.92, 117.99, 20.66. MS-EI calculated for 197.1204, found 197.1231

Yellowish solid; Mp = 131°~133 °C; $^1$H NMR (400 MHz, CDCl$_3$) δ 7.09 (dt, $J = 17.8, 8.8$ Hz, 3H), 6.99 (d, $J = 8.4$ Hz, 2H), 6.82 (d, $J = 7.6$ Hz, 2H), 6.70 (d, $J = 7.4$ Hz, 1H), 5.58 (s, 1H), 2.29 (d, $J = 4.3$ Hz, 6H). $^{13}$C NMR (101 MHz, CDCl$_3$) δ 143.95, 140.44, 139.17, 130.83, 129.84, 129.15, 121.23, 118.98, 117.59, 114.05, 21.53, 20.68. MS-EI calculated for 197.1204, found 197.1235

Yellowish solid; Mp = 109°~111 °C; $^1$H NMR (400 MHz, CDCl$_3$) δ 7.55 (d, $J = 7.9$ Hz, 2H), 7.48 (s, 2H), 7.38 (d, $J = 7.6$ Hz, 2H), 7.30 ~ 7.25 (m, 3H), 7.10 (d, $J = 7.8$ Hz, 4H), 6.93 (d, $J = 7.3$ Hz, 1H), 5.72 (s, 1H). $^{13}$C NMR (101 MHz, CDCl$_3$) δ 142.94, 142.64, 140.92, 133.82, 129.47, 128.82, 128.04, 126.67, 126.61, 121.33, 118.20, 117.90. MS-EI calculated for 245.1204, found 245.1193
Yellowish solid; Mp = 132~135 °C; ^1H NMR (400 MHz, CDCl₃) δ 7.55 – 7.52 (m, 2H), 7.46 – 7.44 (m, 2H), 7.40 – 7.36 (m, 2H), 7.25 (d, J = 7.0 Hz, 1H), 7.08 – 7.00 (m, 6H), 5.67 (s, 1H), 2.30 (s, 3H). ^13C NMR (101 MHz, CDCl₃) δ 143.51, 140.99, 138.81, 133.06, 129.22, 128.78, 127.82, 127.44, 126.51, 124.14, 119.23, 116.96, 20.78. MS-EI calculated for 259.1361, found 259.1347

White solid; Mp = 92~96 °C; ^1H NMR (400 MHz, CDCl₃) δ 7.07 (d, J = 8.1 Hz, 2H), 7.03 – 6.86 (m, 6H), 5.60 (s, 1H), 2.29 (s, 3H), 2.27 (s, 3H). ^13C NMR (101 MHz, CDCl₃) δ 170.02, 144.11, 141.85, 140.42, 131.02, 129.91, 122.23, 118.81, 117.73, 21.09, 20.68. MS-EI calculated for 241.1103, found 241.1127
III. NMR spectra of all products

**Figure S7.** $^1$HNMR of c1

**Figure S8.** $^{13}$CNMR of c1
Figure S9. $^1$HNMR of c2

Figure S10. $^{13}$CNMR of c2
Figure S11. $^1$HNMR of c3

Figure S12. $^{13}$CNMR of c3
Figure S13. $^1$HNMR of c4

Figure S14. $^{13}$CNMR of c4
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Figure S16. $^{13}$CNMR of c5
Figure S17. $^1$HNMR of c6

Figure S18. $^{13}$CNMR of c6
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Figure S20. $^{13}$CNMR of c7
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Figure S22. $^{13}$CNMR of c8
Figure S23. $^1$HNMR of c9

Figure S24. $^{13}$CNMR of c9
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Figure S28. $^{13}$CNMR of c11
Figure S29. $^1$HNMR of d1

Figure S30. $^{13}$CNMR of d1
Figure S31. $^1$HNMR of d2

Figure S32. $^{13}$CNMR of d2
Figure S33. $^1$HNMR of d3

Figure S34. $^{13}$CNMR of d3
Figure S35. $^1$HNMR of d4

Figure S36. $^{13}$CNR of d4
**Figure S37.** $^1$HNMR of d5

**Figure S38.** $^{13}$CNMR of d5
Figure S39. $^1$HNMR of d6

Figure S40. $^{13}$CNR of d6
Figure S41. $^1$HNMR of d7

Figure S42. $^{13}$CNR of d7
Figure S43. $^1$HNMR of d8

Figure S44. $^{13}$CNMR of d8
Figure S45. $^1$HNMR of d9

Figure S46. $^{13}$CNMR of d9
Figure S47. $^1$H NMR of d10

![HNMR of d10](image1)

Figure S48. $^{13}$C NMR of d10

![CNMR of d10](image2)