Supporting Information for

Palladium on Manganese ferrite: an efficient catalyst for one pot synthesis of primary amides from iodobenzene.

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Experimental Section.

Materials.

All Chemicals purchased were of analytical grade. FeCl3.6H2O and MnCl2.4H2O was purchased from MS/ S.D fine Chemicals, iodobenzene derivatives were purchased from Alfa Aesar and used without further purifications.

1. Synthesis of Pd-MnFe2O4

The catalyst is prepared by sonochemical coprecipitation method with little modification without addition of any capping agent [1]. The Pd incorporated MnFe2O4 nanoparticles were prepared by adding PdCl2 and KCl [2] as electrolytes in to the reaction mixture of MnFe2O4. The MnFe2O4NPs were prepared by sonochemical assisted co-precipitation method. The aqueous solutions of iron (III) chloride (9.5 mmol, 50 mL) and manganese (II) chloride tetrahydrate (4.4 mmol, 50 mL) in distilled water were mixed together and placed in an ultrasonic bath (frequency 30 kHz and power of 150 Watts) . To this we added solution (50mL) of PdCl2 (60 mg) and KCl(0.5 g). The temperature of the bath was initially maintained at 27°C. 30 ml of 3M NaOH was added drop wise to this solution, with continuous ultrasound irradiation. The temperature of the bath was then increased up to 60°C and maintained for 30 min and open to the atmosphere which resulted in the blackish brown colored precipitate. The reaction temperature was slowly brought to 80°C, maintained for 1h and then aged overnight at room temperature. The blackish brown colored precipitate was then separated by filtration, washed several times with distilled water and finally with ethanol. The solid product was then further dried in an oven at 120°C for nearly two hour and
finally dried at 200°C for 4h to yield the ferrite catalyst. The synthesized sample by this method was named as Pd–MnFe2O4 MNPs.

Figure 1: TEM images for Pd-MnFe2O4 magnetic nanoparticles with different magnifications
Figure 2: BET surface area and inset corresponding BJH desorption dV/dD pore volume distribution plots.

2. General procedure for one pot synthesis of amides from iodobenene

A clean and dry glass vial charged with iodobenzene (1 mmol), K₄Fe (CN)₆ (0.25 mmol), K₂CO₃ (1.2mmol) and DMSO: H₂O (2:1) as a solvent system and Pd-MnFe₂O₄ (30 mg, 1mol% Pd). Then vial was screw capped with silicon septum and placed in a oil bath at 110°C and stirred for 18h. After completion of the reaction vial was cooled to room temperature, catalyst was separated magnetically. Water was (5ml) added to reaction mixture and extracted with ethyl acetate (10mL X 2 times). The organic layer is then dried over sodium sulphate. The crude product was purified by column chromatography
(Silica 60-120 mesh) using ether / ethyl acetate (20%) as eluent to give the pure product.

Purified product

was characterized by mass spectroscopy and $^1$H NMR techniques.
3. Spectral Data

$^1$HNMR spectra were recorded on Agilent 400MHz, Bruker 300 MHz instrument and $^{13}$C were recorded on 100MHz.

**Benzamide: (Table 2 Entry 1) (white solid); mp 126-128 °C**

GC-MS (EI, 70 eV) m/z (%): 121 (M$^+$, 74), 105 (99), 77 (100), 51 (37).

$^1$H NMR (300 MHz, CDCl$_3$): δ 7.92 (d, 2 H, 3J = 7.2 Hz, HAr), 7.55-7.52 (m,1H, HAr), 7.45-7.42 (m, 2 H, HAr), 3.40 (br, s, 2H, NH).  $^{13}$C (100 MHz, CDCl$_3$): δ169.8, 133.4, 132.0, 128.7, 127.35 ppm.

**2-Methyl Benzamide: (Table 2 Entry 3)**

(Off-white solid); 140-142 °C, GC-MS (EI, 70 eV) m/z (%): 135 (M$^+$, 81.), 119 (88), 91 (100), 65 (35), 44 (30). $^1$H NMR (300 MHz, CDCl$_3$): δ 7.47-7.37 (m, 3 H), 7.31-7.22 (m, 2 H), 2.50 (s, 3 H), δ 5.88 (br, s, 1 H, NH).  $^{13}$C NMR (100 MHz, CDCl$_3$): δ 171.9, 136.4, 135.0, 130.5, 127.0, 125.8, 20.0 ppm.

**4-Nitro, 3-Methyl benzamide: (Table 2 Entry 4)**

(Off white solid mp 166-168 ºC,) 1H NMR (400 MHz, DMSO D6): 8.59-8.39 (S, 1H), 8.1-8.3 (d, 1H), 7.73-7.46 (d, 1H), 2.44-2.57 (S, 3H) 13C(100 MHz): 166.06, 149.15, 136.34, 133.74, 133.4, 132.28, 123.84, 19.97 ppm.

GC-MS (EI, 70 eV) m/z (%): 163 (M$^+$, 100), 147(16.2), 118(36.7), 117(16.1), 89(38.2), 63(23.5), 44(26.8).

**2-Methoxy Benzamide (Table 2 Entry 5)**

(White solid); mp 126-127 ºC, GC-MS (EI, 70 eV) m/z (%): 151 (M$^+$, 24), 134 (87), 105 (86), 77 (81), 63 (26). $^1$H NMR (300 MHz, CDCl$_3$): δ 8.2 (dd, J = 8.0, 2.0 Hz, 1H),7.74 (br s, 1H), 7.50-7.45 (m, 1H), 7.09 (dt, J = 7.6, 0.8 Hz, 1H), 7.01 (dd, J = 8.4, 0.8 Hz, 1H), 6.04 (br s, 1H), 3.97 (s, 3H). $^{13}$C NMR (100 MHz, CDCl$_3$): δ167.0, 157.8, 133.4, 132.6, 121.3, 120.7, 111.3, 56.0 ppm.
2- Fluoro benzamide: (Table 2 Entry 6)

(Light brown solid mp 116-118 °C); GC-MS (EI, 70 eV) m/z (%): 139 (M^+, 75), 123 (100), 95 (90), 75 (34), 44 (19) \(^1\)H NMR (300 MHz, DMSO D₆): δ 7.8 - 7.5 (d, 2H), 7.6-7.4 (t, 1H). 7.1-7.3 (t 1H). \(^{13}\)C NMR (100 MHz, CDCl₃): δ 165.7, 160.9, 158.4, 132.93, 132.85, 130.6, 130.64, 124.8, ppm. 19F(DMSO 100 MHz) δ109.01 ppm

4-Methyl Benzamide (Table 2 Entry 7)

(White solid mp 158-160 °C);\(^1\)H NMR (400 MHz, DMSO D₆): δ 7.78-7.62 (dd, 2H), 7.38-7.15 (q, 2H) 2.3(s, 3H). \(^{13}\)C NMR (100 MHz, DMSO D₆): δ 168.15, 141.1, 131.2, 129, 127.1, 21.3. GC-MS (EI, 70 eV) m/z (%): 135 (M^+, 81,) 119 (88), 91 (100), 65 (35), 44 (30).

4-Methoxybenzamide (Table 2 Entry 8)

(White solid); mp 166-167 °C (lit mp 166 °C); \(^1\)H NMR (300 MHz, CDCl₃): δ 7.80-7.77 (m, 1H), 6.95-6.92 (d, 2H, 3J = 8.8 Hz, HAr), 6.0 (br, s, 1H, NH) 3.80 (s, 3 H, OCH₃). \(^{13}\)C NMR (100 MHz, CDCl₃): δ168.9, 162.6, 129.3, 125.5, 113.8, 55.0 ppm. GC-MS (EI, 70 eV) m/z (%): 151 (M^+, 51), 135 (100), 107 (18), 92 (19), 77 (34), 64 (14), 44 (12).

4-nitrobenzamide: (Table 2 Entry 9)

(White solid); mp 198-200 °C \(^1\)H NMR (400 MHz, DMSO D₆): δ 8.4-8.2 (d, 2H), 8.2-8.0 (d 2H) 7.8-7.6 (2H NH) \(^{13}\)C NMR (100 MHz, DMSO D₆): δ 167, 149, 141, 129, 124 ppm. GC-MS (EI, 70 eV) m/z (%): 166 (M^+, 61.1), 167(29), 150(100), 120(17.5), 104(35.3),75(27.5), 65(54), 50(32).

3,5 dimethoxy benzamide: (Table 2 Entry 10)

(off white solid 146-148 °C) \(^1\)H NMR (400 MHz, DMSO D₆): δ 8.1-7.78 (S, 1H), 7.5-7.2 (s, 1H), 7.15-6.8 (S, 2H) 6.15-.45 (S, 1H), 3.89 (s , 6H).\(^{13}\)C NMR (100 MHz, DMSO D₆): 167.7, 161.1, 137.4, 105.8, 103.5, 56.1; GC-MS (EI, 70 eV) m/z (%): 181 (M^+, 100), 165(75.4), 137(39), 122(28.9), 107(22.4), 77(18.4), 63(14.7), 44(10.3)

4-Bromobenzamide: (Table 2 Entry 11)

(off white solid); mp 192-193 °C \(^1\)H NMR (400 MHz, DMSO D₆): δ 8.1-7.7 (d, 2H), 7.7-7.3(d, 2H) \(^{13}\)C NMR (100 MHz, DMSO D₆): 167.3, 133.8, 131.6, 130, 125.4 ppm. GC-MS (EI, 70 eV) m/z (%): 201 (M^+, 49.4), 199(50.4), 184(94.6), 182(100), 157(40.9),
4-Chlorobenzamide: (Table 2 Entry 12)
(White solid); mp 170-172 ºC GC-MS (EI, 70 eV) m/z (%): 155 (M⁺, 53), 139 (100), 111(58), 75 (44), 50 (26), 44 (51) ¹H NMR (300 MHz, CDCl₃): δ 7.77 (d, J = 8.4 Hz, 2H), 7.45 (d, J = 8.8 Hz, 2H), 6.00 (br s, 2H). ¹³C NMR (100 MHz, CDCl₃): δ168.4, 133.7, 131.9, 130.5, 127.2 ppm.

3-Flurobenzamide: (Table 2 Entry 13)
(White solid); mp 115-117 ºC GC-MS (EI, 70 eV) m/z (%): 139 (M⁺, 75), 123 (100), 95 (90), 75 (34), 44 (19).¹H NMR (300 MHz, CDCl₃): δ 7.58-7.53 (d, 2H), 7.46-7.23 (d, 2H). 6.10 (br s, 2H).

2-chlorobenzamide:
(off white solid); mp 140-141 ºC ¹H NMR (400 MHz, DMSO D₆) δ-7.5 (d, 2H), 7.5- 7.19(m, 2H).
¹³C NMR (100 MHz, DMSO D₆):168.9, 138.1, 130.04, 130.02, 126.9. GC-MS (EI, 70 eV) m/z (%): - 155(M⁺ -48), 139(100), 141(35), 113(42) 111(12), 75(25), 50(15)

Nicotinamide.
(White solid); mp 127-128 ºC
¹H NMR (400 MHz, DMSO D₆) : 8.1(s, 1H), 8.7-8.6( d, 1H), 8.3-8.2(d, 1H), 7.8-7.4(dd, 1H).
¹³C NMR (100 MHz, DMSO D₆): 166.63, 152.2, 149.4, 140.3, 129.3, 123.88, GC-MS (EI, 70 eV) m/z (%): - 122(M⁺ 100), 106(72), 78(83), 94(8.9) 51(45)
4. Mass Spectrum, $^1$H NMR and $^{13}$C NMR spectrum.

Benzamide: (Table 2 Entry 1)
2-Methyl benzamide: (Table 2 Entry 5)
4-Methylbenzamide: (Table 2 Entry 9)
4-Methoxybenzamide (Table 2 Entry 10)
2-Methoxy Benzamide (Table 2 Entry 7)
2- Fluoro benzamide: (Table 2 Entry 8)
19F NMR
4-Chlorobenzamide: (Table 2 Entry 14)
2-chlorobenzamide: (Table 2 Entry 4)
4-nitrobenzamide: (Table 2 Entry 11)
4-Bromobenzamide: (Table 2 Entry 13)
4-Methyl 3-Nitro benzamide:  (Table 2 Entry 6)
3,5 dimethoxy benzamide: (Table 2 Entry 12)
3-Flurobenzamide: (Table 2 Entry 15)
Nicotinamide (Table 2 entry 16)