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Well-dispersed Pd nanoparticles on porous ZnO nanoplates via surface ion exchange for chlorobenzene-selective sensor

Zhenyu Feng,*[a] Cuiling Gao,[b] Xicheng Ma[a] and Jinhua Zhan[a]

Figure legends

Fig. S1. TEM images and EDS spectra of 1% Pd^{2+}@ZnO, 3% Pd^{2+}@ZnO, 5% Pd^{2+}@ZnO, and 10% Pd^{2+}@ZnO, and HRTEM image of porous ZnO nanoplate

Fig. S2. Pd 3d XPS spectra of 5% Pd^{2+}@ZnO and 5% Pd@ZnO

Fig. S3. Response/recovery curves of 5% Pd@ZnO and pure ZnO sensors towards chlorobenzene

Fig. S4. Responses of 5% Pd@ZnO sensor toward chlorobenzene in different relative humidity

Fig. S5. Responses of 5% Pd@ZnO and pure ZnO sensors toward chlorobenzene, 1,2-dichlorobenzene, and 1,3-dichlorobenzene

Fig. S6. Nitrogen adsorption-desorption isotherms of 5% Pd@ZnO and pure porous ZnO nanoplates with BJH pore size distribution insets

Table S1. Chlorobenzene-sensing comparation among results obtained in this work and reported in the literature

a. *Key Laboratory for Colloid and Interface Chemistry of Education Ministry, School of Chemistry and Chemical Engineering, Shandong University, Jinan, Shandong, 250100, P. R. China.*
b. *Shandong Institute for Product Quality Inspection, Jinan, Shandong, 250102, P. R. China.*
* Corresponding author. E-mail: fengzhenyu@sdu.edu.cn; Tel: +86 53188363768.

Fig. S1

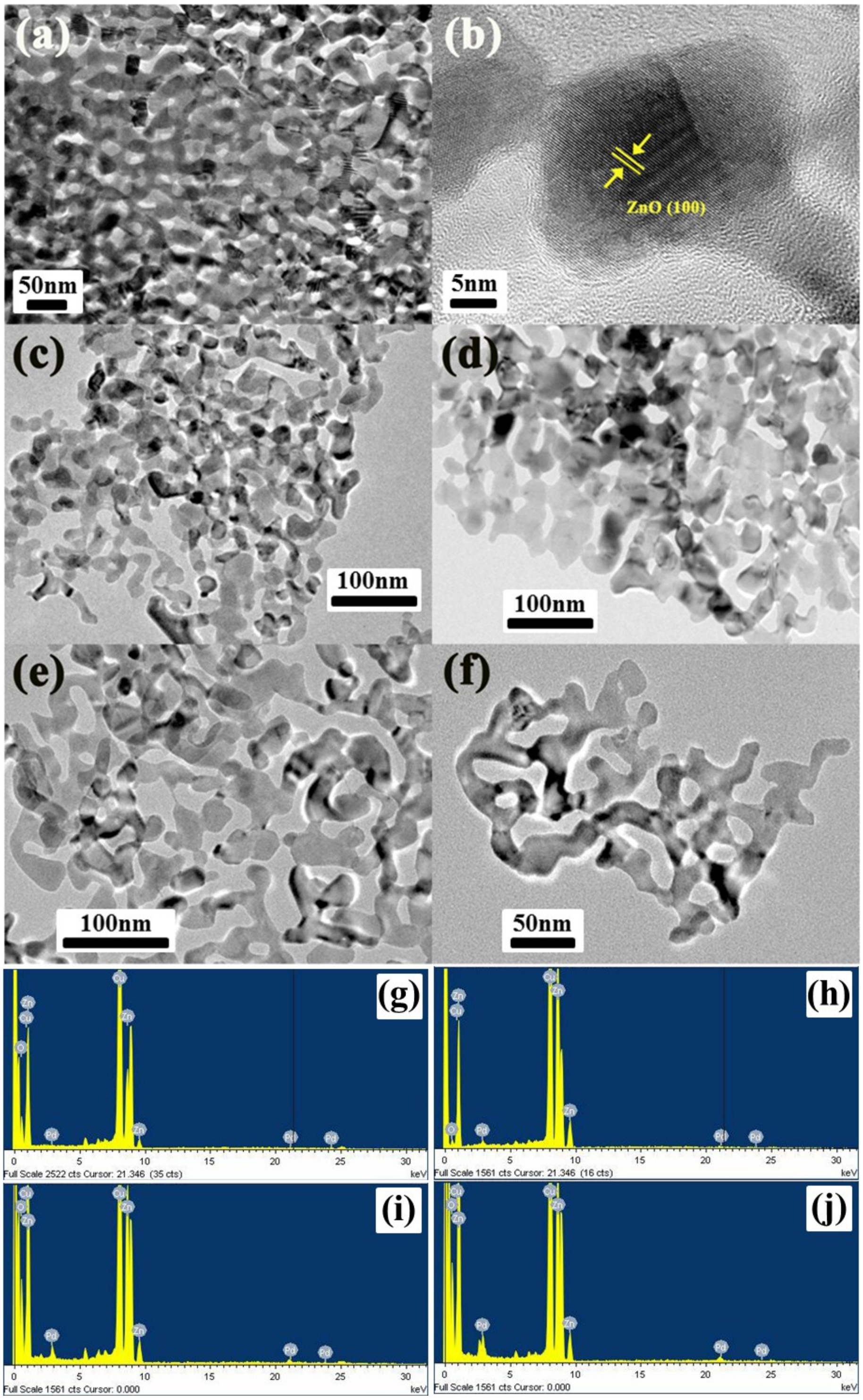

Fig. S1. (a), (c), (d), (e), and (f) represent TEM images of the pure ZnO, 1% Pd^{2+}@ZnO, 3% Pd^{2+}@ZnO, 5% Pd^{2+}@ZnO, and 10% Pd^{2+}@ZnO nanoplates, respectively. (b) shows HRTEM image of the pure ZnO nanoplate. (g), (h), (i), and (j) represent EDS spectra of the 1% Pd^{2+}@ZnO, 3% Pd^{2+}@ZnO, 5% Pd^{2+}@ZnO, and 10% Pd^{2+}@ZnO, respectively.

Fig. S2

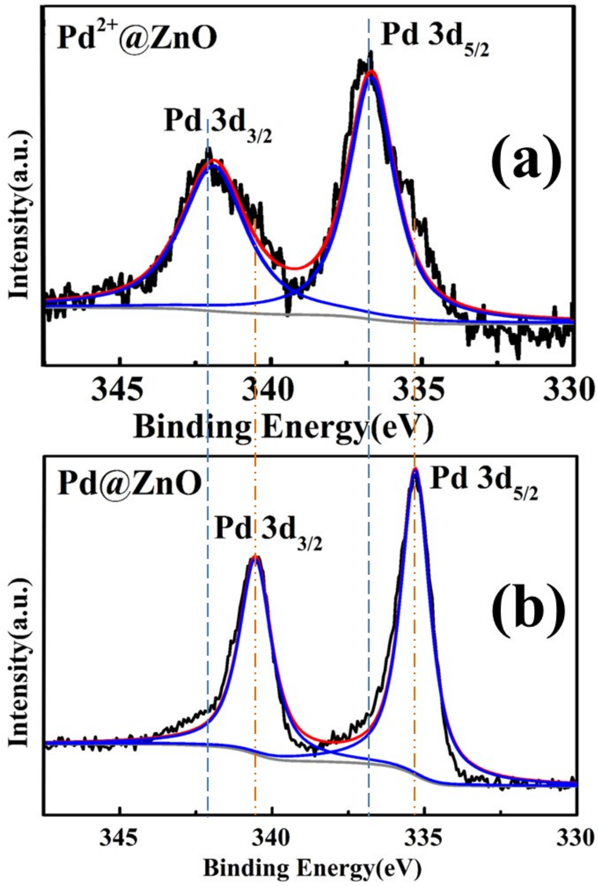

Fig. S2. Pd 3d XPS spectra of the obtained materials: (a) 5% Pd^{2+}@ZnO and (b) 5% Pd@ZnO.

Fig. S3

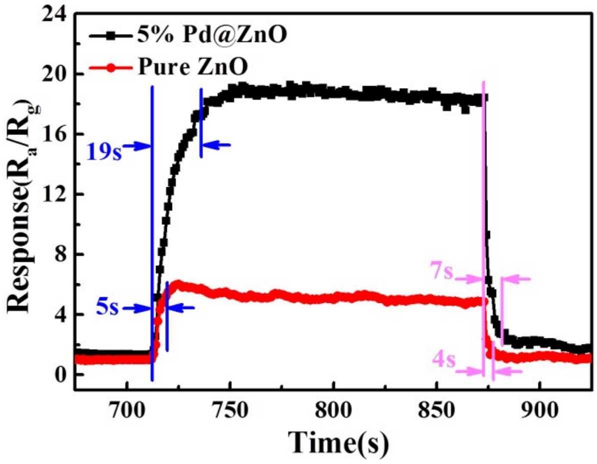

Fig. S3. Response/recovery curves of 5% Pd@ZnO and pure ZnO sensors towards chlorobenzene with 100 ppm at 440 °C.

Fig. S4

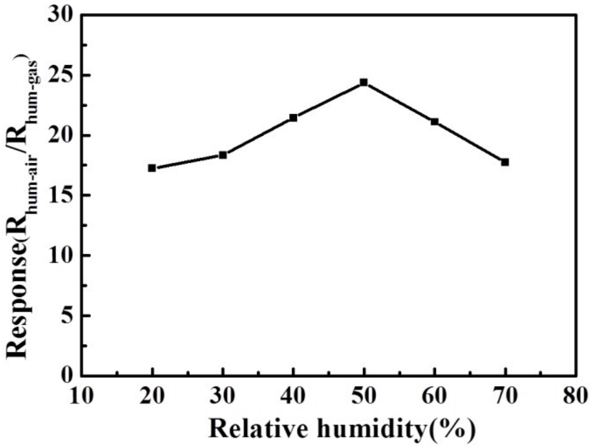

Fig. S4. Responses of 5% Pd@ZnO sensor toward 100 ppm chlorobenzene in different relative humidity at 440 °C. The response is defined as the ratio of sensor resistance ($R_{hum-air}$) in humid air to that ($R_{hum-gas}$) in humid air with 100 ppm chlorobenzene.

Fig. S5

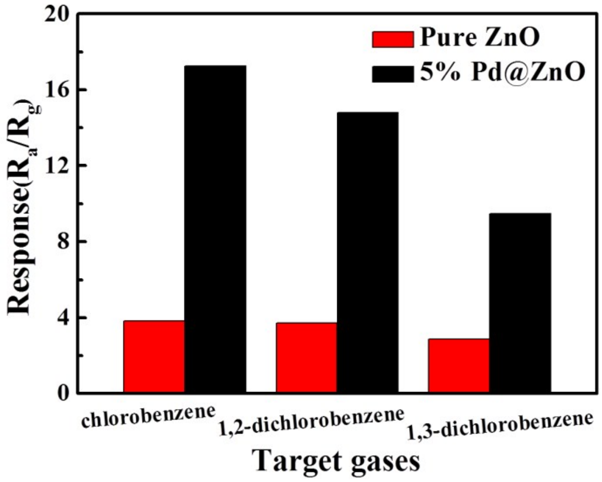

Fig. S5. Responses of 5% Pd@ZnO (black) and pure ZnO (red) sensors towards 100 ppm chlorobenzene compounds (gases) including chlorobenzene, 1,2-dichlorobenzene and 1,3-dichlorobenzene at 440 °C.

Fig. S6

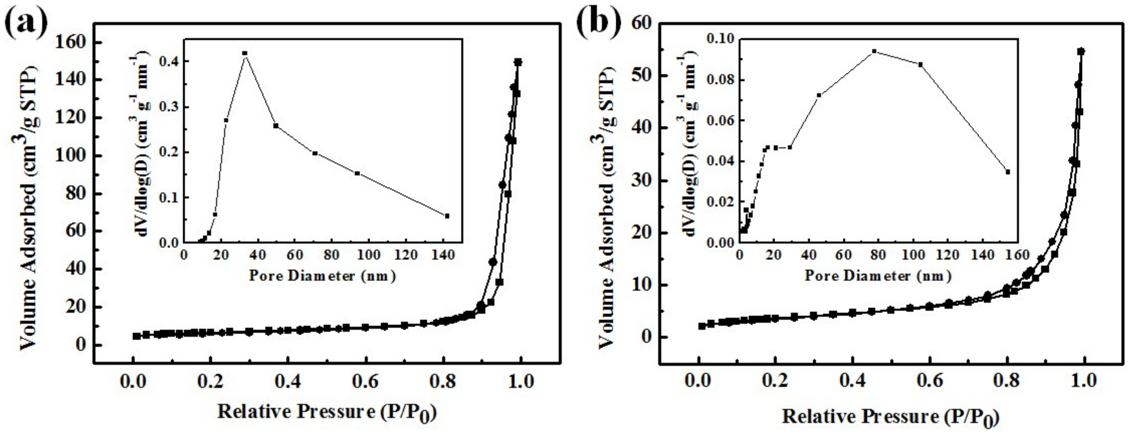

Fig. S6. Nitrogen adsorption-desorption isotherms with BJH pore size distribution insets of (a) pure porous ZnO nanoplates, (b) 5% Pd@ZnO. According to the IUPAC classification, the hysteresis loops corresponding to H3 type reveal the feature of mesoporous material. The specific surface areas of (a) and (b) are 23.28$\pm$0.01 and 12.94$\pm$0.01 m^2/g, respectively.

Table S1. Chlorobenzene-sensing comparation among results obtained in this work and reported in the literature.

Sensor materials	Initial response temperature (°C)	Detection limit	Selectivity study	Response/recovery time (s)	Ref.
Pd@ZnO	240	1 ppm	Yes	19/7	This work
Prussian blue film	25	24 ppm	Yes	18/12	[1]
Pt-decorated porous single-crystalline ZnO nanosheets	200	30 ppb	Yes	20/10	[2]
In-doped coral-like SnO_2 nanostructures	170	0.2 ppm	-	6.7/25.8	[3]
In_2O_3 nanorods and nanoparticles	270	10 ppm	-	-	[4]
Au-deposited porous single-crystalline ZnO nanoplates	260	2 ppm	-	10/14	[5]
Porous ZnO nanoplates	150	-	-	103/22	[6]

Based on different equipment and testing conditions, various gas-sensing materials show their features in chlorobenzene detection. The sensor materials in this work have enhanced response and selectivity compared to controlled ZnO sample, which also have acceptable chlorobenzene-sensing performance compared to results reported in the literature.

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