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Electronic Supplementary Information

Metal-organic framework derived Au@ZnO yolk-shell nanostructures and their highly sensitive detection of acetone

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1. Effect of the synthesis conditions on the morphology of Au@MOF-5

In our experiments, 100 mL autoclave was used. Compared with 25 mL autoclave used in the literature[1], the increase of reaction volume needs to change the concentration of $HAuCl_4$. Fig. S1(a) shows the TEM image of Au/MOF-5 synthesized with the same concentration of $HAuCl_4$ (0.025 g/ml) used in the literature. The results indicate that the core shell structure is not formed well. In our work, low $HAuCl_4$ concentration (0.004 g/mL) was used. The result showed that all Au nanoparticles were surrounded by MOF structure to form the core-shell structure. Moreover, the size of Au nanoparticles is relatively small.

Fig. S1(b) shows the TEM image of Au@MOF-5 synthesized by less dosage of PVP (2.0136 g). It can be observed that the size of Au@MOF-5 nanoparticles are about 270±30 nm without obvious change compared with the sample synthesized by using 5.8272 g PVP. But the size of Au core is 48±8 nm and obviously enlarged. Therefore, the size of Au nanoparticles can be tuned by using different PVP dosages.

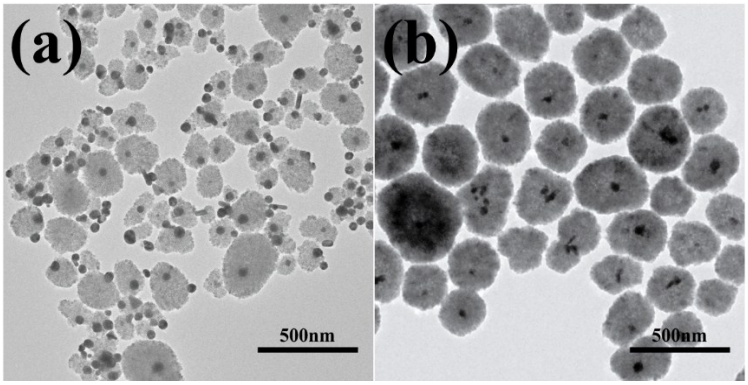

Fig. S1 TEM images of Au@MOF-5 prepared by using (a) 0.025 g/mL $HAuCl_4$ and (b) 2.0136 g PVP

2. XRD analysis of the prepared Au@MOF-5

Powder XRD pattern of Au@MOF-5 is shown in Fig. S2. The diffraction peaks of the prepared Au@MOF samples are identical to simulated crystal structure of the MOF-5 crystals as reported in the previous literature[2-4], indicating the successful preparation of MOF-5. The diffraction peaks of gold nanoparticles are very weak due to the low content.

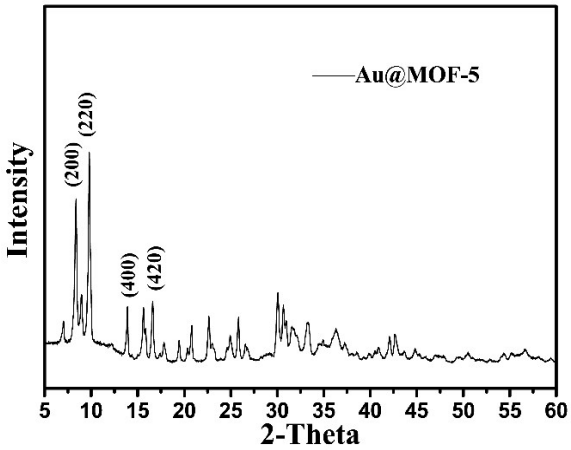

Fig. S2 XRD pattern of the prepared Au@MOF

3. Thermogravimetric analysis of Au@MOF

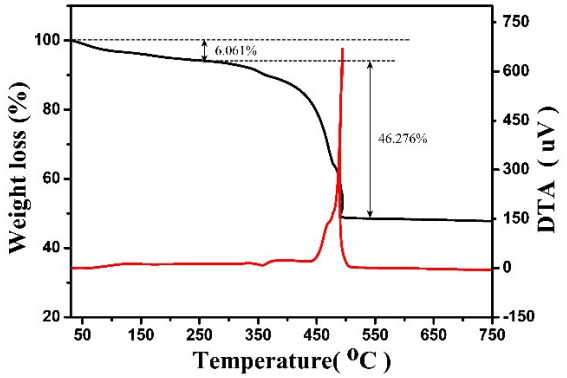

Fig. S3 Thermogravimetric analysis of the core-shell Au@MOF

In Fig. S3, the weightlessness of sample can be divided into two parts based on the change of mass loss rate. At the first step, mass loss rate decreased gradually with the temperature in the range of 30 °C to 200 °C. The weight lost mainly comes from the removal of guest molecule, such as water molecules and gas molecules existing in pore. At the second step, the organic ligands decompose and metal ions are oxidized, resulting in the formation of metal oxide. From the TGA figure, the weight loss percentage can be calculated as 46.62%, closing to the theory value of 44.57%.

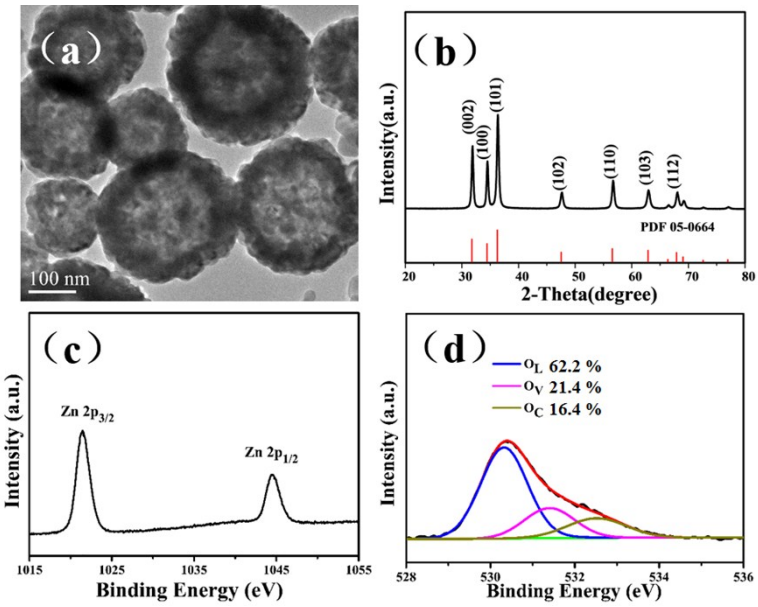

Fig. S4 TEM image (a), XRD pattern (b), and the Zn 2P (c) and O 1s (d) XPS spectra of ZnO hollow spheres

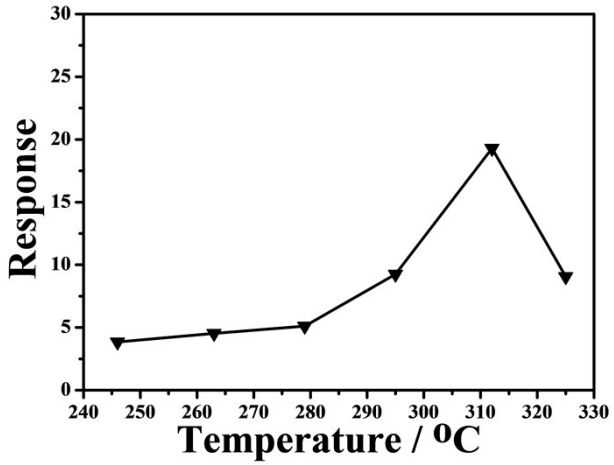

Fig. S5 Responses of Au@ZnO to ethanol at different operating temperatures

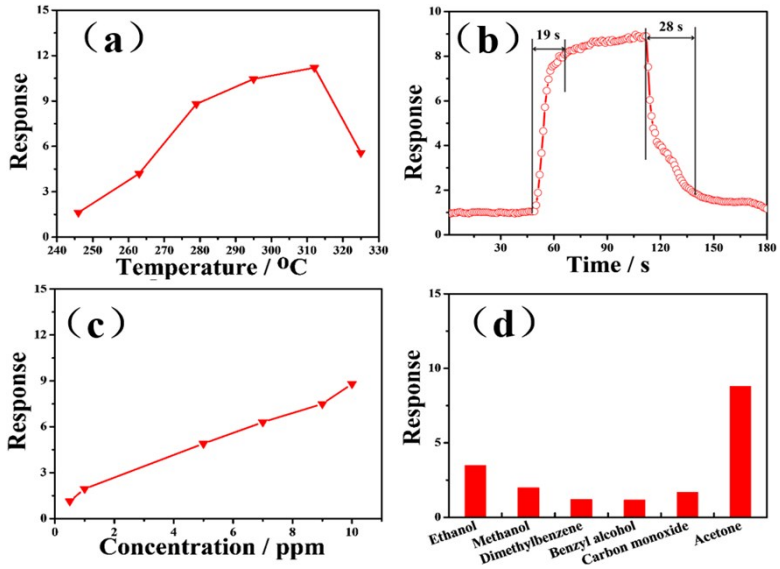

Fig. S6 Sensing properties of ZnO hollow spheres: responses to 10 ppm acetone at different operating temperatures (a); response-recovery curve to 10 ppm acetone (b); response to different concentrations of acetone (c); responses to 10 ppm different toxic gases (d)

References

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