

Electronic Supplementary Information (ESI) for

**Megranate-Like Nanoreactor with Multiple Cores and an
Acidic Mesoporous Shell for a Cascade Reaction**

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Synthesis of silica nanorattles-SH: Silica nanorattles-SH were prepared according to literatures with some minor modifications. In a typical reaction, solution A (2 mL of TEOS in 18 mL of ethanol), solution B (20 mL of 28 wt % aqueous NH_3 and 60 mL of ethanol) and solution C (100 μL of TSD in 8 mL of ethanol) were prepared. Solution A (5 mL) was added dropwise into solution B and reacted for 10min under vigorously stirring to form the cores. Then, solution C and identical volume of solution A were added into the reaction mixture synchronously at a rate of 1 mL/min, to form the middle layer of organicsilica framework. Lastly, remaining solution A and MPTMS (60 μL) were added to form the outer layer of silica shell. The reaction was kept for 3 hours at 30 °C. The hybrid silica spheres were isolated by centrifugation and washed with ethanol and water repeatedly and lastly resuspended in water. Silica nanorattles-SH were produced by etching the as-prepared hybrid silica spheres with 10 wt % HF (aqueous solution). Briefly, a certain amount of 10 wt % HF was added dropwise into silica nanorattles-SH suspension, stirring for 10 min. The product was sufficiently washed repeatedly with water.

Synthesis of silica nanorattles-SO₃H: Silica nanorattles-SO₃H were prepared according to literatures with some minor modifications. The silica nanorattles-SH (1.0 g) were dispersed in H_2O_2 (40 g, 30 wt %) and stirred at RT for 24 h before centrifugation. The dried silica nanorattles-SO₃H (1.0 g) were then stirred in HCl (200 mL, 0.01 M) for 12 h at RT for acidification. After being thoroughly washed with deionized water, the solid product was dried at 60 °C overnight.

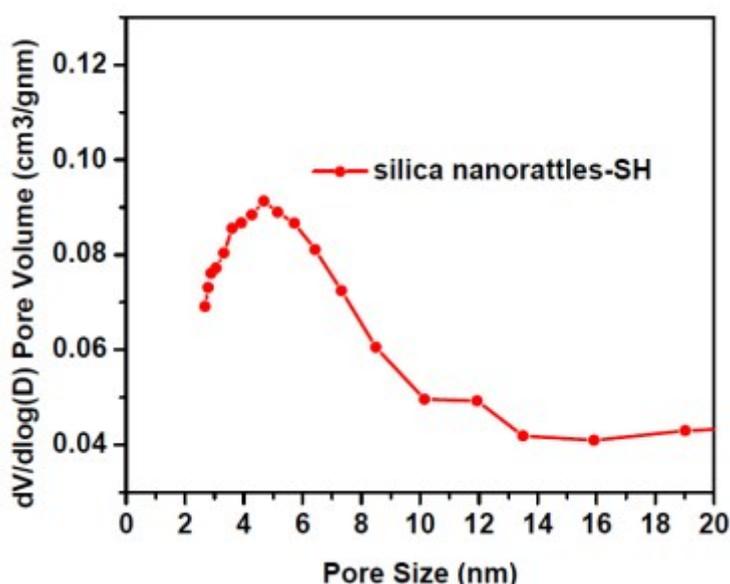


Fig. S1 Pore size distribution obtained from the BJH model applied to the adsorption branch of silica nanorattles-SH

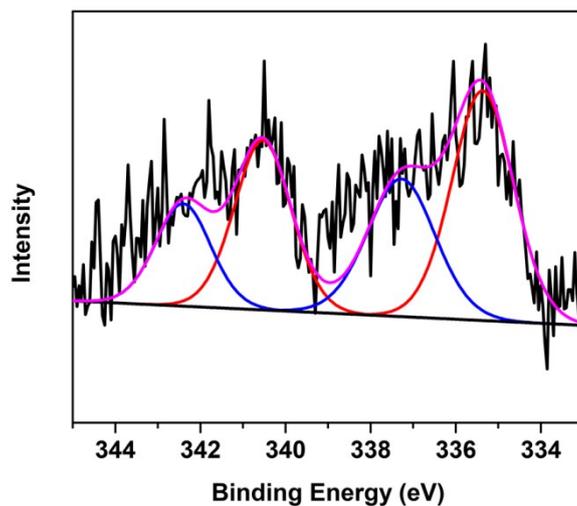


Fig. S2 Pd 3d XPS spectra of megranate-like of Pd-silica nanorattles-SO₃H

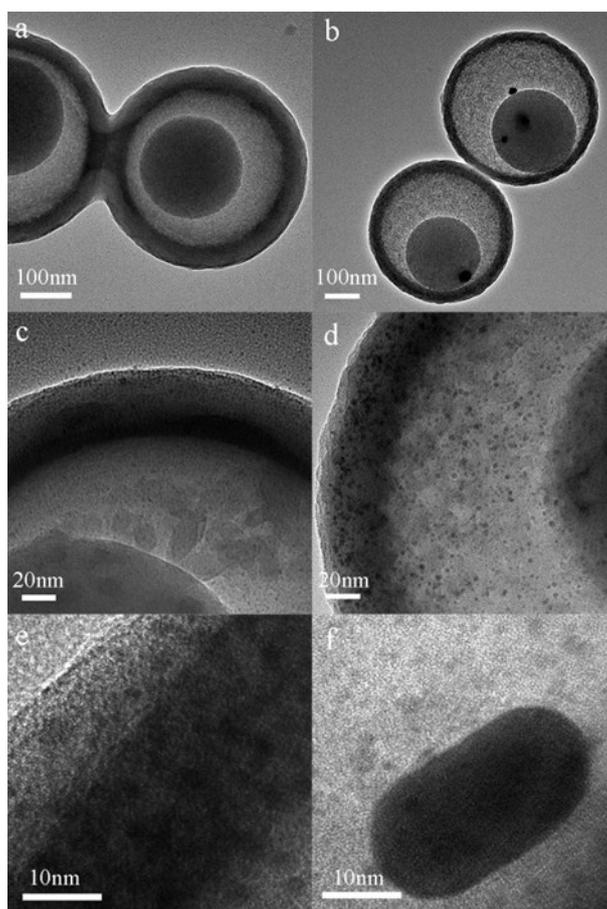


Fig. S3 a, b) TEM images, and c, d, e, f) HRTEM images of (a, c, e) Pt-silica nanorattles-SH; (b, d, f) Au-silica nanorattles-S

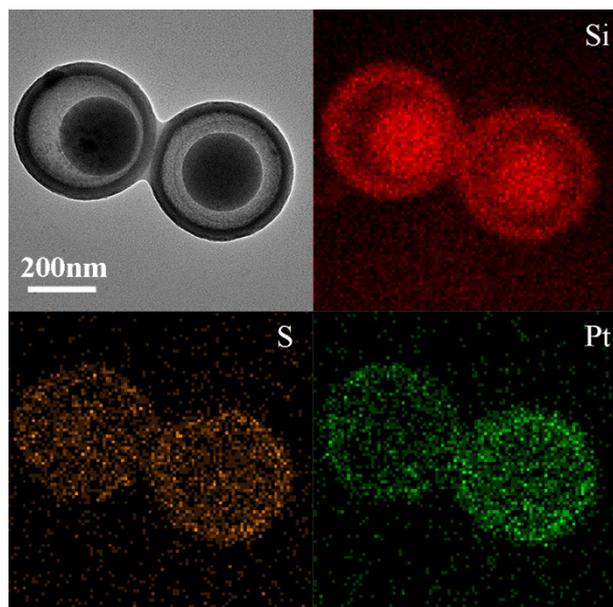


Fig. S4 Elemental mappings of Pt-silica nanorattles-SH

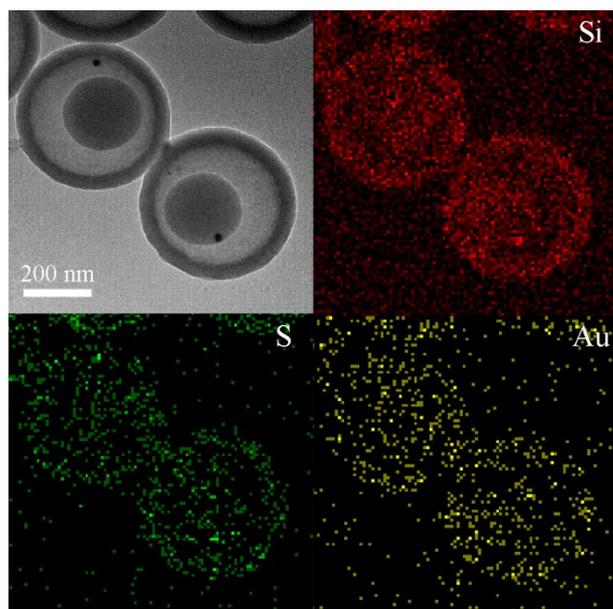


Fig. S5 Elemental mappings of Au-silica nanorattles-SH

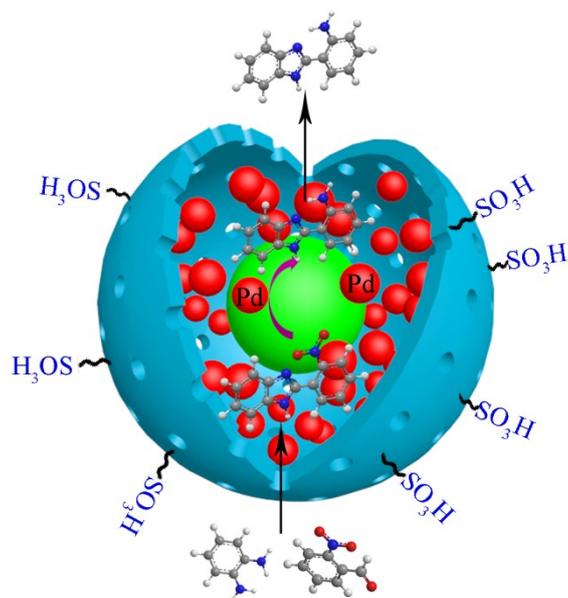


Fig. S6 Schematic illustration the megranate-like Pd-silica nanorattles-SO₃H as a nanoreactor for the cascade reaction

Characterization data for 2-(2-nitrophenyl)-1H-benzimidazole

¹H-NMR (300 MHz, (CD₃)₂SO): δ 8.42 (s, 4H), 7.67 (s, 2H), 7.28 (m, 2H), 3.33 (s, 1H).

HRMS ESI: [M+H]⁺, for [C₁₃H₉N₃O₂+H]⁺ calcd. 240.1; found 240.2.