Electronic Supplementary Material (ESI) for RSC Advances

Electronic Supporting Information

Heteropolytungstic Acids Incorporated in Ordered Mesoporous Zirconia Framework as Efficient Oxidation Catalysts

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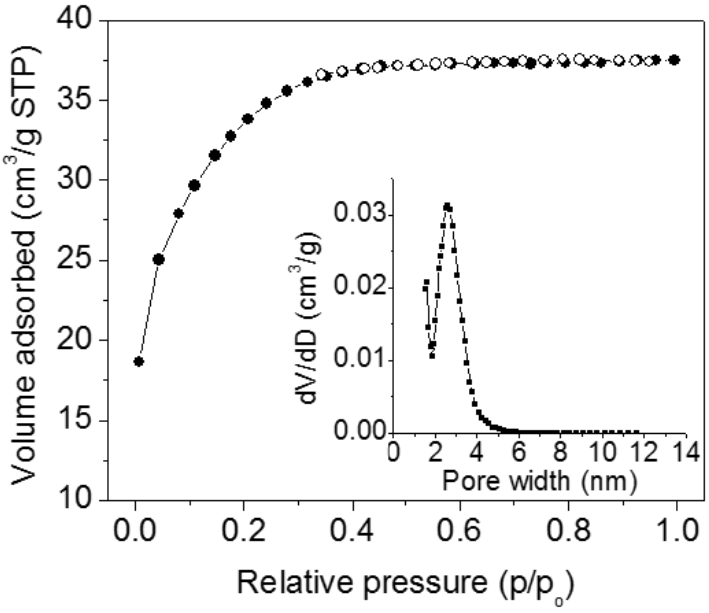

Fig. S1 Nitrogen adsorption and desorption isotherms at 77K of mesoporous zirconia (*meso*-ZrO_2). Analysis of the adsorption data with the BET method gives surface area of 118 m^2g^{-1} and pore volume of 0.06 cm^3g^{-1}. Inset: the NLDFT pore size distribution calculated from the adsorption branch, indicating mesopore diameter of 2.5 nm.

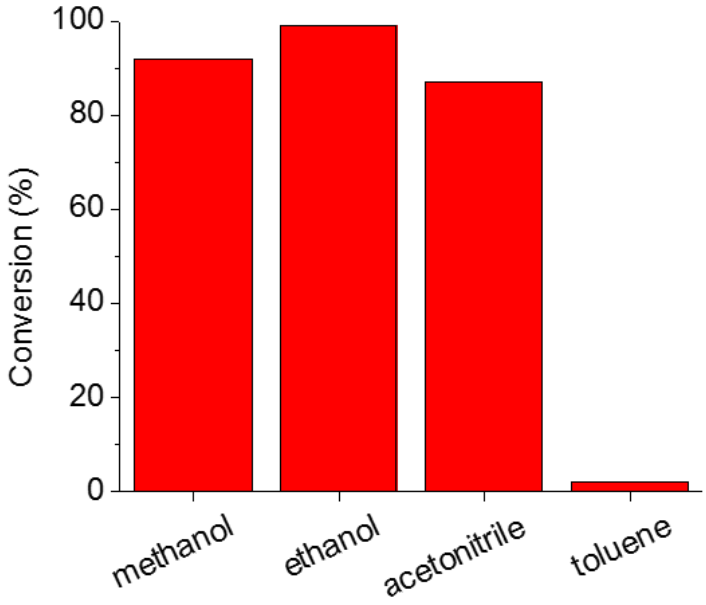

Fig. S2 Oxidation of 1,1-diphenyl-2-methylpropene over ZrSTA(5) catalyst in different media. *Experimental conditions*: 0.1 mmol substrate, 0.5 mmol catalyst (containing 2 mol% STA), 3 equiv. H_2O_2 (30% in water), 3 mL ethanol, 50 ^oC, 1 h.

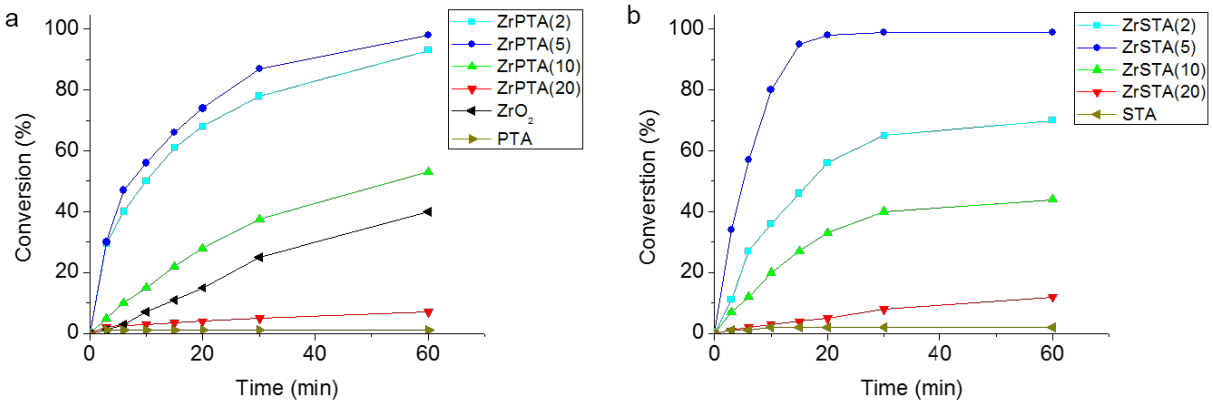

Figure S3. Time evolution of 1,1-diphenyl-2-methylpropene oxidation catalyzed by hydrogen peroxide using mesoporous zirconia (*meso*-ZrO_2), ZrPTA(*w*) and ZrSTA(*w*) materials and PTA ($H_3PW_{12}O_{40}$) and STA ($H_4SiW_{12}O_{40}$) compounds as catalysts.

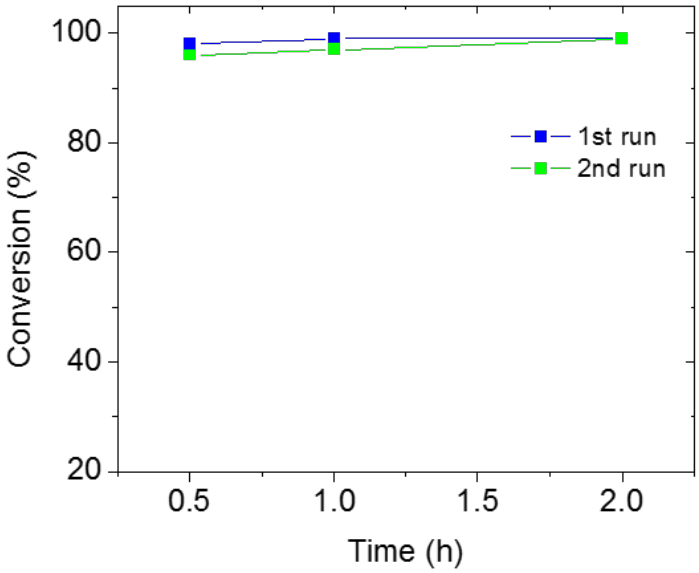

Figure S4. Recycling study of the mesoporous ZrSTA(5) catalyst (*experimental conditions:* 0.1 mmol of 1,1-diphenyl-2-methylpropene, 0.5 mmol of catalyst (containing 2 mol% STA), 3 equivalent of H_2O_2 (30% in water), 3 mL of ethanol, 50 ^oC).

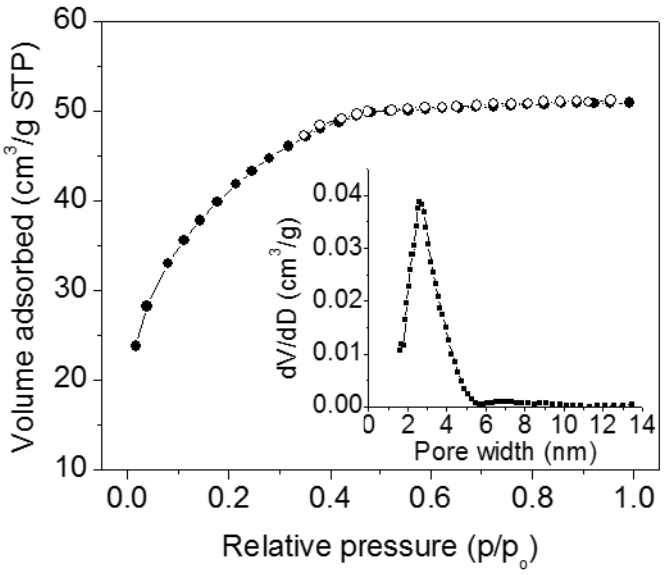

Figure S5. N_2 adsorption and desorption isotherms at 77K of reused ZrSTA(5) catalyst. Analysis of the adsorption data with the BET method gives surface area of 149 m^2g^{-1} and total pore volume of 0.08 cm^3g^{-1}. Inset: the corresponding NLDFT pore size distribution, indicating pore size of ~2.6 nm.

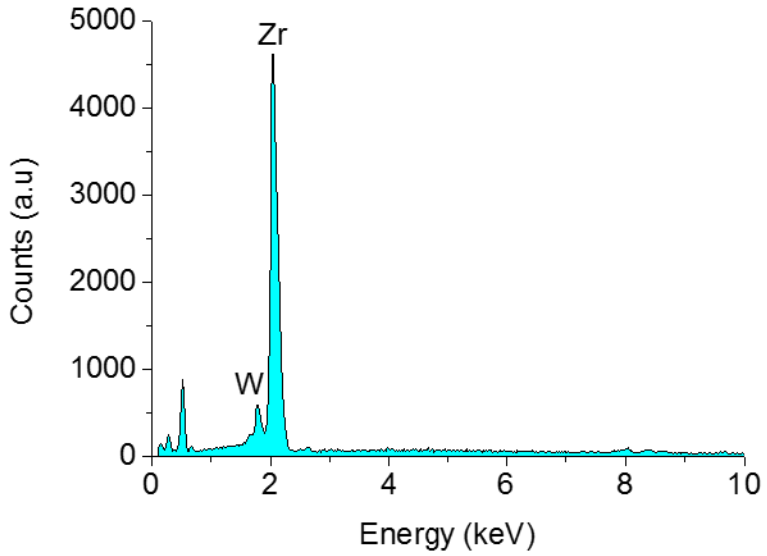

Figure S6. Typical EDS-SEM microanalysis spectrum obtained from the ZrSTA(5) sample after catalytic reactions.

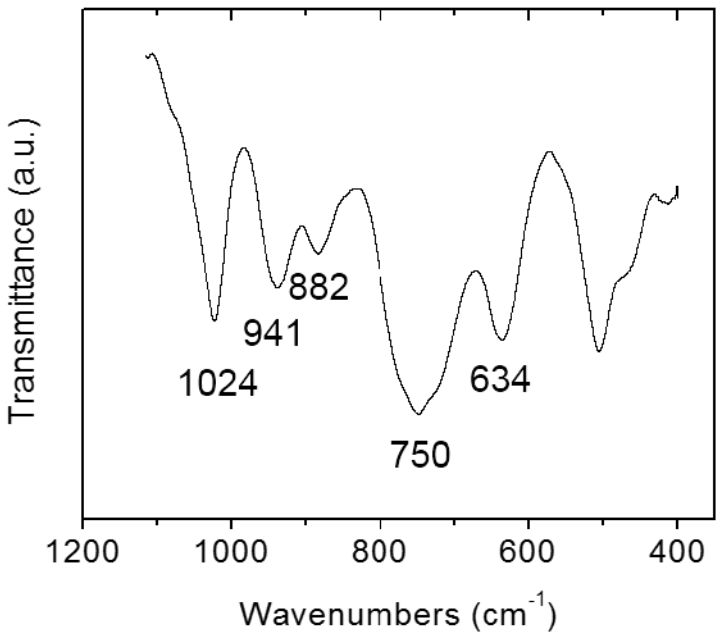

Figure S7. IR spectrum of reused ZrSTA(5) catalyst, showing intense absorption peaks at ~1024, ~941 and ~882 cm^{-1} that are attributed to the stretching vibrations of Si–O, W=O_d and W–O_b–W bonds in the $[SiW_{12}O_{40}]^{4-}$ Keggin clusters. The strong absorption peaks at ~750 and ~634 cm^{-1} are assigned to the stretching vibration bands of Zr–O and Zr–O–Zr of zirconia matrix, respectively