

Supplementary Materials

Production of H₂-Free Carbon Monoxide from Formic Acid

Dehydration: The Catalytic Role of Acid Sites in Sulfated Zirconia

Hyun Ju Lee ^{1,†}, Dong-Chang Kang ^{2,†}, Eun-Jeong Kim ³, Young-Woong Suh ⁴, Dong-Pyo Kim ², Haksoo Han ^{1,*}, Hyung-Ki Min ^{5,*}

¹ Department of Chemical and Biomolecular Engineering, Yonsei University, Seoul 03722, Korea.

² Department of Chemical Engineering, Pohang University of Science and Technology (POSTECH), Pohang 37673, Korea.

³ School of Energy and Chemical Engineering, Ulsan National Institute of Science and Technology (UNIST), Ulsan 44919, Korea.

⁴ Department of Chemical Engineering, Hanyang University, Seoul 04673, Korea.

⁵ LOTTE Chemical Research Institute, Daejeon 34110, Korea.

* Correspondence: hshan@yonsei.ac.kr (H.H.); pulcherrima7@gmail.com (H.-K.M.)

[†]These authors contributed equally to this work.

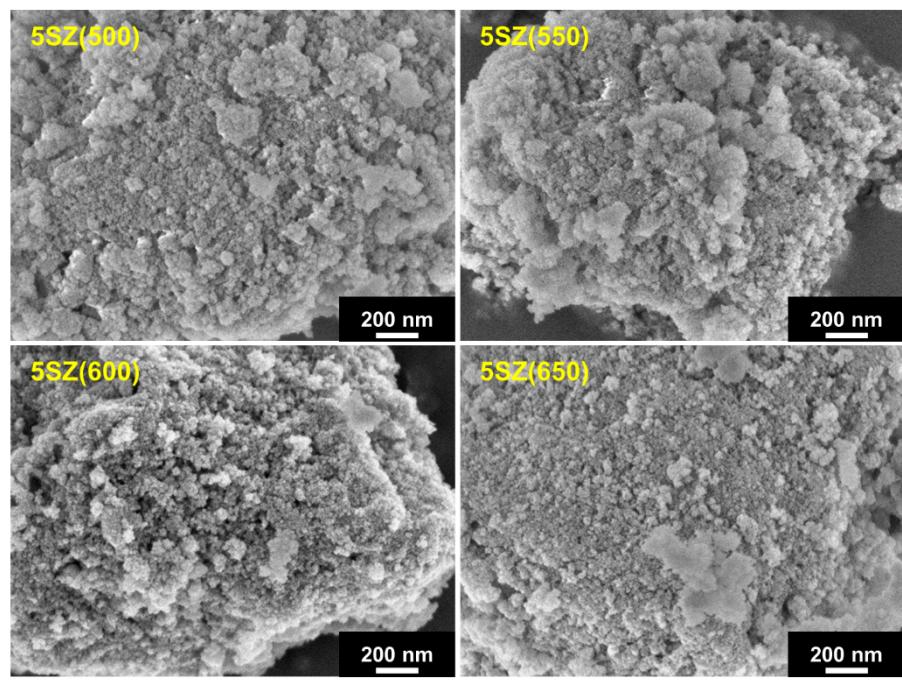


Figure S1. Scanning electron microscope (SEM) images of 5SZ(y) catalysts.

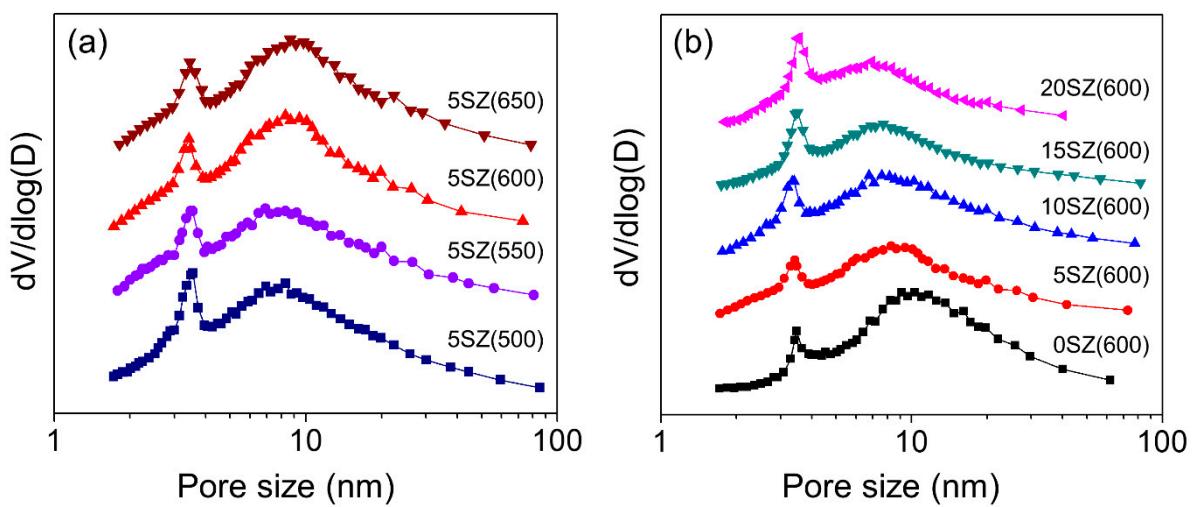


Figure S2. Pore size distribution of (a) $5\text{SZ}(y)$ and (b) $x\text{SZ}(600)$ catalysts calculated from the desorption branch.

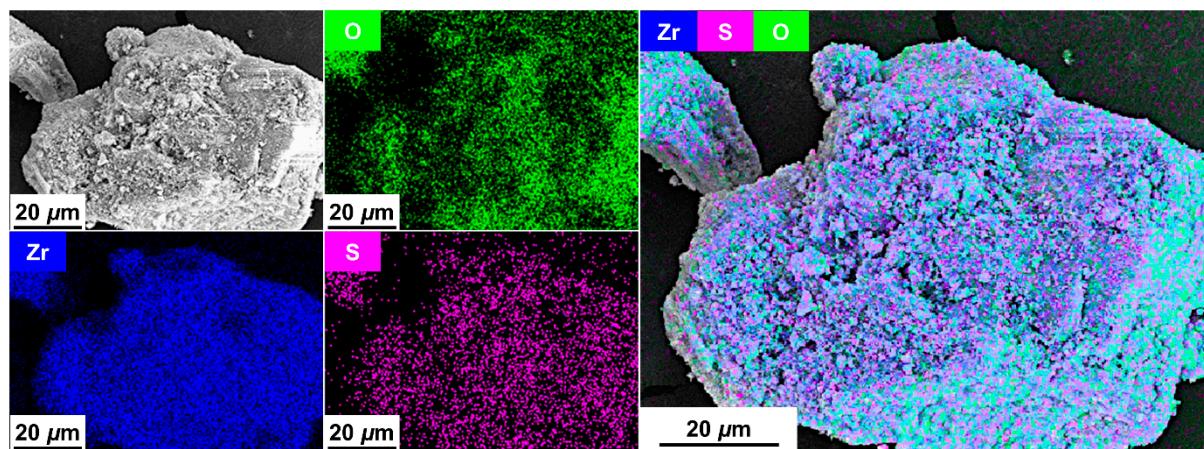


Figure S3. Scanning electron microscope–energy dispersive X-ray spectroscopy (SEM-EDS) images of 5SZ(600) catalyst.

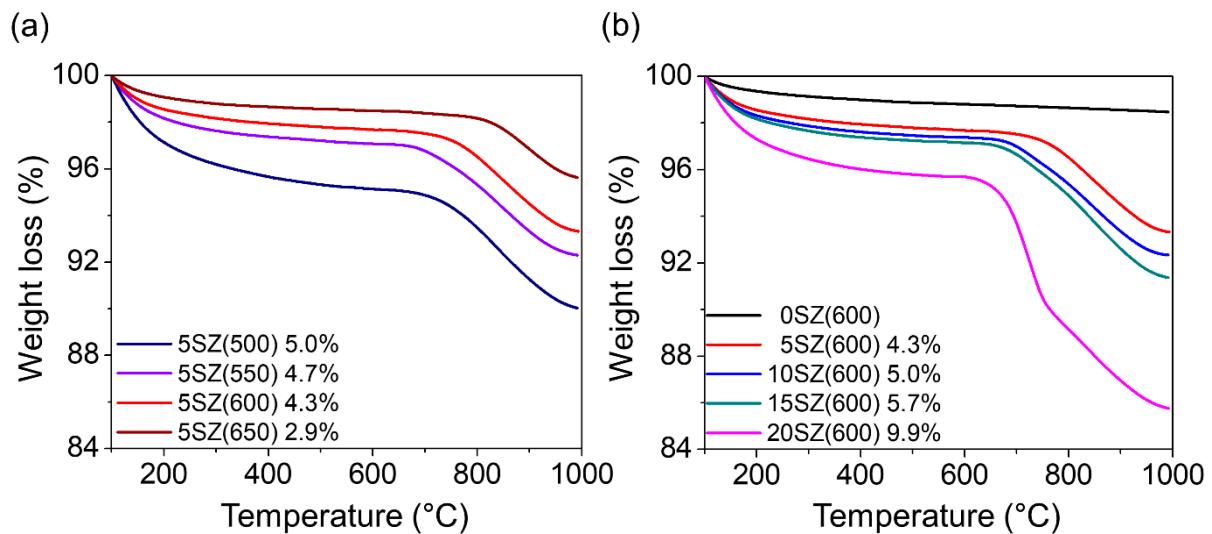


Figure S4. Thermogravimetric analysis profiles of (a) 5SZ(y) and (b) x SZ(600) catalysts.

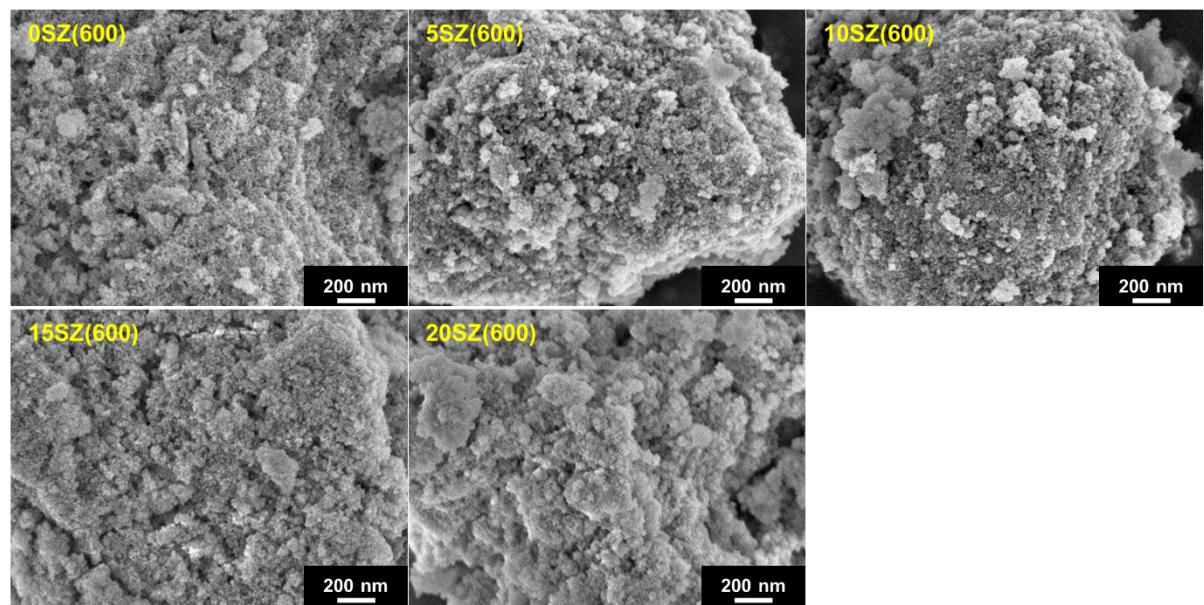


Figure S5. SEM images of x SZ(600) catalysts.

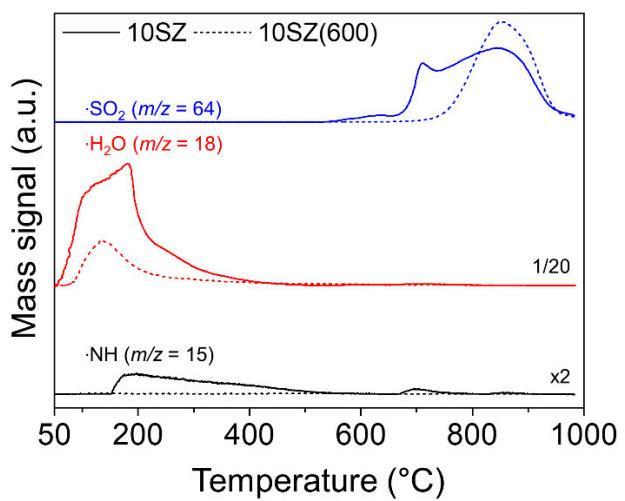


Figure S6. Evolution of $\cdot\text{NH}$ ($m/z = 15$), $\cdot\text{H}_2\text{O}$ ($m/z = 18$), and $\cdot\text{SO}_2$ ($m/z = 64$) in mass spectra as a function of temperature during temperature-programmed decomposition of as-prepared 10SZ (solid line) and calcined 10SZ(600) (dashed line) catalysts.

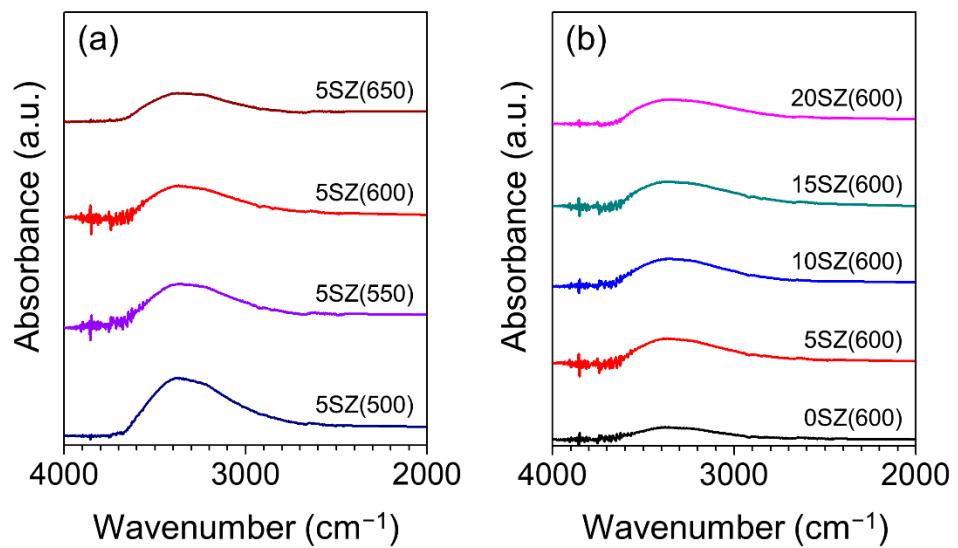


Figure S7. FT-IR spectra of (a) $5\text{SZ}(y)$ and (b) $x\text{SZ}(600)$ in the range of 2000 – 4000 cm^{-1} .

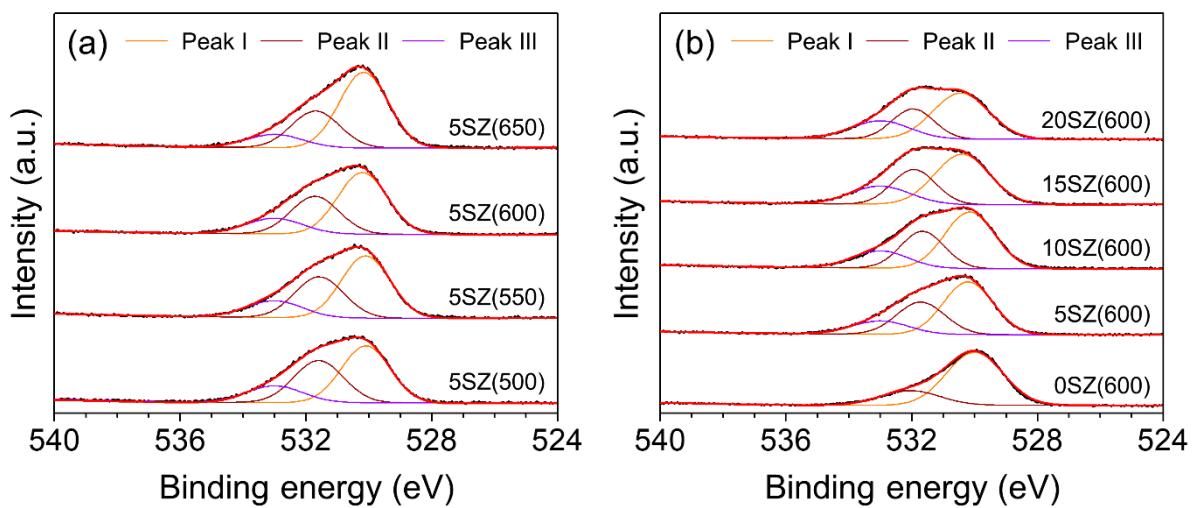


Figure S8. Deconvoluted O 1s XPS spectra for (a) 5SZ(y) and (b) x SZ(600) catalysts.

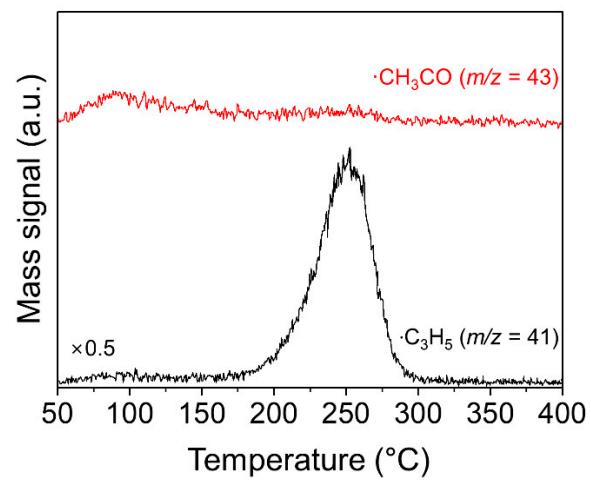


Figure S9. Evolution of $\cdot\text{CH}_3\text{CO}$ ($m/z = 43$) and $\cdot\text{C}_3\text{H}_5$ ($m/z = 41$) in mass spectra as a function of temperature during IPA-TPD of 0SZ(600).

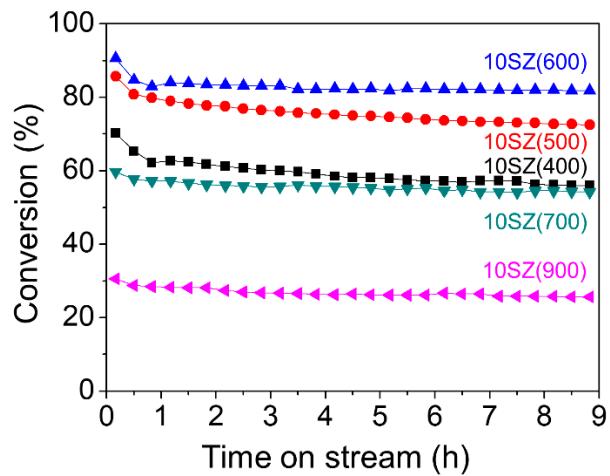


Figure S10. Formic acid conversion as a function of time on stream over 10SZ(y) catalysts at 260 °C and 6.0 h⁻¹ WHSV.