

Electronic Supplementary Information

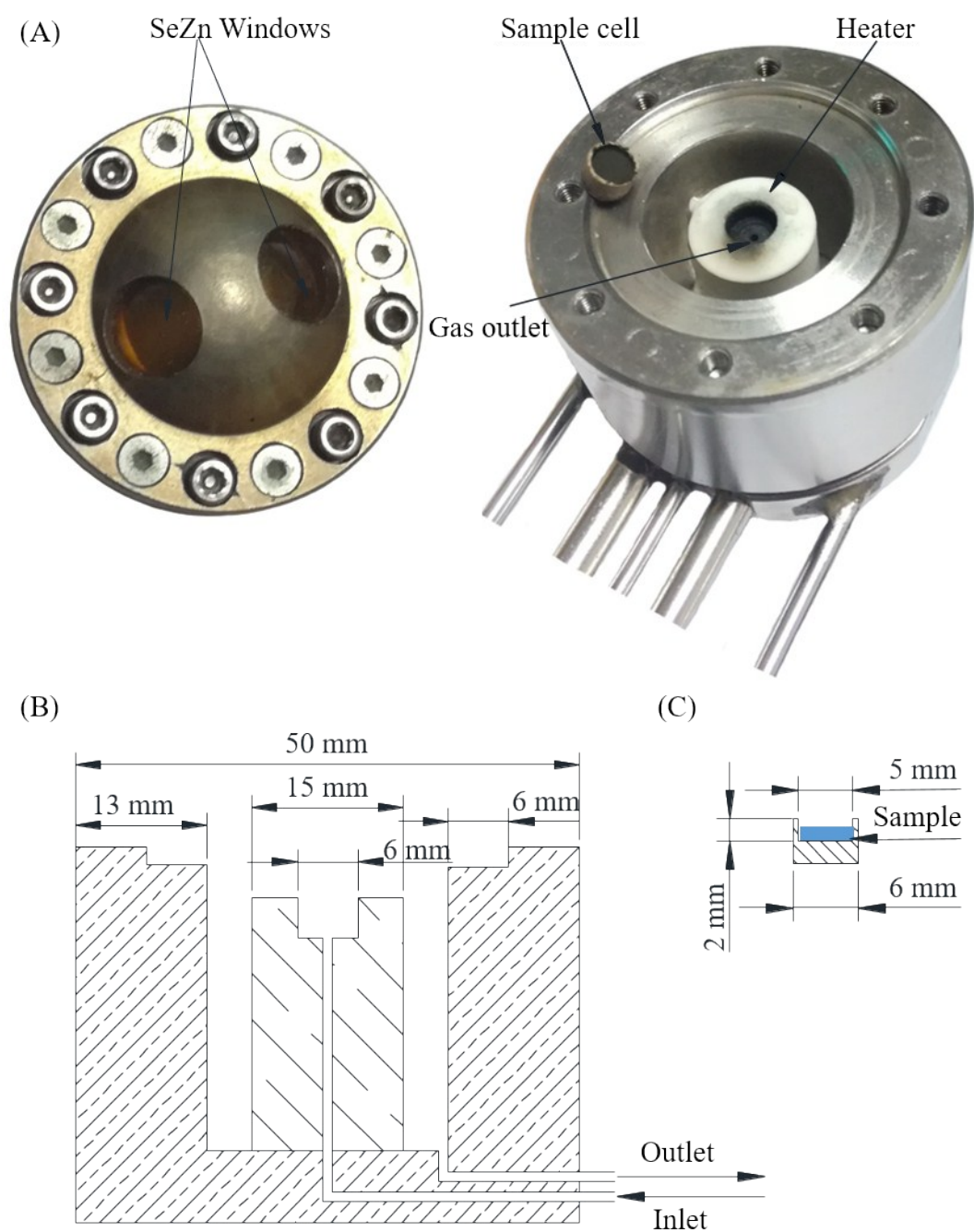


Fig. S1. Image of high temperature DRIFTS reactor cell (A), schematic representation of high temperature DRIFTS cell (B) and sample cell (C).

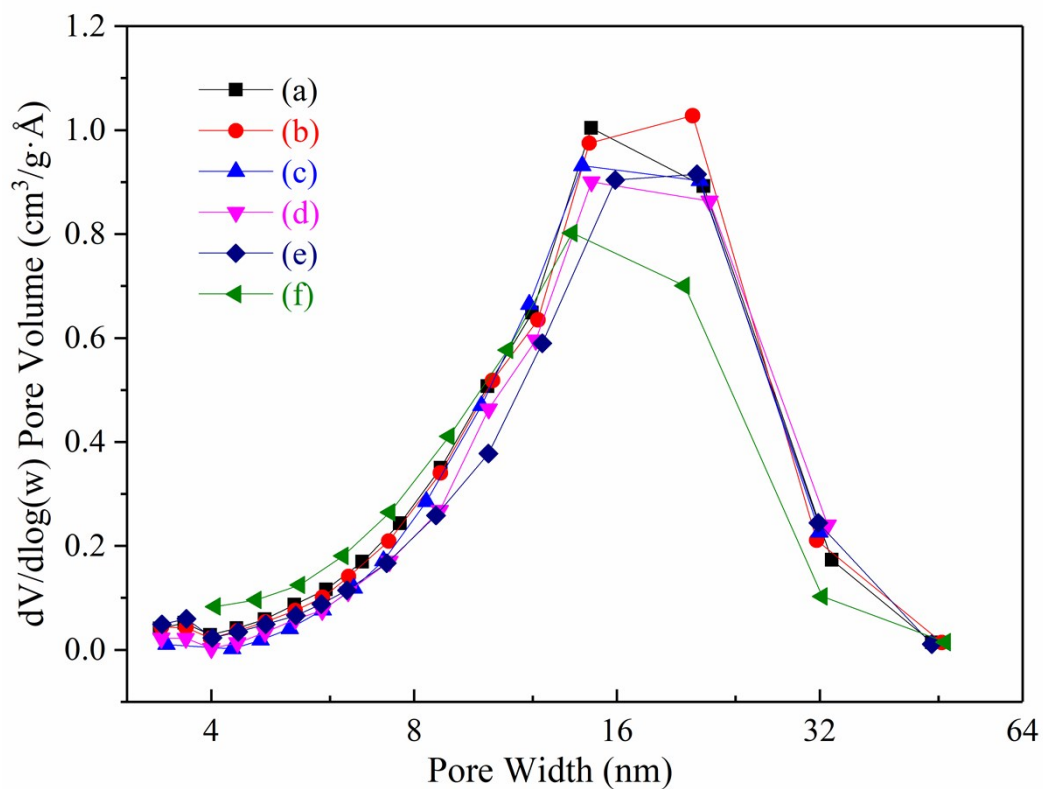


Fig. S2. The pore size distributions of fresh catalysts: (a) Co/Si, (b) Co/NbSi-1, (c) Co/NbSi-2, (d) Co/NbSi-3, (e) Co/NbSi-4, and (f) Co/NbSi-5. It is clear that a pore size distribution around 6~48 nm was observed for each catalyst sample, while the average pore sizes of the samples are approximately 14 nm.

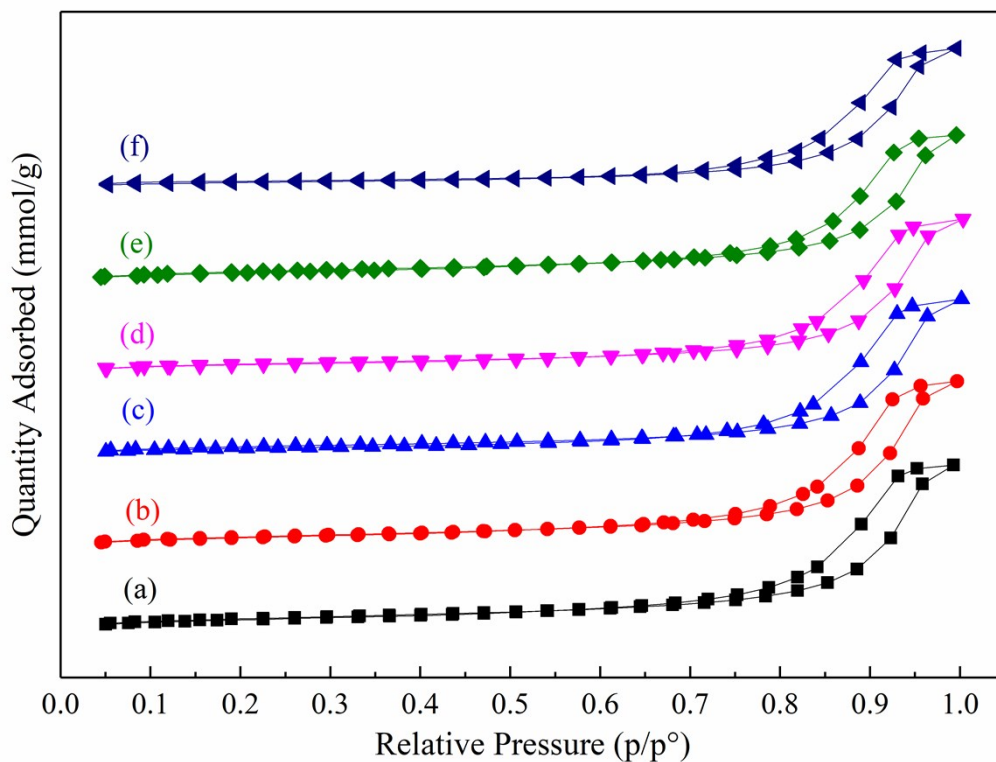


Fig. S3. N₂ adsorption and desorption isotherms of fresh catalysts: (a) Co/Si, (b) Co/NbSi-1, (c) Co/NbSi-2, (d) Co/NbSi-3, (e) Co/NbSi-4, and (f) Co/NbSi-5. The isotherms of catalysts exhibit classical irreversible IV type adsorption behavior, with a distinct H1 hysteresis loops. The condensation step on the isotherm at 0.5 to 0.95 indicated the presence of large mesoporous in the catalysts, which can provide channels for rapid large molecular transportation.

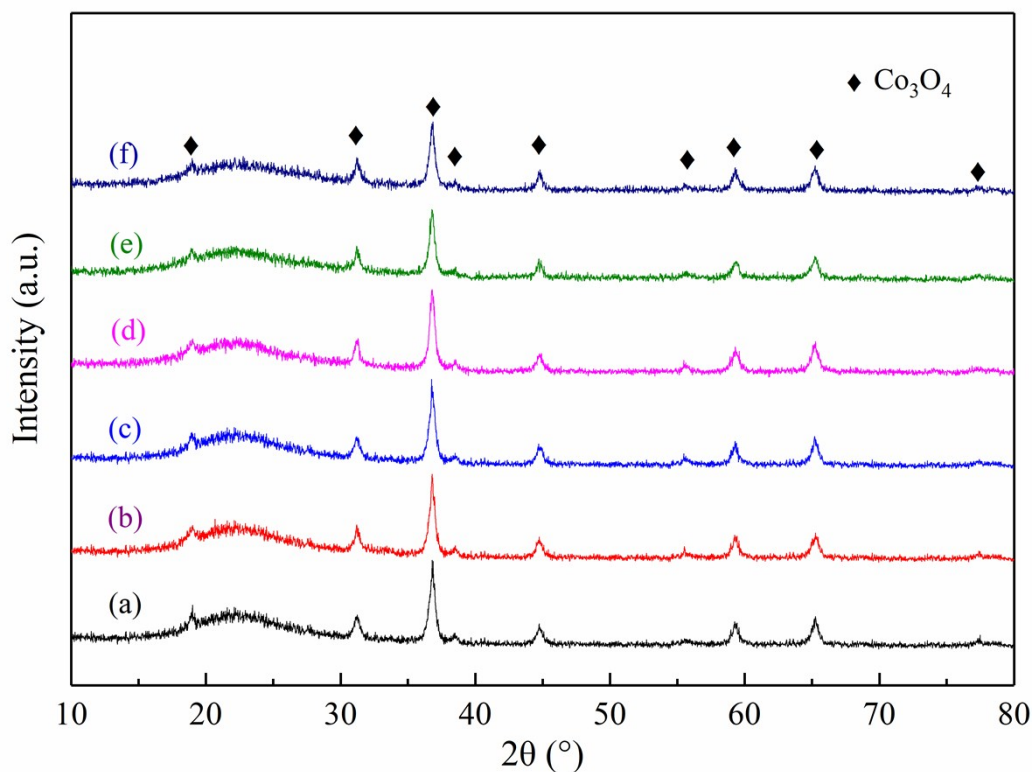


Fig. S4. XRD patterns of the calcined catalysts: (a) Co/Si, (b) Co/NbSi-1, (c) Co/NbSi-2, (d) Co/NbSi-3, (e) Co/NbSi-4, and (f) Co/NbSi-5. The diffraction peaks observed at $2\theta = 19.0^\circ, 31.2^\circ, 36.8^\circ, 44.8^\circ, 55.6^\circ, 59.3^\circ,$ and 65.2° are in accordance with the corresponding crystal of spinel Co_3O_4 crystalline phase¹. Also, a broad peak at about 22° (from 15° to 30°) for each sample indicates the presence of amorphous silica.² And no niobium species was significantly detected from XRD profiles, possibly owing to a low crystallinity of NbO_x at a low concentration. Therefore, no obvious peaks corresponding to Nb_2O_5 was observed.

References

- 1 A. Y. Khodakov, *Catal. Today*, 2009, **144**, 251.
- 2 M. Nurunnabi and S. Q. Turn, *Fuel Process. Technol.*, 2015, **130**, 155.