Synthesis of a $SiO_2/Co(OH)_2$ Nanocomposite Catalyst for SO_X/NO_X Oxidation in Flue Gas

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Preparation of Stöber silica. The precursor tetraethyl orthosilicate (TEOS) (0.59 M) was dissolved in isopropanol and hydrolyzed by adding 7.19 M ammonium hydroxide (25% NH_4OH in water). The solution was stirred for 24 h. Then, the silica was washed with water-ethanol solution (1:1) and dried for 16 h at 50°C. The resulting 500 nm SiO_2 nanoparticles are shown in Figure S1. Before cobalt fixation, the silica was washed thrice with water to dissolve ammonia residues.

Figure S1 exhibits SEM-EDX imaging of the Stöber silica-based nanocomposites. SEM analysis was carried out to determine the composition, distribution, and morphology of the catalysts and understand the poor reactivity of the catalyst. Figure S1a shows that the cobalt particles were too small to be identified in the SEM image when the Stöber silica was used. Rather, the cobalt particles could only be observed by SEM-EDX imaging and are marked as purple dots in Figure S1b. The particles were very small and more likely that the cobalt to be adsorbed to the inner pores of the porous silica particles, which might explain the reduced activity of this nanocomposite catalyst.

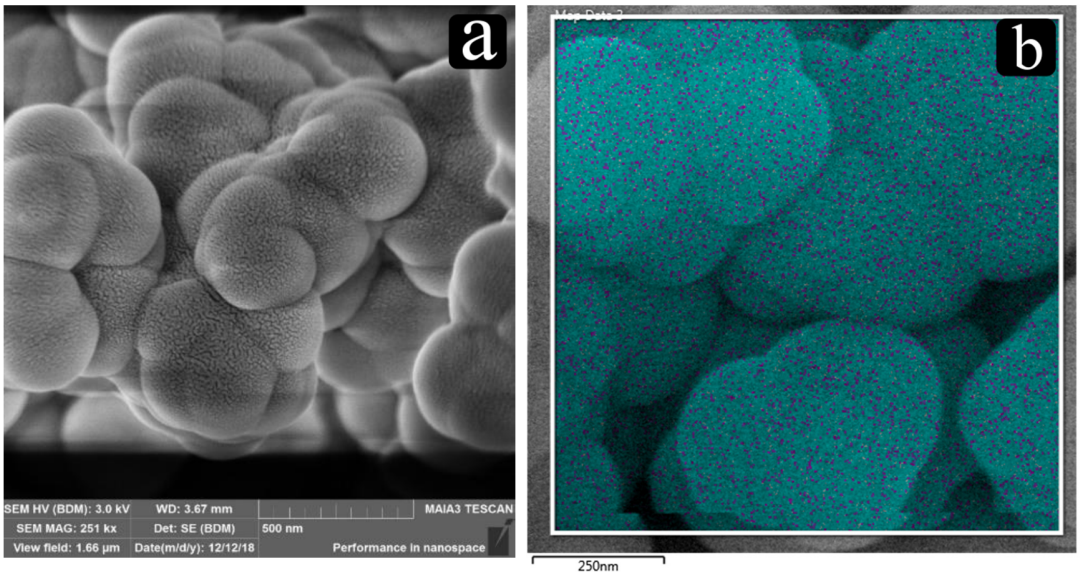

Figure S1. Electron microscopy images of Stöber silica-based nanocomposite catalyst morphology and elemental mapping. (a) SEM image of $SiO_2/Co(OH)_2$. The surface roughness stems from the gold coating procedure for SEM imaging. (b) SEM-EDX mapping of the nanocomposite particles. Cobalt atoms are marked by purple dots.

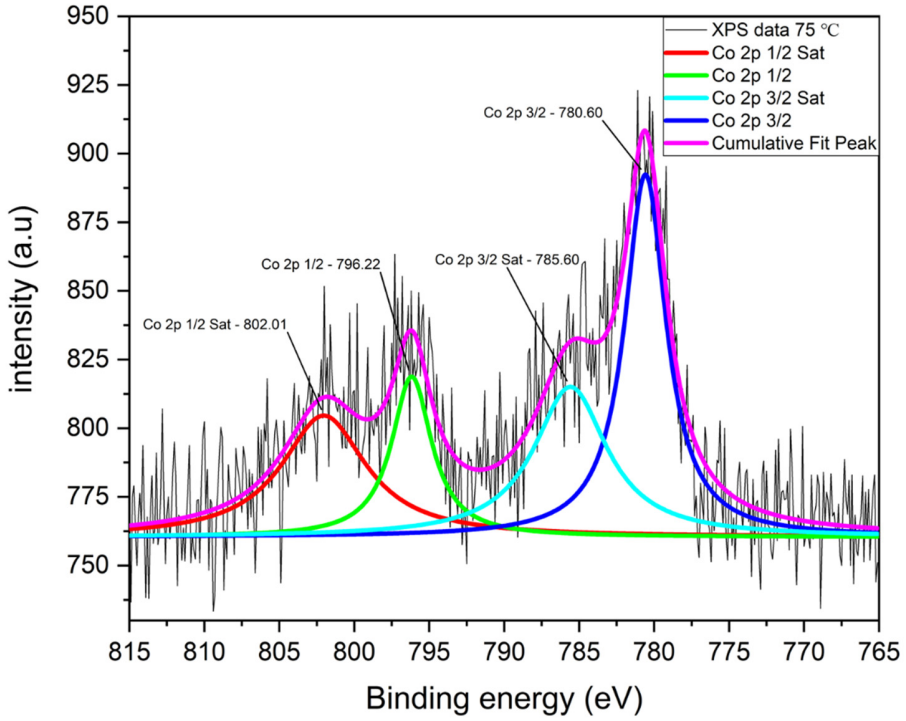

Figure S2. High-resolution XPS spectrum of $SiO_2/Co(OH)_2$ synthesized at 75℃.

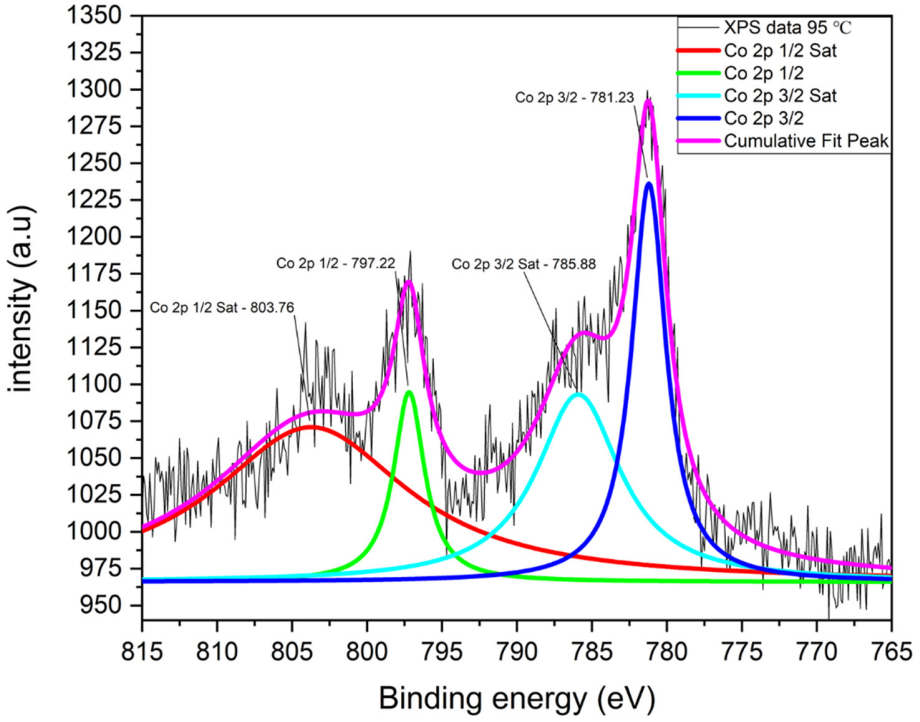

Figure S3. High-resolution XPS spectrum of $SiO_2/Co(OH)_2$ synthesized at 95℃.

To analyze catalyst composition and morphology, the catalyst slurry was filtered through a 0.22 µm nylon filter, dried at room temperature, and ground to a fine powder.

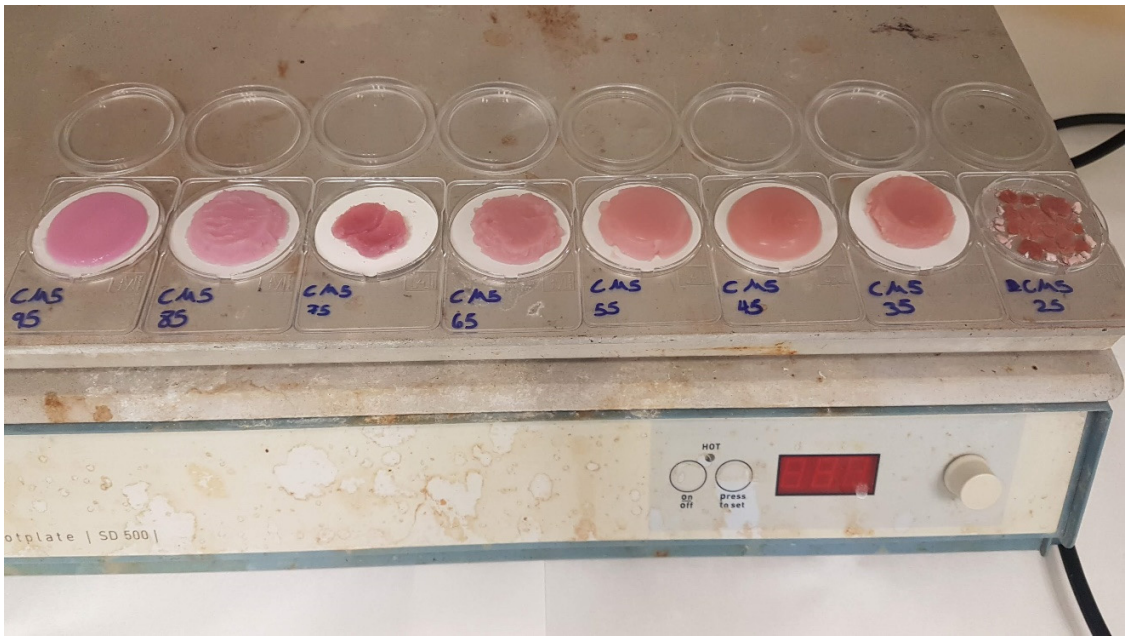

Figure S4. Filtered catalysts, 25-95°C

Figure S5. Ground powder of the catalysts, 25-95°C

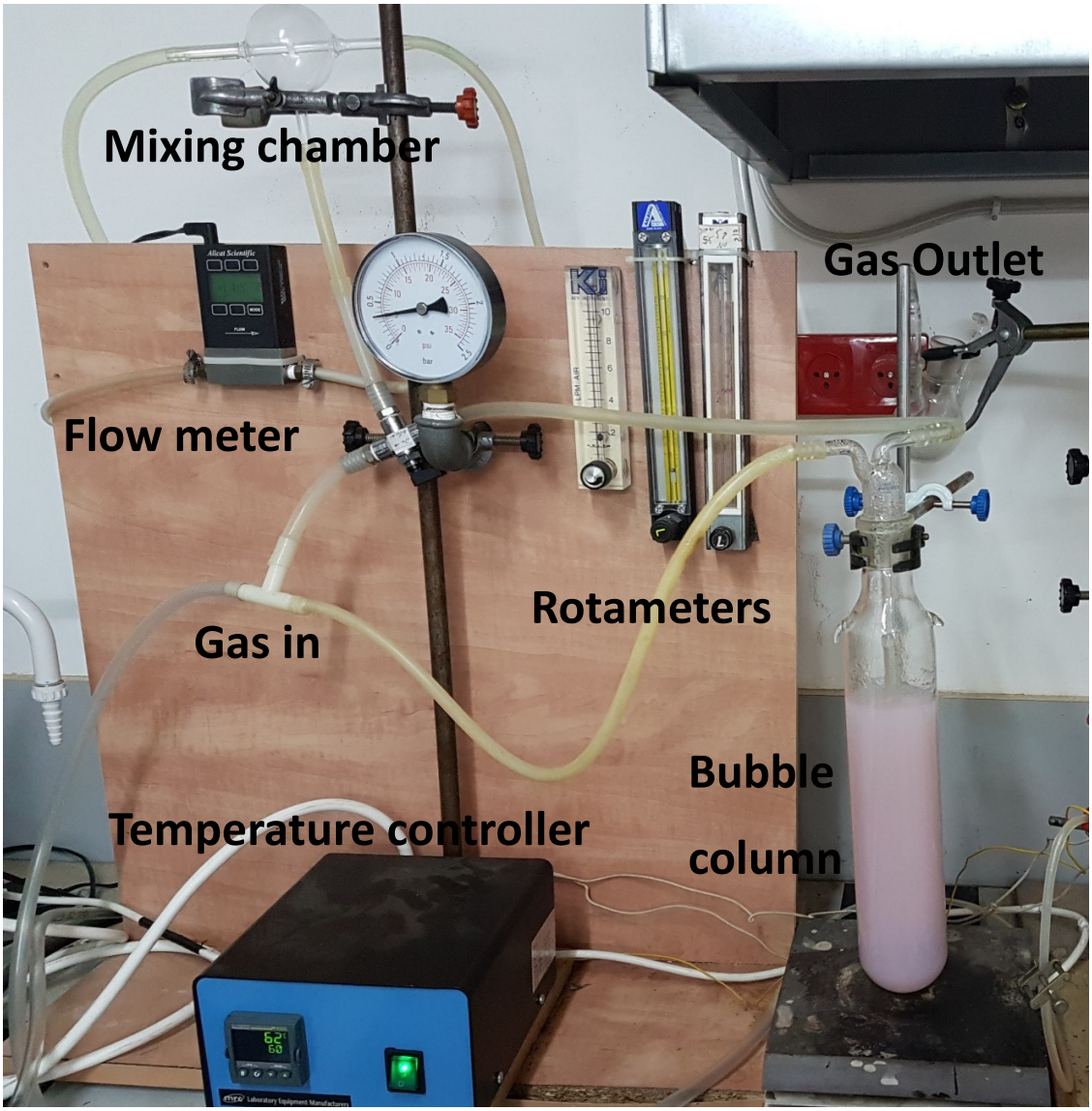

Figure S6. The laboratory wet scrubbing pilot unit.

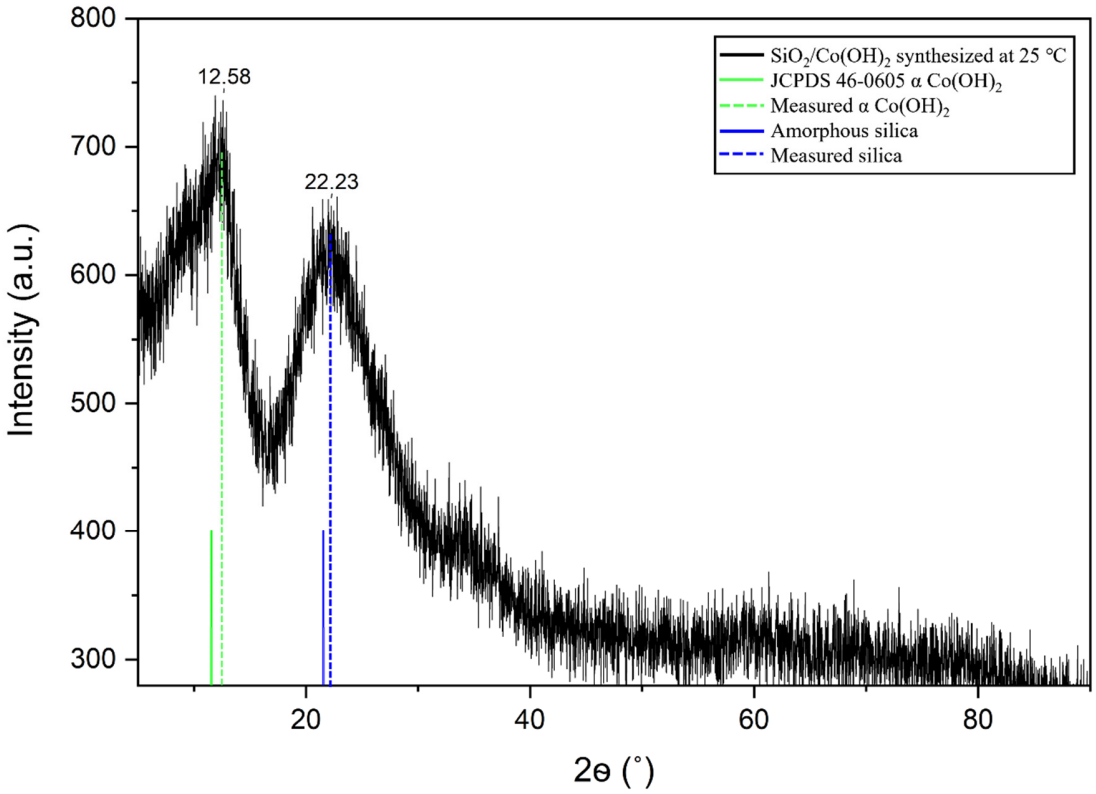

Figure S7. Powder XRD pattern of $SiO_2/Co(OH)_2$ synthesized at 25°C

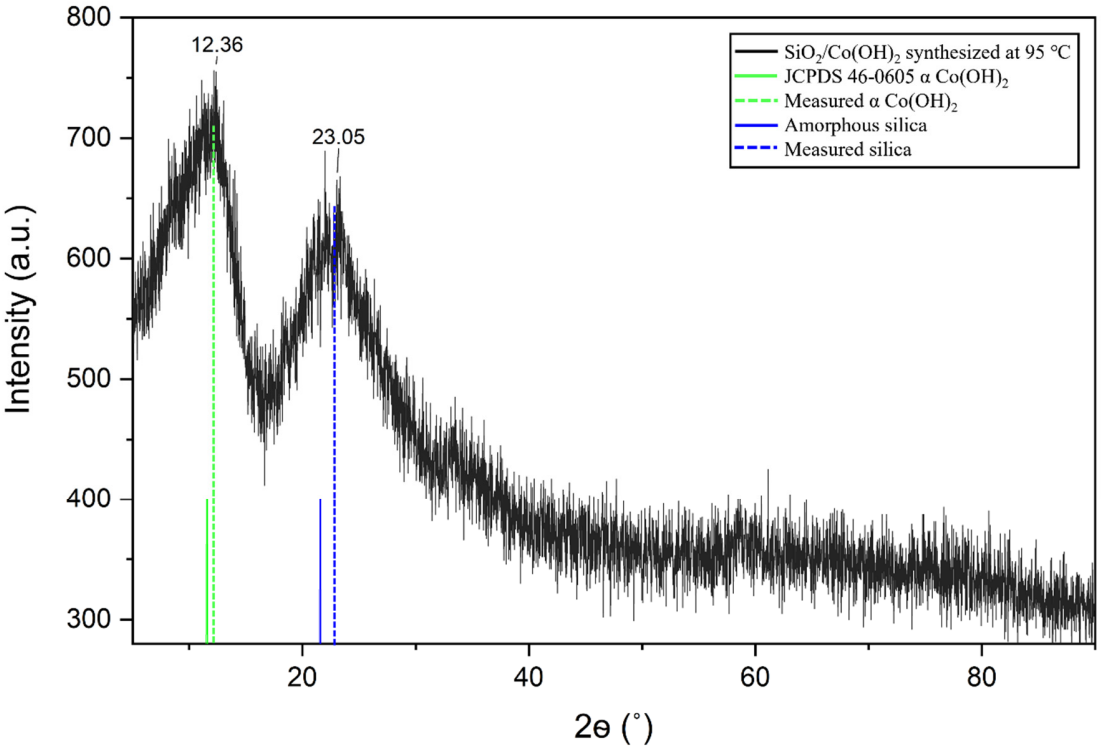

Figure S8. Powder XRD pattern of $SiO_2/Co(OH)_2$ synthesized at 95°C

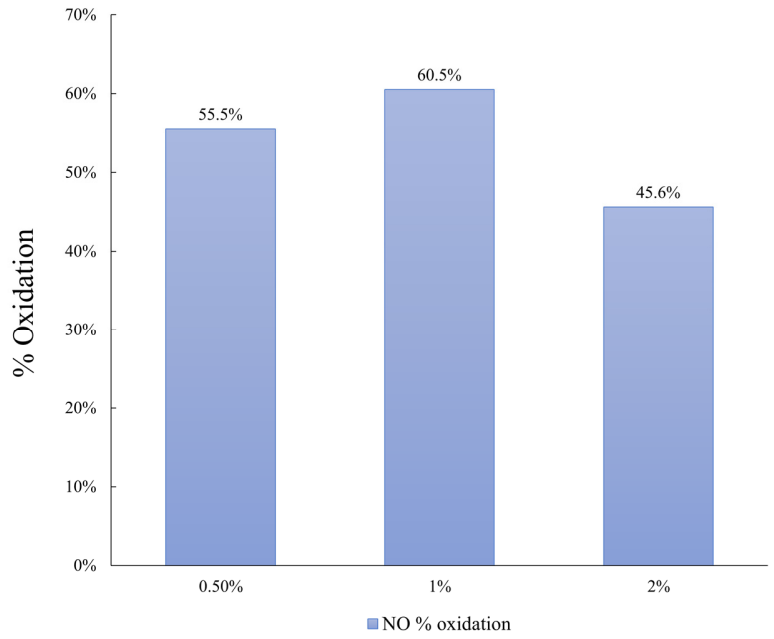

Figure S9. Effect of silica concentration on catalyst activity ($SiO_2/Co(OH)_2$; [Co] = 6 mM).

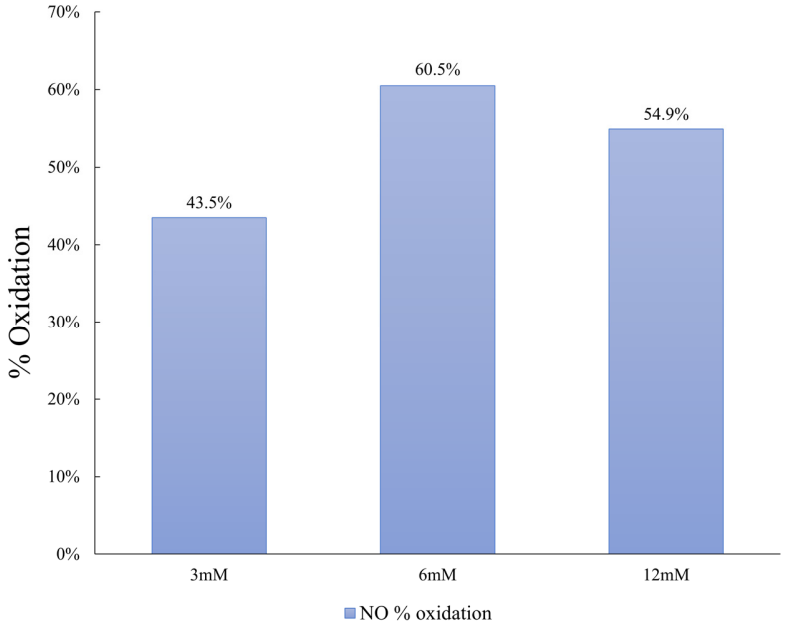

Figure S10. Effect of cobalt concentration on catalyst activity ($SiO_2/Co(OH)_2$; [SiO_2] = 1 wt%).