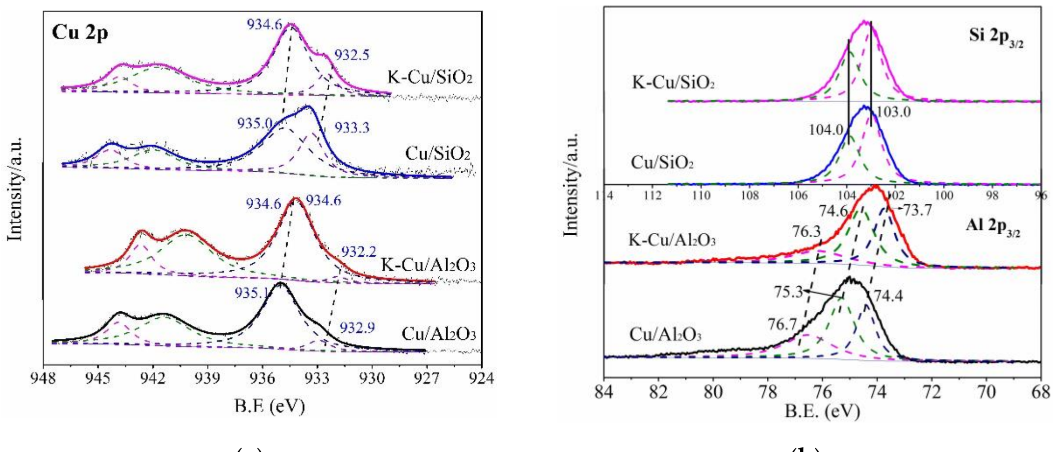
Supplementary Material

The Support Effects on the Direct Conversion of Syngas to Higher Alcohol Synthesis over Copper-Based Catalysts

In order to make a comparison, we consulted Handbook of X-ray Photoelectron Spectroscopy: A Reference Book of Standard Spectra for Identification and Interpretation of XPS Data [1], which has the reference value theoretical basis.

Figure 1S showed the X-ray photoelectron spectroscopy (XPS) spectra of Cu/Al_2O_3, K-Cu/Al_2O_3 and Cu/SiO_2, K-Cu/SiO_2 catalysts: (a) $Cu2p_{3/2}$, (b) Al2p and Si2p. The standard XPS spectra of $Cu2p_{3/2}$, Al2p, and Si2p [1] were displayed in Figure 2S,3S,4S, respectively.

As displayed in Figure 1Sa, two peaks at around 933.0 and 935.0 eV, ascribed to Cu^{2+} in CuO and Cu^{2+} in $CuAl_2O_4$, respectively [2,3], were found Cu/Al_2O_3 catalyst. Two peaks at 933.3 eV and 935.0 eV, attributed to CuO and copper phyllosilicate [4–6], were clearly observed in the Cu/SiO_2 catalyst. From Figure 2S, the standard XPS spectra of $Cu2p_{3/2}$ was 933.6 eV. Figure 1Sb presented the Al2p XPS spectra of Cu/Al_2O_3, K-Cu/Al_2O_3, and Si2p XPS spectra of Cu/SiO_2, K-Cu/SiO_2 catalysts. Three peaks at 74.4, 75.3 and 76.7 eV attributed to aluminum species were obviously observed in the Cu/Al_2O_3 catalyst, and two peaks centered at 103.1 and 103.9 eV were found on the Cu/SiO_2 catalyst, indicating that the Si element possessed two chemical states in the catalyst [5,6]. As shown in Figure 3S,4S, the standard XPS spectra of Al2p and Si2p were 103.3 and 74.4 eV, respectively. These results clearly showed that the values of $Cu2p_{3/2}$, Al2p, and Si2p in the prepared catalysts obviously shifted compared to the standard XPS spectra of $Cu2p_{3/2}$, Al2p, and Si2p. It revealed that the oxidation state or chemical environment in the Cu/Al_2O_3, K-Cu/Al_2O_3 and Cu/SiO_2, K-Cu/SiO_2 catalysts were different from that in Al2O3, SiO2, and CuO alone.



(**a**) (**b**)

Figure S1. X-ray photoelectron spectroscopy (XPS) spectra of Cu/Al_2O_3, K-Cu/Al_2O_3 and Cu/SiO_2, K-Cu/SiO_2 catalysts: (**a**) $Cu2p_{3/2}$ and (**b**) Al2p and Si 2p.

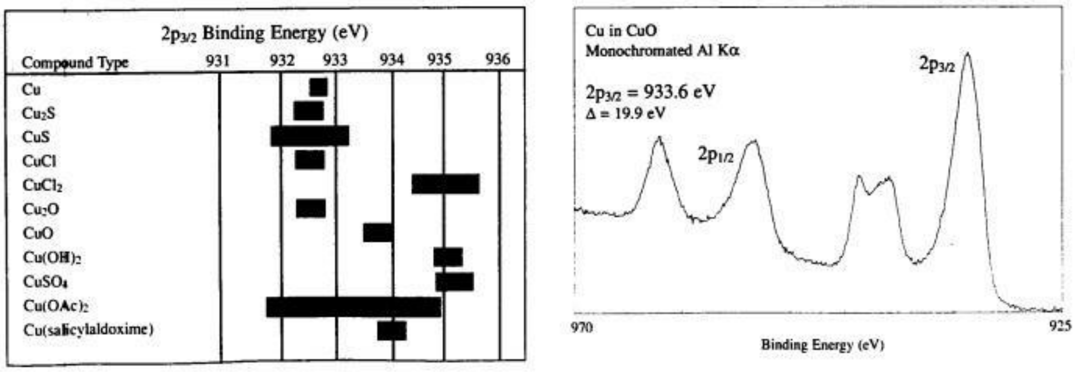


Figure S2. XPS spectra of Cu2p3/2 [1].

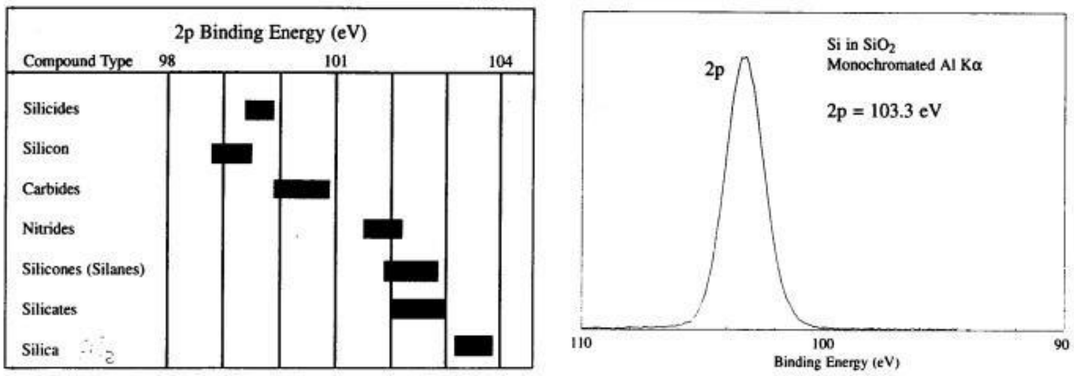


Figure S3. XPS spectra of Al2p [1].

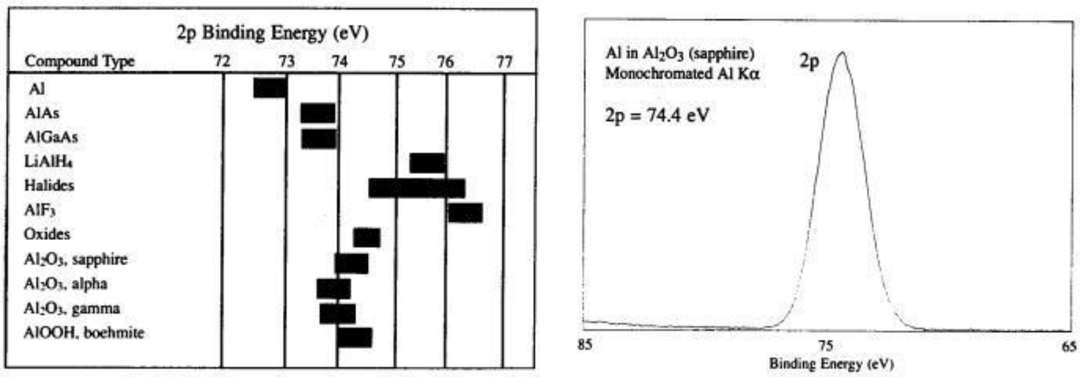


Figure S4. XPS spectra of Al2p [1].

References

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