Effect of MOF-derived Cu/CeO_2 Catalysts Depending on Calcination Temperature in Water-Gas Shift Reaction

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ABSTRACT

The WGS(Water Gas Shift) reaction is essential for the process of producing high-purity hydrogen from natural gas. The WGS reaction proceeds in two stages with different reaction temperatures due to thermodynamic limitations. For the efficient operation of the power system, a compact reformer with a small size is important. In the case of a compact reformer, a single-stage WGS reaction is applied due to the limitation of the reformer size. In this study, tailored WGS catalysts for small reformers were prepared by varying calcination temperatures that affect the physicochemical properties of the catalysts. That is, tailored Cu/CeO_2 catalysts for WGS in small reformers were prepared using CeO_2 supports derived from metal-organic frameworks (MOFs) at various calcination temperatures. The MOF-derived CeO_2 supports were prepared using various hydrothermal synthesis methods. Cu was added to the MOF-derived CeO_2 support via incipient wetness impregnation method. Various techniques such as Brunauer-Emmett-Teller (BET), Oxygen Storage Capacity (OSC), and X-ray Diffraction (XRD) were performed to understand the relationship between the catalytic performance and physicochemical properties of the Cu/CeO_2 catalysts. Among the prepared catalysts, the Cu/CeO_2 catalyst prepared using MOF-derived CeO_2 support calcined at 400°C exhibited high CO conversion (Xco=74%) at a very high gas hourly space velocity of 50,233 $mL \cdot g^{-1} \cdot h^{-1}$ and high stability for 50 h. This excellent catalytic performance is mainly attributed to its high oxygen storage capacity for enhancing the WGS reaction. In conclusion, the Cu/CeO_2 catalyst using the MOF-derived CeO_2 support calcined at 400°C is expected to be a suitable WGS catalyst for a small reforming reactor to produce hydrogen from natural gas.

Keyword: Water gas shift/ Metal-organic frameworks/ Oxygen storage capacity / Calcination temperature

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