Ni loading effect on Ni-support interactions in ethanol steam reforming over Ni/$CeZrO_x$-Al_2O_3 catalysts

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xNi/CeZrO-Al_2O_3 catalysts for ethanol steam reforming were successfully prepared at different loading amounts of Ni. Depending on the Ni loading amounts, Ni interacts with various components of the support in different priority sequences. At a low Ni amount, Ni preferentially formed $NiAl_2O_4$ phase, subsequently reducing the acidity of the catalyst to attenuate the dehydration that occurs on acidic sites of Al_2O_3. When the Ni content was 10%, the Ni interaction with the support mainly extended to CZ to form Ni metal particles with more oxygen vacancies. For 15 and 20Ni/CZ-Al, the over-saturated Ni were located near acidic sites over Al_2O_3. The Ni sites surrounded by the acidic sites were responsible for coke formation. 10Ni/CZ-Al showing the optimal Ni-CZ interaction resulted in the best catalytic performance owing to the combined reaction route of steam reforming over Ni and water gas shift reaction over oxygen vacancy in the CZ structure. Furthermore, the oversaturated Ni site surrounded by Al_2O_3 for 15 and 20Ni/CZ-Al accelerated the coke formation where C_2H_4 produced on the acidic sites via dehydration of ethanol were readily transformed into coke near the Ni metallic sites.