Al_2O_3-coated Ni/CeO_2 nanoparticles as coke-resistant catalyst for dry reforming of methane

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Nickel is the most suitable catalyst for dry reforming of methane (DRM). The major problem is deactivation with carbon deposition on the catalyst surface via the Boudouard reaction. To mitigate the deactivation, Ni/CeO_2 catalysts are designed which consist of Ni nanoparticles supported on CeO_2 nanorods, and Al_2O_3 layers were further coated using atomic layer deposition (ALD), denoted as Ni/CeO_2/Al_2O_3. The thickness of Al_2O_3 is proportional to the number of ALD cycles, and the catalysts deposited with different ALD cycles from 1 to 10 are compared for DRM at 700 and 800 °C. The catalyst performance and amount of carbon deposited change with the thickness of Al_2O_3. In particular, all catalysts coated with Al_2O_3 are evaluated as coke-free catalysts by thermogravimetric analysis, unlike Ni/CeO_2. The ALD process did not change the original structure of catalyst, and it was confirmed that the reducibility of Ni and CeO_2 significantly affected under reduction condition at 700 °C before DRM. In conclusion, the atomically controlled oxide layers with ALD technique improves the stability against coke deposition and sintering while retaining the properties of the catalyst.