Structure, activity, and stability of atomically dispersed Rh in methane steam reforming

Supporting information

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Table S1: Textural properties of supports and catalysts after calcination at 773 K and rhodium content in catalysts.

Samples	Rh wt.%	S_{BET} (m^2/g)	Pore Volume (cm^3/g)	Pore Diameter (nm)
Al_2O_3	-	163	0.28	4.8
Rh/Al_2O_3	0.45	160	0.27	4.9
$12CeO_2$-Al_2O_3	-	128	0.28	6.4
$Rh/12CeO_2$-Al_2O_3	0.55	127	0.21	5.1
$6Sm_2O_3$-$6CeO_2$-Al_2O_3	-	134	0.23	5.1
$Rh/6Sm_2O_3$-$6CeO_2$-Al_2O_3	0.48	128	0.22	5.1

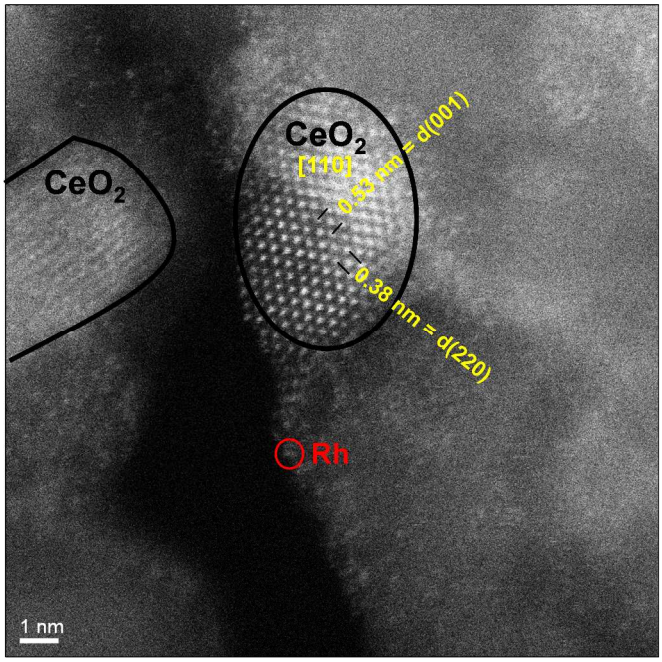

Figure S1: HAADF-STEM micrograph of Rh/6Sm_2O_3-6CeO_2-Al_2O_3 after 48 h MSR stability test at 773 K. The experimentally measured interplanar distances of a ceria crystal oriented along [110] and indices are indicated. The isolated bright spots are most likely rhodium.

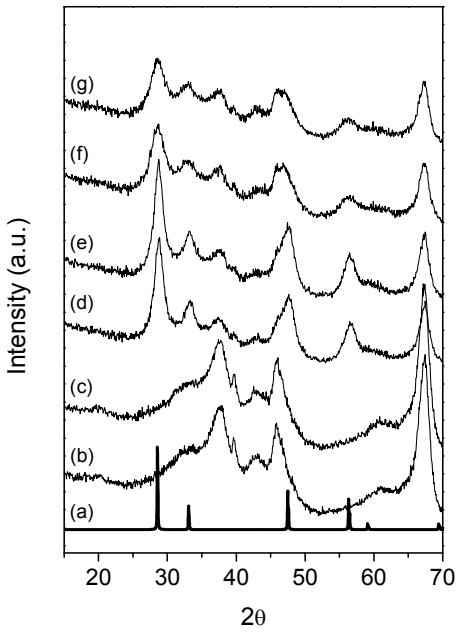

Figure S2: XRD patterns of: (a) CeO_2 of fluorite-type structure, (b) Al_2O_3, (c) Rh/Al_2O_3, (d) $12CeO_2$-Al_2O_3, (e) $Rh/12CeO_2$-Al_2O_3, (f) $6Sm_2O_3$-$6CeO_2$-Al_2O_3 and (g) $Rh/6Sm_2O_3$-$6CeO_2$-Al_2O_3.

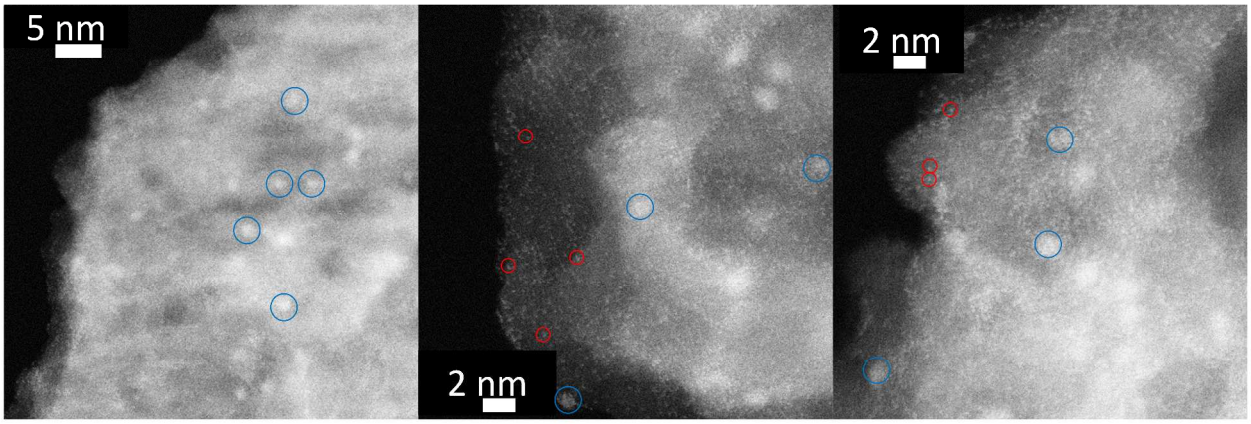

Figure S3: Additional representative HAADF-STEM micrographs of Rh/6Sm_2O_3-6CeO_2-Al_2O_3 after MSR at 1033 K. Blue and red circles mark the nanoparticles and atomically dispersed rhodium, respectively.

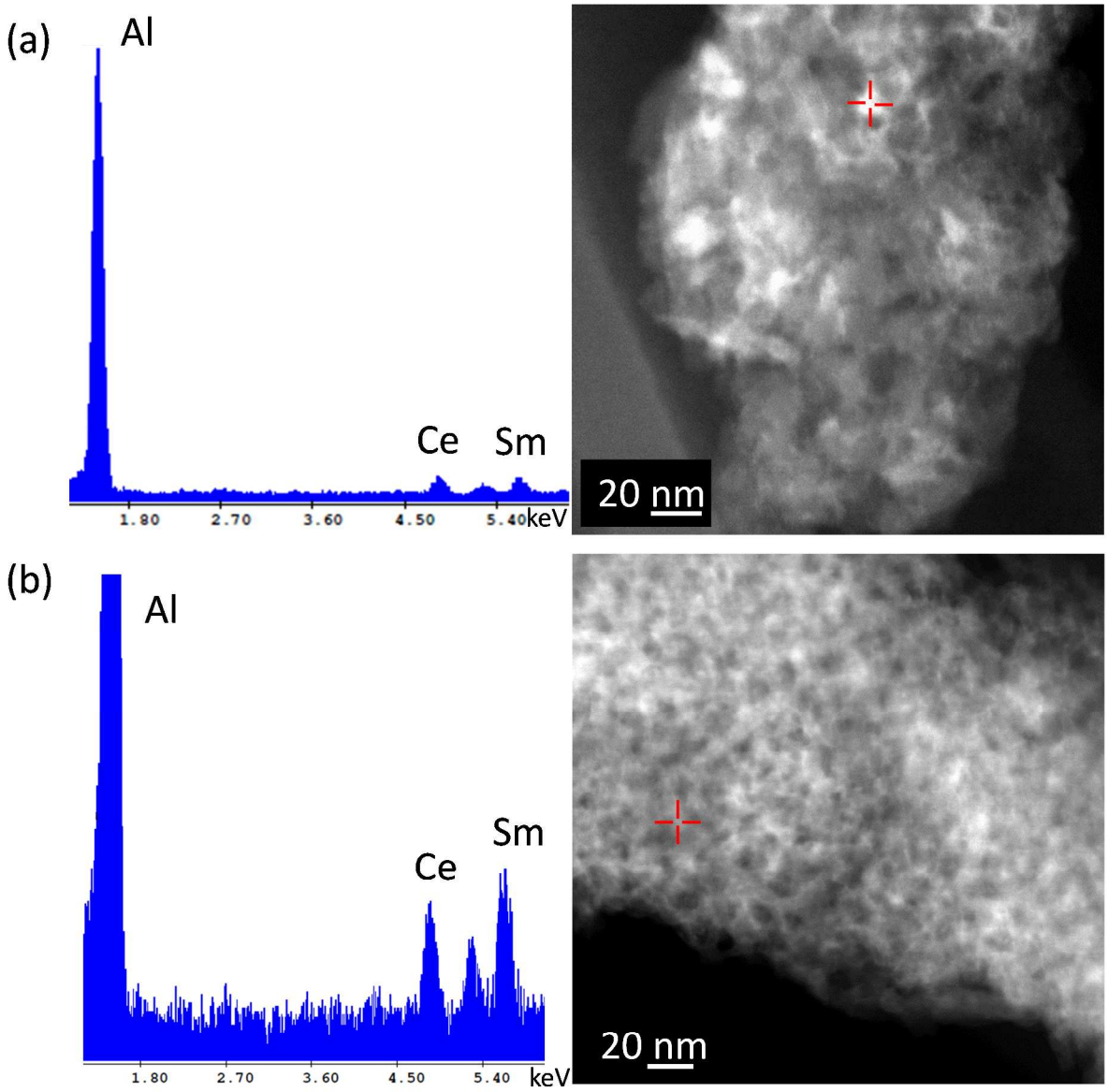

Figure S4: EDXS spot analysis and STEM micrographs of Rh/6Sm_2O_3-6CeO_2-Al_2O_3 after reduction at 873 K (a) and after MSR at 1033 K (b). The positions analyzed are specified in the STEM micrographs.

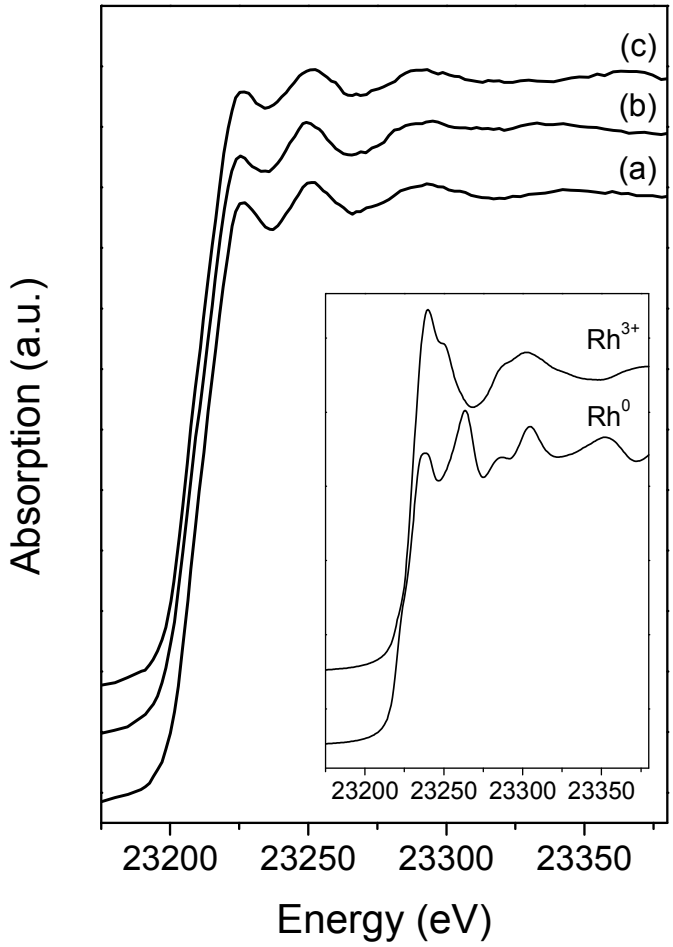

Figure S5: Rh K-edge XANES spectra of (a) Rh/Al_2O_3, (b) $Rh/12CeO_2$-Al_2O_3 and (c) $Rh/6Sm_2O_3$-$6CeO_2$-Al_2O_3 during reduction at 773 K. The insert shows the reference spectra of Rh foil and Rh_2O_3.