Electronic Supplementary Material (ESI) for Physical Chemistry Chemical Physics.

Nanoporous Gold Functionalized with Praseodymia-Titania Mixed Oxides as a Stable Catalysts for the Water-Gas Shift Reaction

Junjie Shi[a,b], Arne Wittstock[a,e], Christoph Mahr[c], M. Mangir Murshed[d,e], Thorsten M. Gesing[d,e], Andreas Rosenauer[c,e], Marcus Bäumer[a,e]*

[a]*Institute of Applied and Physical Chemistry and Center for Environmental Research and Sustainable Technology, University of Bremen, Leobener Str. 6, 28359 Bremen, Germany*

[b]*Shandong Applied Research Centre of Gold Nanotechnology, Department of Chemistry & Chemical Engineering, Yantai University, Yantai, China*

[c]*Institute of Solid State Physics, University of Bremen, Otto-Hahn- Allee. 1,28359, Bremen, Germany*

[d]*Solid State Chemical Crystallography, Institute of Inorganic Chemistry and Crystallography, University of Bremen, Leobener Str. 7, 28359 Bremen, Germany*

[e]*MAPEX Center for Materials and Processes, University of Bremen, Bibliothekstr. 1, 28359 Bremen,Germany*

*Corresponding author: Leobener Strasse UFT, Bremen, Germany, Phone: +49 421 218 63170, Email: mbaeumer@uni-bremen.de

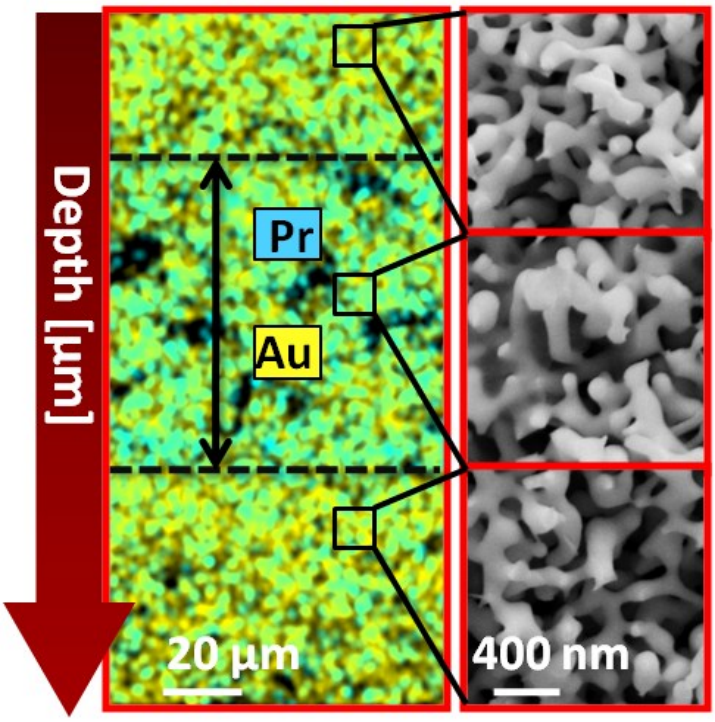

Figure S1. SEM and elemental maps of freshly broken cross-sections of PrO_x/npAu disks acquired at different depths along the cross sections.

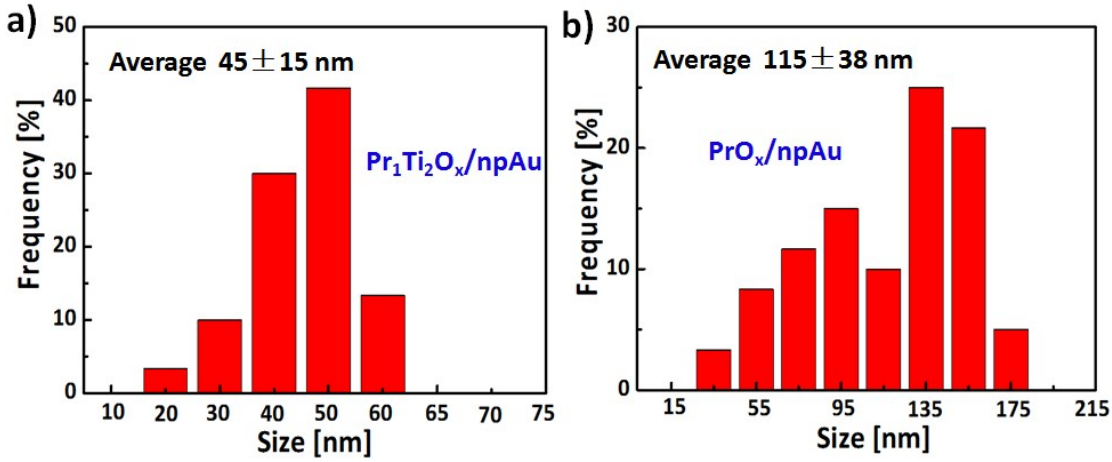

Figure S2. a) and b) show the gold ligament size distributions of $Pr_1Ti_2O_x$/npAu and PrO_x/npAu, respectively. Both samples were first heated to 450°C in helium and then used for WGS for more than 40h (eed-gas mixture: 5.8 vol% CO, 22 vol% H_2O, helium as carrier gas; total gas flow 32 mL min^{-1}).

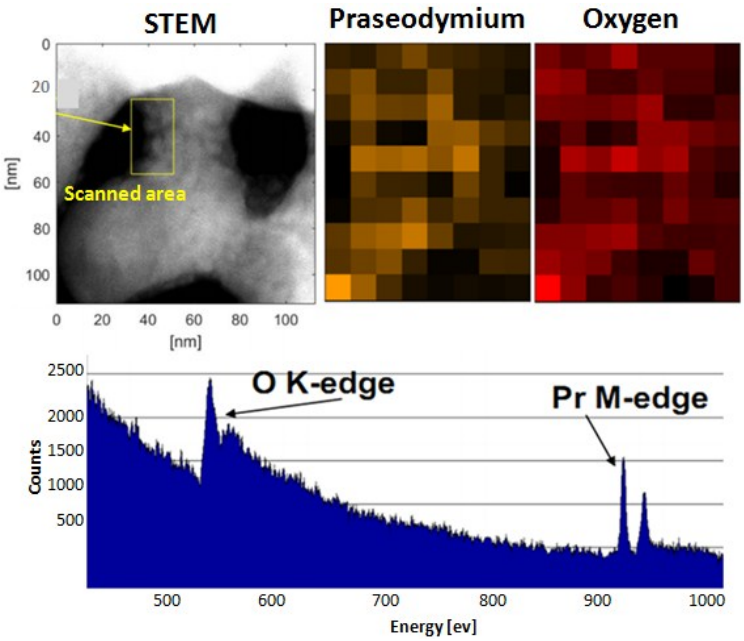

Figure S3. STEM image of PrO_x/npAu, representative EELS spectrum and resulting elemental distribution. Evaluation of O-edge (in red), and Pr-M edge (in brown).

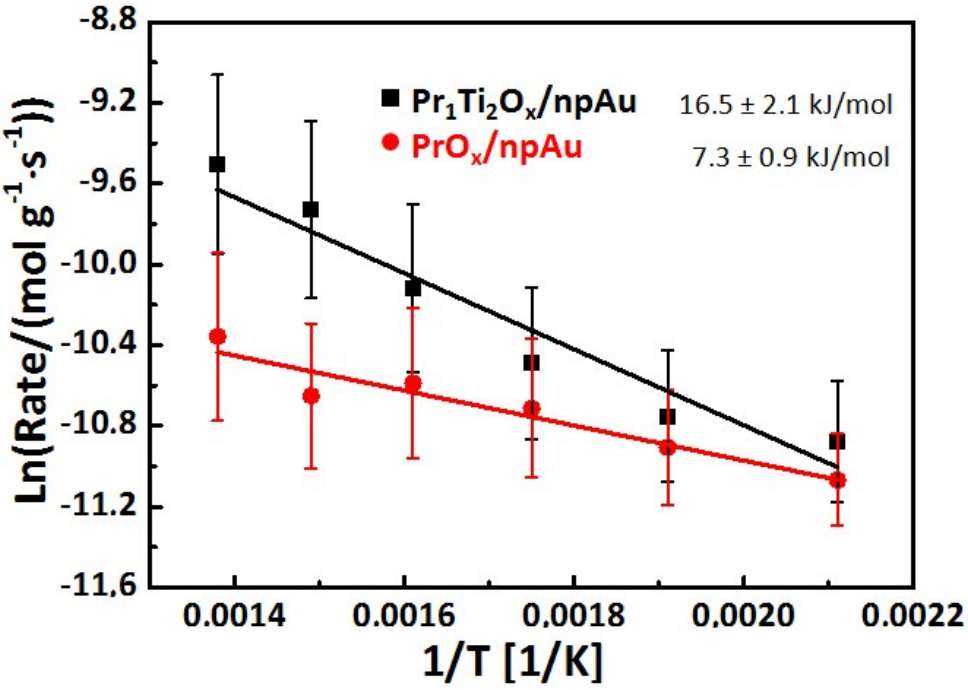

Figure S4. Arrhenius plots of the samples revealing an apparent activation energy of WGS of 16.5 ± 2.1 kJ/mol for $Pr_1Ti_2O_x$/npAu and 7.3 ± 0.9 kJ/mol for PrO_x/npAu.

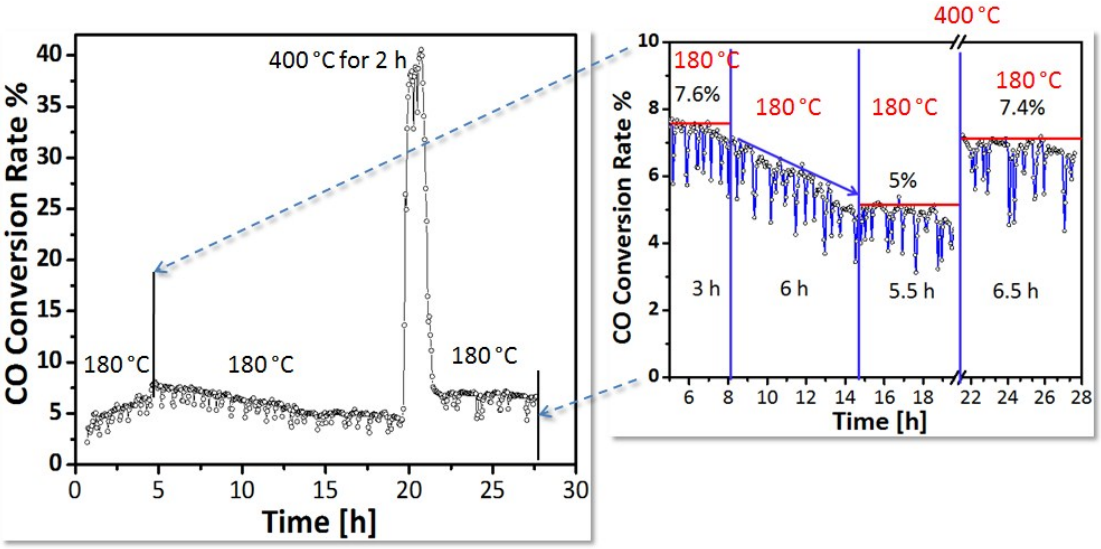

Figure S5. Stability tests carried out with the $Pr_1Ti_2O_x$/npAu catalysts for WGS at 180 °C. Reaction at 180 °C in feed gas; after 20h temperature rise to 400°C for 2 h; cool-down to 180 °C. Feed-gas mixture: 5.8 vol% CO, 22 vol% H_2O, helium as carrier gas; total gas flow 32 mL min^{-1}, m_{catal} = 15.0 ± 0.2 mg, space velocity 128 000 mL $h^{-1}g_{cat}^{-1}$. (In the whole process the full feed-gas mixture continuously passed through the reactor without any change.)

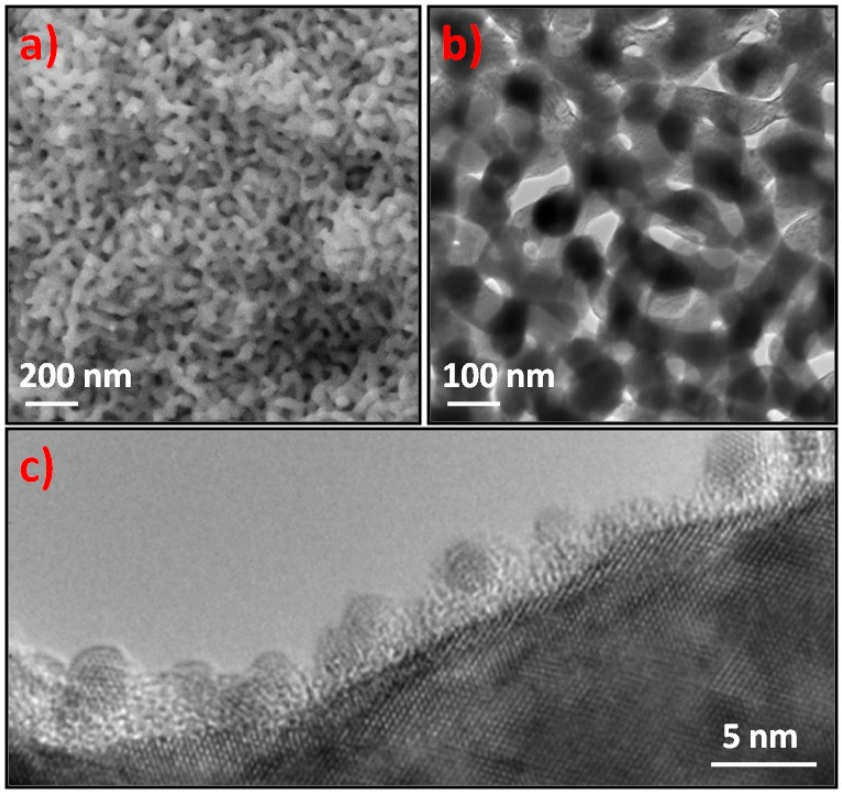

Figure S6. (a) SEM, (b) TEM and (c) HRTEM images of $Pr_1Ti_2O_x$/npAu after WGS at 400 °C for 40h. Feed-gas mixture: 5.8 vol% CO, 22 vol% H_2O, helium as carrier gas.