Supplementary information

Design of A New *In-House* Ambient Pressure XPS and Surface Chemistry of Ceria under Reaction Conditions

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1. CAD drawing and photo of the *in-house* ambient pressure system (AP-XPS)

*Fig. S1* CAD drawing of the in-house ambient pressure system reported here.
2. Reaction cell of the *in-house* ambient pressure system (AP-XPS)

![Diagram](image)

**Fig. S2** Representation of Fig. 3a with details. 1: Manipulator of the reaction cell for operando studies; 2: The reaction cell; 3: Door to lock the reaction cell or change samples.

![Diagram](image)

**Fig. S3** Representation of Fig. 3b with details. 1: Manipulator of the reaction cell for operando studies; 2: The reaction cell; 3: The sample stage in gaseous environment of reactants; 4: Nozzle; 5: Si$_3$N$_4$ window for X-ray transmission; 6: X-ray reaches sample surface; 7: UHV cavity to keep e-beam heater; 8: Filament of electron beam heater in UHV; 9: First differential pumping stage.