Supporting information

Scheme 1. Schematic picture for the structure activation mechanism of mesoporous RuO$_x$H$_y$ during the gas treatment (CO/O$_2$). a) Stick and ball model of the stoichiometric RuO$_2$ surfaces in mixed gas. O and Ru atoms are shown as large and small balls, respectively. A bridge bonded O (O$_{br}$) which are coordinated only to two Ru atoms underneath, a 3-fold coordinated O atom (O$_{3f}$), and a 1-fold under-coordinated Ru atom (1f-cus-Ru) which are coordinated only to five O atoms, are active elements, are indicated. b) Formation of O vacancy resulting from the missing O which is consumed by oxidation of CO.