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CO oxidation over noble metals: The continuum from ultrahigh vacuum to atmospheric pressures

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Catalytic oxidation of CO has been investigated for many decades by numerous researchers and is considered to be one of the best understood catalytic reactions. Because of its importance in pollution control, fuel cells, etc., this reaction has received considerable attention for fundamental and practical reasons. Removal of CO from automobile exhaust is accomplished by catalytic converters using supported Pt-group metals of Pt, Pd and Rh catalysts. The catalytic removal of traces of CO from H₂ by Pt-group metals to the few ppm level is required for efficient operation in fuel cells. Efforts in our laboratory have addressed the adsorption of CO and the kinetics of CO-oxidation on single crystals and supported metal catalysts over a wide temperature (400–650 K) and pressure (1×10^{-7} ~ 500 Torr) range. Two active phases, CO-dominated and O-dominated, have been identified for which the mechanisms for CO catalytic oxidation are entirely different. The highly active phase formed in oxygen-rich reaction condition exhibits CO₂ formation rates several orders higher than the rates found for stoichiometric reaction conditions. This highly active surface was determined to consist of approximate one monolayer of surface oxygen using Auger spectroscopy and X-ray photoemission spectroscopy.