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CO oxidation on Pt₇ on h-BN/Rh(111) : Stability and catalytic activity.

The complexity of real catalysts in terms of their electronic and geometric structure and their interaction with the support makes fundamental studies much simpler on model catalysts. In this contribution we report on the stability and CO oxidation on mass selected Pt₇ supported on hexagonal boron nitride (h-BN) grown on a Rh(111) surface. In the first case, the idea of our experiments is to reduce the size of catalytic particles to their ultimate limit in order to make car exhaust catalysts that contain less Pt. In the second case, the inert h-BN layer is expected to minimize the effect of the support on the catalytic reaction and will also be used as an ordered array to stabilize the small Pt particles. h-BN forms a single sp² bonded atomic honeycomb layer. The misfit with the underlying Rh(111) surface leads to a strongly corrugated Moiré pattern with 2 nm diameter areas that are strongly bound and surrounded by 1 nm wide areas that are only van-der-Waals bound and 1 Å higher. The low-lying regions of the Moiré are known to be good trapping centers for molecules and clusters. Recent studies show that h-BN presents a great potential as future catalysts support[1]. The stability of the Pt nanoparticles is investigated in-situ by means of Scanning Tunneling Microscopy (STM), operated at 80 K. Catalytic reactions on the catalyst are measured in situ in a custom made UHV reactor. CO oxidation has been studied using alternating ¹³C¹⁶O and ¹⁸O₂ pulses, (at a frequency of 0.2 Hz) on the Pt/h-BN/Rh(111) catalyst as a function of temperature (300-700 K). We find that Pt clusters annealed to 700 K exhibit Smoluchowski ripening, above, intercalation of the Pt under h-BN takes place. The stability is strongly reduced under reaction conditions, a phenomenon which has also been observed for other systems such as Co/h-BN/Rh(111)[2] and Pt/TiO₂(110)[3]. The onset temperature of the CO oxidation is at 500 K and thereby higher than on titania[4]. Intercalated clusters exhibit a by 100 K lower onset temperature of the CO oxidation reaction thus improving the cold start behavior.

References.

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