In-situ E-TEM study of the morphology of TiO$_2$ supported gold nanocatalysts under oxidizing (O$_2$) and reducing (H$_2$) atmosphere

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Since the discovery of the capabilities of nanometer sized gold clusters for the oxidation of carbon monoxide by Haruta et al. [1], supported-gold nanoparticles (NPs) are being intensively studied in the field of heterogeneous catalysis. Despite this on-going interest, the link between catalytic activity and morphology of the NPs is still not completely clear. This results from the lack of direct observations of these NPs in their reaction environments. In this contribution, we present in situ gas TEM studies of the morphological transformation of Au NPs supported on rutile-TiO$_2$ nanorods under oxidizing (O$_2$) and reductive (H$_2$) atmospheres as function of gas pressure and temperature.

Monometallic gold NPs were fabricated by pulsed laser deposition and deposited on rutile-TiO$_2$ nanorods. In-situ gas TEM up to atmospheric pressure and 400 °C was performed in an environmental gas-cell from Protochips Inc. Figure 1 shows a series of dark-field images of TiO$_2$-supported Au NPs under 750 Torr of O$_2$ between room temperature and 400 °C. Above 200°C, the NPs present truncated octahedron-like shape bounded by (100) and (111) facets. Below 200°C, the NPs present more rounded-like shape. This implies a change in surface energies of the (111) and (100) facets that form the truncated octahedron shape as well as a growth of (110) facets that make the NPs look more rounded.

The influence of the reaction medium (O$_2$, H$_2$) as well as the gas pressure and the temperature on the morphology of Au NPs will be discussed in this presentation.

Figure 1. TiO$_2$ supported gold NPs under 750 Torr of O$_2$ at 400°C, 300°C, 200°C, 100°C and RT.

References

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