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Reduction of Gold Nanoparticles Supported in a Titanium Oxide Mesoporous Substrate

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Beamline(s): X10C, X18B

Introduction: Gold is usually considered to be an inert material. However, it has been shown that Au can be made catalytically active depending on its size and on the material it is supported on [1]. In particular, small Au nanoparticles approximately 2 nm in diameter have been shown to be particularly active. We are investigating methods of producing catalytically active, stable, monodisperse Au nanoparticles by supporting them in mesoporous substrates

Methods and Materials: Mesoporous TiO_2 was synthesized following the method of Yang et al [2]. The pore size was approximately 6 nm. The mesoporous TiO_2 was then impregnated with an aqueous solution of HAuCl_4 . This resulted in a Au loading of nominally 10 wt%. X-ray absorption spectra at the Au L_{III} edge were recorded in transmission from ~ 150 mg of pressed sample. The sample could be treated *in situ* by heating in flowing H_2 or 2% O_2 / He (X10c). The near edge spectra were recorded at < 370 K. EXAFS spectra (X18b) were recorded at < 100 K.

Results: Following impregnation, the Au was highly oxidized. EXAFS indicated that the Au was bound to O and no longer bound to Cl. As shown by the intensity of the pre-edge "white line" feature in the figure below, the Au became reduced as it was heated in O_2 . By 673 K the Au was essentially fully reduced. The oxidized Au was easily reduced. Exposure to H_2 at 300 K resulted in full reduction.

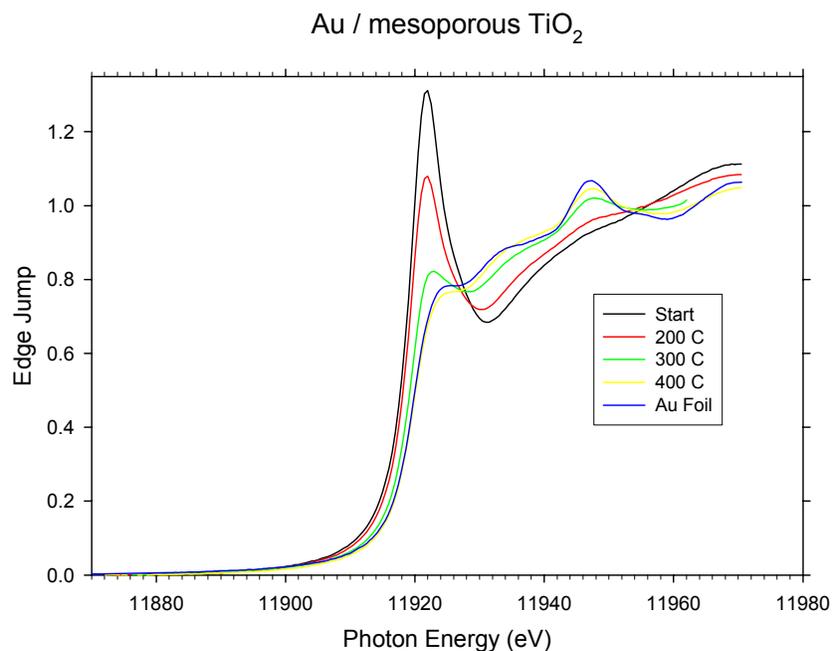


Fig. 1 - Au L_{III} for Au supported in mesoporous TiO_2 .

Conclusions: Mesoporous TiO_2 that is impregnated with aqueous HAuCl_4 forms AuO_x . The AuO_x thermally decomposes in oxygen when heated up to 673 K. The AuO_x is chemically reduced to metallic Au by H_2 at room temperature.

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References:

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