A surface science approach to CO oxidation at low temperatures

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Instead of reminiscing about more than 60 years of LEEM or 20 years LEEMPEEM I will talk about some work I have been doing with the collaborators listed above during a few summer weeks over the last 6 years or so. I wanted to do something very useful in my old days, solving a longstanding problem of our modern world, the elimination of CO. With the advent of electric vehicles this may be less pressing anymore and the elimination of the reaction product may be more important but the lessons we learn from low temperature CO oxidation will be useful for many other chemical reactions. Lowering reaction temperatures in technical processes for example will save huge amounts of power. The goal of the study which I will present is to find out the conditions for long operating times at room temperature with a cheap catalyst, hematite (α-Fe_2O_3) using LEEM, LEED, XPEEM, XPS and other surface science techniques. As the instrument central to this project, the SPELEEM, does not allow the high pressures needed for making comparison with technical processes, it has been connected to a reaction chamber which allows reactions at local pressures up to the 10 mbar range. In this manner the catalyst can studied before and after reaction. In a separate NAPXPS system, combined with a mass spectrometer, the catalyst and the reaction products can be followed during the reaction.

Low temperature CO oxidation has been studied with chemically prepared catalysts for more than 30 years [1] but is so sensitive to many uncontrolled parameters that it is still incompletely understood [2]. A catalyst prepared with surface science methods eliminates many of these problems and promises to make a major contribution to the understanding. In this study it is an epitaxial α-Fe_2O_3(0001) layer on Pt(111), which has been well studied with STM and first principle calculations [3]. Its superstructure surface provides an excellent template for the formation of Au nanoparticles and Au^+ clusters, which play an important role in CO oxidation. After giving a brief background on this surface I will discuss not only some of the studies, which we have made but also some of the experimental problems encountered, ending with a brief outlook.

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References

[1] Haruta, M.; Kobayashi, T.; Sano, H.; Yamada, N. Novel Gold Catalysts for the Oxidation of Carbon Monoxide at a Temperature far Below 0°C. *Chem. Lett.* **1987**, 105-108.

[2] Fujitani, T.; Nakamura, I.; Haruta, M. Role of water in CO oxidation on Gold catalysts. *Catal. Lett*. **2014**, *144*, 1475–1486 and references therein

[3] Lewandowski, M; Groot, I. M. N.; Qin, Z.-H.; Ossowski, T.; Pabisiak, T.; Kiejna, A.; Pavlovska, A.; Shaikhutdinov, S.; Freund, H.-J.; Bauer, E. Nanoscale Patterns on Polar Oxide Surfaces. *Chem. Mater*. **2016**, *28*, 7433−7443