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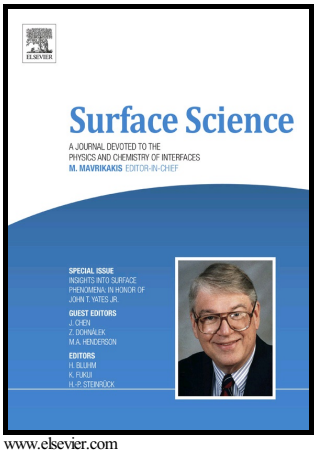

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Pd segregation to the surface of Au on Pd(111) and on Pd/TiO_2(110)

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Abstract

The interaction of Au and Pd in bimetallic systems is important in a number of areas of technology, especially catalysis. In order to investigate the segregation behaviour in such systems, the interaction of Pd and Au was investigated by surface science methods. In two separate sets of experiments, Au was deposited onto a Pd(111) single crystal, and Pd and Au were sequentially deposited onto TiO_2(110), all in ultra-high vacuum using metal vapour deposition. Heating Au on Pd/TiO_2(110) to 773 K resulted in the loss of the Au signal in the LEIS, whilst still remaining present in the XPS, due to segregation of Pd to the surface and the formation of a Au-Pd core-shell structure. It is likely that this is due to alloying of Au with the Pd and surface dominance of that alloy by Pd. The Au:Pd XPS peak area ratio is found to substantially decrease on annealing Au/Pd(111) above 773 K, corresponding with a large increase in the CO sticking probability to that for clean Pd(111). This further indicates that Au diffuses into the bulk of Pd on annealing to temperatures above 773 K. It therefore appears that Au prefers to be in the bulk in these systems, reflecting the exothermicity of alloy formation.

Keywords: model catalysts, nanoparticles, core-shell, Au-Pd alloys, TiO_2(110), Pd(111).

1. Introduction

Alloyed / bi-metallic catalysts have applications in a wide range of processes, due to their increased activity, stability and selectivity compared to their component metals[1]. The activity of a bimetallic catalyst depends on several factors, including the distribution of electron density over the particle, the positions of the component species on the catalyst and changes in geometry caused by the interactions of the two metals[2].

Au-Pd catalysts are used in a number of applications. There has recently been a large amount of interest in their use in the synthesis of hydrogen peroxide from H_2 and O_2[3]. Hutchings investigated the synthesis of hydrogen peroxide by the oxidation of hydrogen[4]. Supported Au was found to be very selective when anchored to the right support; however, adding Pd leads to a huge improvement in catalytic activity. Au-Pd bimetallic catalysts are also used for the industrial production of vinyl acetate monomer via the acetoxylation of ethylene[5-7]. The addition of Au to Pd significantly enhances its selectivity, activity and