A MEIS, STM and RAIRS investigation of the adsorption of CO on cobalt/palladium bimetallic surfaces

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Bimetallic catalysts often outperform their monometallic analogues both in terms of their activity and selectivity [1]. There are many examples of industrial heterogeneous catalysts whose active component consists of bimetallic nanoparticles. Fischer-Tropsch (FT) catalysis is used to convert syngas (CO/H_2 mixtures) into hydrocarbon products. Cobalt is one of the most important metals for FT catalysis and the addition of palladium has been shown to enhance the catalytic performance of cobalt catalysts [2]. Establishing the composition of bimetallic surfaces in the presence of the reactive gas phase is an important step towards understanding the promoting effect of the second metal on a catalytic reaction. The unique depth profiling capabilities of medium energy ion scattering (MEIS) are highly suited to characterising the phenomenon of adsorbate induced segregation [3,4]. We report an investigation of the growth and annealing behaviour of ultrathin Co films on Pd{111} using MEIS, low energy electron diffraction (LEED) and scanning tunnelling microscopy (STM). Incremental annealing of Co/Pd{111} results in intermixing and the formation of an ordered CoPd alloy at 560 K. Under these conditions, MEIS reveals that the top three layers consist of an approximately equimolar mixture of Co and Pd. STM and LEED provide evidence that the overlayer has a p(2×1) registry leading to the conclusion that the surface is terminated in the {111} plane of the CoPd $L1_0$ structure [5]. In addition, we report the adsorption of CO onto bimetallic CoPd surfaces on Pd{111} using a combination of reflection absorption infrared spectroscopy (RAIRS) and MEIS. The vibrational frequency of adsorbed CO provides crucial information on the adsorption sites adopted by CO and MEIS probes the surface composition before and after CO exposure. We show that cobalt segregation is induced by CO adsorption and rationalise these observations in terms of the strength of adsorption of CO in various surface adsorption sites [6].

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