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The interaction of nickel with a carbon surface at 20–280 °C

H den Daas†‡, H Zeijlemaker†, J Verhoeven†, E J Puik§ and M J van der Wiel§

† FOM Institute for Atomic and Molecular Physics, Kruislaan 407, 1089SJ Amsterdam, The Netherlands

§ Association Euratom—FOM Institute for Plasma Physics, Edisonbaan 14, 3439MN Nieuwegein, The Netherlands

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Abstract. The thermal stability of the nickel–carbon system as well as the growth dynamics of nickel on carbon were investigated by AES. For temperatures higher than 120 °C, changes in the system, which can be ascribed to island formation, are observed. Below 240 °C there is no indication of carbide formation. Changes in the Ni MNN peak are observed for temperatures higher than 240 °C but cannot be explained yet. For substrate temperatures of 20 and 120 °C a difference in the growth dynamics is observed when the film thickness exceeds 2.5 Å. The difference is explained by increasing island formation at high temperatures.

The combination of nickel and carbon is successfully applied in multi-layer structures for x-ray reflection [1] which are used as dispersive elements in synchrotron radiation [2]. The thermal stability is investigated in this study, because changes in structure due to a high heat load will destroy the desired multi-layer properties. The reflective and dispersive properties of multi-layer structures depend on the microscopic roughness of the interfaces, which in turn depends on the growth dynamics during deposition. The surface of a growing nickel film shows an increasing roughness [3]. The influence of the temperature on the growth of nickel on an amorphous carbon surface was investigated.

The experiments were performed in a vacuum of better than 10^{-9} Torr during nickel deposition. For the investigation of thermal stability a 10 Å nickel layer was deposited at room temperature on top of a 200 Å amorphous carbon layer. AES was used to study the changes in structure. The substrate was heated by radiation from the back of the sample. The data in figure 1 show the ratio of the Ni MNN to the C KLL Auger peaks, on heating from room temperature up to four temperatures between 180 and 280 °C. At temperatures up to 200 °C, small changes are observed while, above 250 °C, large changes which seem to stabilise after 1.5 h occur. These changes are probably caused by the formation of nickel clusters [4]. From the shapes of the Ni MNN peak and the C KLL peak, no indication of carbide formation was found up to 240 °C. Also one monolayer of carbon on top of a nickel film 200 Å thick does not reveal the well known carbide [5]

‡ Permanent address: Van 't Hoff Laboratory, University of Utrecht, Padualaan 8, 3584 CH Utrecht, The Netherlands.

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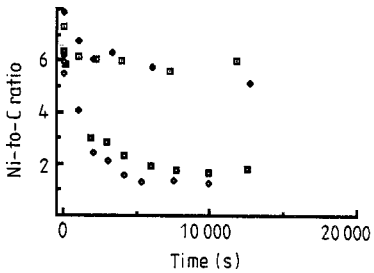

Figure 1. The ratio of the Ni MNN to C KLL Auger peaks as a function of time, during heating to 180 °C (⊡), 200 °C (◆), 250 °C (■) and 280 °C (◆).

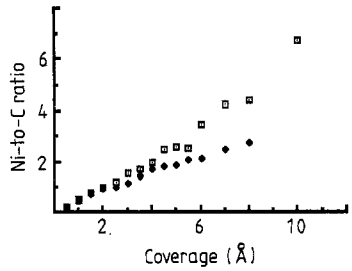

Figure 2. The ratio of the Ni MNN to C KLL Auger peaks as a function of nickel coverage, for substrate temperatures of 20 °C (⊡) and 120 °C (◆).

features after heating. Above 240 °C there is an indication of a chemical shift of the Ni MNN Auger peak, which will be more thoroughly investigated in the future.

Figure 2 shows the ratio of the Ni MNN to C KLL Auger peaks for different coverages of nickel deposited at room temperature and 120 °C. It is striking that, for the first 2 Å, no difference in the growth of nickel on carbon can be observed. At higher coverages the nickel-to-carbon ratio for deposition at 120 °C is lower than that for deposition at room temperature; this is caused by both a smaller decrease on the carbon signal and a smaller increase on the nickel signal, and can only be explained by an increase in the height of the islands [3]. It can be concluded that up to temperatures of 120 °C, only small changes are expected in the multi-layer structure of Ni/C. For nickel coverages below 4 Å, island formation and hence interface roughness is not temperature dependent. For nickel coverages of more than 4 Å, island formation increases for higher temperatures.

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