Indice

Abstract

We study the adsorption of H and K on a GaAs(110) surface by Time-of-Flight Ion-Scattering (ISS) and Direct Recoiling (DRS) Spectrometry. The method for cleaning and preparation of the surface consists in cycles of grazing bombardment with 20 keV Ar^+ combined with annealing. Since this is the first time that this method is applied to a semiconductor surface, the crystallographic structure of the grazing ion bornbarded surface is first characterized by ISS and DRS. The variations of the projectile scattered intensity as a function of the incident and azimuthal angles are interpreted in terms of calculated shadowing and focusing effects. The crystallographic structure of the GaAs(110) surface prepared by this method presents the surface relaxation observed for cleaved surfaces.

The adsorption of H on GaAs(110) is studied as a function of the H_2 exposure and the surface temperature. The behavior of the intensity of projectiles scattered from the first two As and Ga layers is consistent with a process of unrelaxation towards the ideal surface termination upon H adsorption. We have determined that for exposures of 1000 L and 2000 L the AsI-GaI splitting corresponding to the unrelaxed surface is reduced to $\Delta Z = (0.0 \pm 0.08)$ Å, as it should be expected for the bulk terminated surface. In addition, the fraction of the surface remaining relaxed as in the clean surface decrcases strongly with the H_2 exposure.

The H atoms adsorbed on the surface can be detected as recoils produced in quasi-single collisions allowing the study of the adsorption kinetics. The variations of the H recoil intensity with the exposure show that the sticking coefficient changes strongly with the H coverage since the beginning the adsorption. Above $\sim$ 500 L, the adsorption kinetics deviates from the initial behavior and the sticking coefficient becomes almost constant and small. The simultaneous measurements of the H coverage (with DRS) and the changes in the atomic structure (with ISS) as a function of the exposure indicate that the initial strong decrease in the rate of unrelaxation is mainly a consequence of the variation of the sticking coefficient. Below 100 L, most of the H atoms participate in the unrelaxation process. However, above 500 L, it is necessary

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to increase strongly the H coverage to produce small changes in the atomic structure of the surface. The measurements of the As and Ga direct recoils intensities change with the incident direction of the projectile in accordance with the crystallographic structure of the surface. On the other hand, the H recoil intensity is almost independent of the crystallographic sample orientation, indicating that an important fraction of the H atoms are not adsorbed in well ordered sites. Measurements as a function of the sample temperature show a continuous decrease of the H DR intensity for both low and high exposures. The combined results of forward recoiled atom and scattered projectile intensities suggest that an important fraction of the adsorbed H atoms is not bonded in a well ordered layer and may be forming molecules since the beginning of the adsorption process.

The adsorption of K on GaAs(110) is mainly studied by DRS. The analysis of the K direct recoil intensity indicates that at room temperature, the adsorption of K saturates at 0.5 ML, which corresponds to an atom density of $\sim 4.4 \times 10^{14}$ at/cm^{-2}. The adsorption process proceeds in two stages, which depend on the K coverage (O(K)). At low coverages, $\Theta(K) < 0.1$ ML, the K atoms are adsorbed exclusively on the [001] Ga rows and close to the sites of a new As layer, with a local crystallographic order. At high coverages the K atoms start to adsorb also along the As rows, although with a lower probability than on the Ga rows. At saturation, the K layer does not form an ordered structure. The dependence of the direct-recoil ion fractions on the K coverage is consistent with the structural information obtained from the analysis of the total recoiled intensity (ions plus neutrals). At low coverages, the K atoms mainly modify the electronic properties close to the Ga atoms. After K deposition, O reacts strongly with the surface. The comparison of different adsorption scans performed at different rates suggests that the O atoms are adsorbed preferentially along the [001] As rows.