# Observation of a new mode in the energy loss spectrum of the Sb/GaAs(110) system

Autor(en): **Angeli, E. / Betti, Maria Grazia / del Pennino, U.**

Objekttyp: **Article**

Zeitschrift: **Helvetica Physica Acta**

Band (Jahr): **62 (1989)**

Heft 6-7

PDF erstellt am: **21.09.2024**

Persistenter Link: https://doi.org/10.5169/seals-116112

# Observation of a new mode in the energy loss spectrum of the Sb/GaAs(110) system

E. Angeli, Maria Grazia Betti*, U. del Pennino and Carlo Mariani
Dipartimento di Fisica, Università di Modena, via Campi 213/A, I - 41100 Modena
* Present address: Istituto di Struttura della Materia del C.N.R., via E. Fermi 38, I - 00044 Frascati

A new feature has been singled out and identified in the high resolved electron energy loss spectrum of the Sb/GaAs(110) system at room temperature. Its evolution up to the completion of a thick Sb layer has been followed. We attribute it to an electronic transition of the antimony layer.

At the first adsorption stage the Sb/GaAs(110) surface presents mainly semiconducting characteristics, the thicker policrystalline layer shows the proper semimetallic properties of antimony. These stages of chemisorption are reflected into the several interface properties, like the Schottky barrier, the change in band bending and the surface lattice dynamics [1,3].

High Resolution Electron Energy Loss Spectroscopy (HREELS) has revealed to be a powerful surface technique for vibrational and collective properties of semiconductors, and of their characteristics related to the electronic transitions[4]. Surface sensitivity and high resolution make the HREEL the proper spectroscopy to study electronic properties for narrow gap systems and allow to follow a transition from semiconductor to semimetal.

We performed a HREELS experiment in the low energy loss region (0-300 meV) for the Sb/GaAs(110) system, as a function of antimony coverage at room temperature. A few observations can be done on analysing the HREELS data in the elastic peak region and in the (0-80) meV energy loss range, as a function of Sb coverage. For the clean GaAs surface, the Fuchs Kliewer phonon is at about 38 meV, while the plasmon, induced by the dopant's free carriers, is at about 24 meV. At the completion of 1 ML, the surface phonon disappears, as well as the plasmon. At the higher coverages, the expected wider elastic peak widths subsequent to a metallisation of the surface is compensated by the strong quenching of the plasmon and phonon amplitudes[5]. Between the coverages of 1 and 4 ML the elastic peak intensity decreases and the LEED image disappears into the background in agreement with previous works[6]. Therefore, we assume this evidence as an amorphisation of the Sb layer around 4 ML of coverage.

At higher energy losses we observe a structure at about 90 meV ($\Theta \simeq 15ML$), as shown in Fig. 1. Its "center of mass" shifts to higher loss energies, upon increasing the

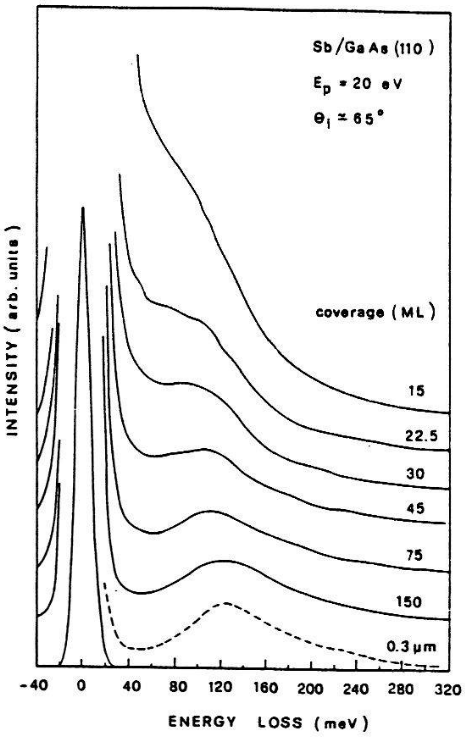


**Fig. 1**

High resolution electron energy loss spectra of the Sb/GaAs(110) interface as a function of coverage. The loss region showing the electronic transition is enlarged by a factor 50. The lowest spectrum, inserted for comparison, corresponds to about 0.3 $\mu$m of Sb sublimated onto a sputtered GaAs(110) surface.

Sb coverage, up to about 125 meV for the 150 ML film. The spectrum relative to this last coverage presents a structure whose spectral shape and position are very similar to those of a thick Sb layer. Our observation is the first evidence obtained through a surface sensitive technique of a structure at this energy on this interface. This loss could be attributed to an electronic excitation of antimony. If we suppose a relatively high joint density of states (JDOS) at those energy values where a gap opens electronic interband transitions can be observed across the gaps, superimposed to a continuum of intraband transitions typical of the semimetal.


[1] R.M. Feenstra and P. Mårtensson, Physical Review Letters **61** (1988) 447

[2] F. Schäffler et al.Physical Review B **36** (1987) 1328

[3] M. Hünermann et al. Surface Science **189/190** (1987) 322;

[4] GaAs(110): Maria Grazia Betti, U. del Pennino and Carlo Mariani, Phys. Rev. B (1989) and reference therein; Si(111)-(2x1): U. del Pennino, M.G. Betti, C. Mariani, C.M. Bertoni, S. Nannarone, I. Abbati, L. Braicovich and A. Rizzi, Surface Science **189/190** (1987) 689 and reference therein

[5] Carlo Mariani, Maria Grazia Betti and U. del Pennino, presented at the $9^{th}$ General Conference of the Condensed Matter Division of the E.P.S., Nice (France), March 1989

[6] J. Carelli and A. Kahn, Surface Science **116** (1982) 380