



	Experiment title: Atomic roughness at the Ge/Si interface in $(\text{Ge}_m\text{Si}_n)_p$ by x-ray reflectivity and absorption at the Ge -K edge	Experiment number: Si-514
Beamline:	Date of experiment: from: 20/1/2000 to: 28/1/2000	Date of report: 29-2-2000
Shifts:	Local contact(s): D. Bowron	<i>Received at ESRF:</i>
Names and affiliations of applicants (* indicates experimentalists): R. Gunnella Universita' di Camerino P. Castrucci Universita' di Camerino V. Rossi Albertini , ISM -CNR- Roma		

Report:

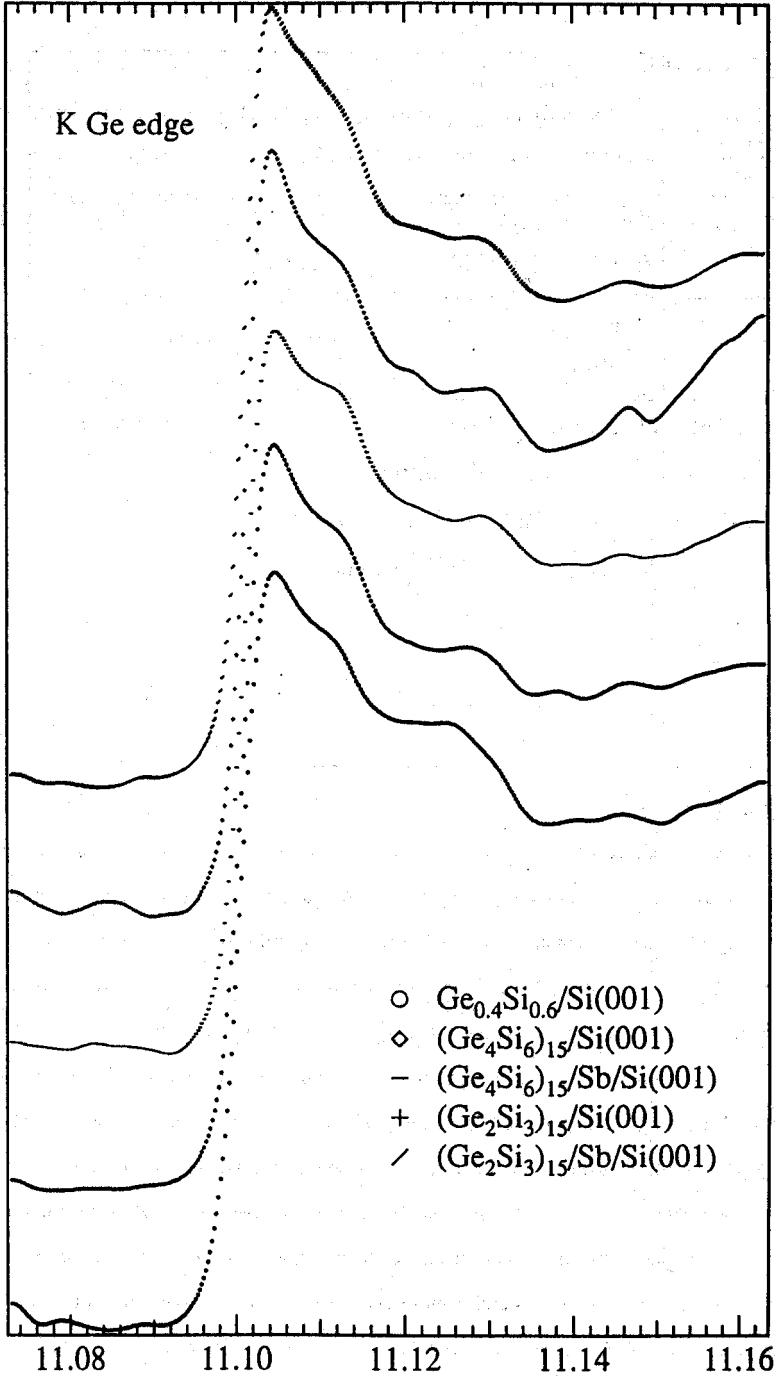
The experiment aimed to model the structural/roughness properties of the Si/Ge interface in terms of intermixing or ordered alloying using the techniques of absorption and anomalous reflectivity in Si/Ge superlattices. A first attempt to perform test X-ray reflection measurements on these samples has been carried out on the beamline BM 29. In this way the equipment recently installed for this kind of measurements has been tested. As the result, on one side, prescriptions to upgrade the new apparatus by substituting too heavy parts that compromise the fine positioning have been obtained. On the other side, a study of one of the samples [Si(50Å)/SiGe(200Å)/Si (001) substrate] has been successfully performed (reflectivity spectrum in fig.1). The oscillations due to the interference of the waves reflected by the external surface and by the two buried interfaces allowed to determine the thickness of the two films and an estimation of their roughness. However the result of the measurements on the other samples were not satisfying, since a higher reproducibility of the experimental conditions and a more accurate scanning system are required, currently beyond the possibilities of the BM29 prototype. The XAS measurements are reported in Fig.2 for 5 samples. From bottom to the top we have 1) 200Å $\text{Ge}_{0.4}\text{Si}_{0.6}/\text{Si}(001)$; 2) $(\text{Ge}_4\text{Si}_6)_{15}/\text{Si}(001)$; 3) $(\text{Ge}_4\text{Si}_6)_{15}/\text{Sb}/\text{Si}(001)$; 4) $(\text{Ge}_2\text{Si}_3)_{15}/\text{Si}(001)$; 5) $(\text{Ge}_2\text{Si}_3)_{15}/\text{Sb}/\text{Si}(001)$. In this case notable differences between the growth of the superlattices in presence or not of Sb (sample 4) vs 5) are observable especially for the short period sample

(Ge₂Si₃)₁₅. The differences are much less important between the large period samples which are closer (in peak intensity and energy position) to that of the alloy sample (1)) indicating a high degree of alloying.

The preliminar conclusion we obtain from a simple visual inspection (multiple scattering calculations will follow) of the experimental results is that the Sb efficiency in enhancing epitaxy and avoiding alloying at the Ge/Si interface is greatly reduced if large period superlattice are considered. This stresses once more the importance of this kind of studies whose aim is to establish the real efficiency of elements used to assist growth. The anomalous reflectivity can have a much higher sensitivity to interface state than XAS, and other experiments on more efficient beamlines are very promising.

Normalized XAS Intensity (arb. units)

K Ge edge



Energy (eV)

