Standard Project

Experimental Report

Proposal title: Early stages of SrTiO3 growth on Ti-passivated GaAs substratess		**Proposal number:** 32-03-721
Beamline: BM 32	**Date(s) of experiment:** from: July 16, 2014 to: July 22, 2014	**Date of report:** March 14, 2016
Shifts: 18	**Local contact(s):** Gilles Renaud	*Date of submission:* *March 14, 2016*

Objective & expected results (less than 10 lines):

Thin (< 1ML) Ti deposits on GaAs(001) surfaces act as passivation layers for further SrTiO3 (STO) growth. In this context, the purpose of this experiment was to determine the structure of GaAs(001):Ti surfaces and its dependence on annealing temperature, as well as the mechanisms of the very early stages of the growth of STO on GaAs. For this purpose, surface X-ray diffraction (SXRD) have been carried out on GaAs:Ti surfaces prepared in situ on the beamline and on STO/GaAs interfaces prepared at INL. Crystal truncation rods (CTR) were recorded, the analysis of which should have allowed for refining atomic models for the GaAs:Ti surface and for the STO/GaAs interface as well as their evolution during the early stages of STO growth.

Results and the conclusions of the study (main part):

We first introduced in the BM32-SUV chamber a GaAs(001) substrate covered by a few nm thick protective As layer, which we desorbed carefully by annealing the sample under UHV, under RHEED supervision. This allowed for obtaining a clean 2x4 reconstructed surface that we extensively analyzed using SXRD to define a reference surface for further experiments. A “surface reconstruction map” as constructed from these SXRD measurements is displayed in Fig.1.

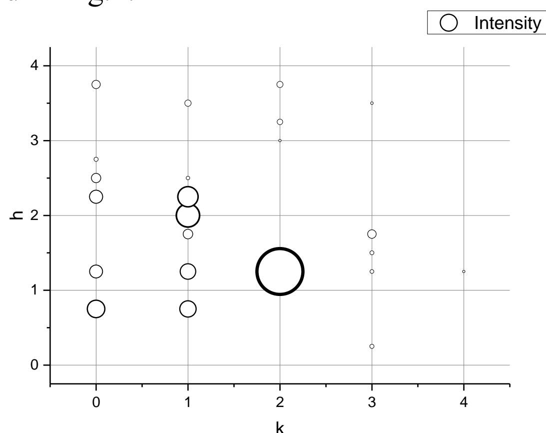

Fig.1: map of the surface reflexions recorded on a As-rich 2x4 reconstructed GaAs surface before Ti deposition. The graph is plotted in surface reciprocal space coordinates, and the ring diameters are proportional to the reflexion intensities.

After these measurements, we deposited on the same sample ½ ML of tTi, and analyzed the surface by RHEED and SXRD. As RHEED showed the expected Ti-rich 4x2 reconstruction, the GIXRD map of the surface was correspondingly significantly modified, as shown in Fig.2.

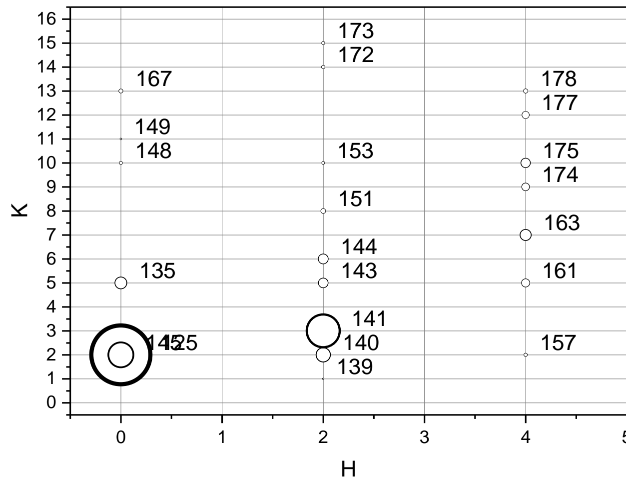

Fig.2: map of the surface reflexions recorded after in-situ deposition of ½ ML of Ti on a As-rich 2x4 reconstructed GaAs

The analysis of this map will a provide a first insight into the organization of the Ti atoms on the GaAs surface. In order to quantitatively assess this organization, crystal truncation rods where recorded. However, due to significant surface disorder, the extension of these CTRs in the reciprocal space was important, leading to strong difficulties in measuring their total intensity.

The same operation was carried out on samples on which a few ML of STO had been deposited by MBE at INL, before the experiments. The analyzed samples included STO layers of various thicknesses deposited with and without Ti surface preparations. For eacth of these samples, CTR were recored and the same issue related to strong extension of the CTRs in the reciprocal space was encountered, leading in each case to significant difficulties in conveniently recording the total diffracted intensity.

The CTRs are currently being analyzed in the view of refining the GaAs:Ti surface structure and the STO/GaAs interface configuration. The experimental difficulties mentioned above, combined with data analysis issued related to strong atomic disorded make this refinment particularly challenging, and up to now unsuccessful. Further efforts will engaged to derive the maximum possible information from these experimental results