# STRUCTURAL PROPERTIES OF $Al_2O_3$/InAs(100) INTERFACES WITH AND WITHOUT PRE-OXIDIZED CRYSTALLINE SURFACES

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We have studied bonding environmental changes at $Al_2O_3$/InAs interfaces depending on the InAs(100) starting surface. Native oxide, sputter-cleaned, pre-oxidized InAs(100)(3×1)-O and InAs(100)*c*(4×2)-O starting surfaces were compared. The pre-oxidized crystalline surfaces[1] are technologically interesting, since they enable surprisingly low defect-state densities at insulator/III-V semiconductor junctions[2-6]. This effect can be exploited in enhancing the energy efficiency of various semiconductor based nano-electronic devices like transistors, solar cells, LEDs, and detectors. However, reasons for the enhancement and the detailed atomic structures of the crystalline surfaces are still unknown. It is unclear for instance, how the deposition of the insulating film changes the structures, and which changes decrease mainly the defect-state density. We have studied therefore the different interface structures by means of synchrotron radiation high kinetic-energy photoelectron spectroscopy, after growing a 12 nm thick $Al_2O_3$ film with atomic layer deposition (ALD) method. In addition, we have fabricated InGaAs photodetectors utilizing the crystalline *c*(4×2)-O structure.

Several interesting structural differences are found between the interfaces. Results are also compared to the data observed from InAs surfaces without the $Al_2O_3$ film[3,4]. For example: (i) $As_2O_3$ oxide phase vanishes during the $Al_2O_3$ film growth, even if the ALD growth starts with an $H_2O$ pulse instead of the more reactive TMA pulse; (ii) $In_2O$ bonding environment changes due to the $Al_2O_3$ growth; and (iii) negative core-level shifts in the photoelectron spectra appear to be an inherent property of the crystalline oxide structures, and hence not caused by the sputter-cleaning of InAs(100) starting surfaces. Moreover, we have investigated the starting surfaces by scanning tunnelling microscopy as well as the $Al_2O_3$ film quality by time-of-flight elastic recoil detection analysis (ToF-ERDA) method[7]. ToF-ERDA results show that the grown $Al_2O_3$ films are homogenous and contain remarkably low concentration of impurities.

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