7th Annual Meeting of the Japanese Synchrotron Radiation Society and Asian Forum on Synchrotron Radiation, Kobe, 11.-13.5.94

P11-58

The Growth of SrF_2 on InP(100)

S. Heun, M. Sugiyama, S. Maeyama, Y. Watanabe, and M. Oshima
NTT Interdisciplinary Research Laboratories, 3-9-11 Musashino-shi, Tokyo 180, Japan
Tel.: +81-422-59-2521, FAX: +81-422-59-3576

InP is a highly promising material for the fabrication of metal-insulator-semiconductor field effect transistors (MISFET) to be used in high-speed devices and microwave power devices. Due to its small lattice mismatch SrF_2 is a good candidate for an insulating layer on this semiconductor. We studied the room temperature (RT) growth of SrF_2 on a clean and on an As-stabilized InP(100)-surface with a variety of methods to obtain electronic and structural informations. The goal of the modification of the substrate was to examine the possible role of As, which is a well known surfactant element for the Si/Ge-case [1].

The experiments were carried out at the Photon Factory on beam line BL-1A in Tsukuba in an UHV-chamber described elsewhere [2]. Since a synchrotron radiation beam of 100 eV was used for photoelectron spectroscopy (SRPES), very surface sensitive information was obtained. Samples were n-type InP(100). After degreasing in ethanol they were mounted on a Mo-sample holder. One sample was then dipped into HF at RT for 30 sec. and transferred into UHV under an ethanol-atmosphere. After deposition of 40 Å SrF_2 at RT on a clean surface the In 4d-peak vanished in the SRPES-spectrum, so we conclude the film is continuous and flat. Even after annealing the film to 500°C this peak does not reappear so the film still remains continuous and flat. This is proved additionally by an AFM- and SEM-examination. Furthermore a strong crystallization effect is measured in the SRPES-Sr 4p- and F 2p-spectra. The SRPES-spectra belonging to these surfaces are shown in fig. 1.

Another sample was exposed to an As_4-beam at 500°C for 10 min. and annealed in vacuum. After this treatment a bright 2x4-RHEED pattern was obtained. The thickness of this InAs-layer was estimated from the attenuation of the XPS-P 2p-intensity to be 5 Å (≈2 ML), which is in good agreement with the results of Moison et al. [3]. In contrast to the clean sample the SRPES-In 4d-peak does not vanish completely after RT-deposition of 40 Å SrF_2 on the As-stabilized surface. This could be explained by a discontinuous film. However, with regard to the low deposition temperature it is more probable that the film is rough and continuous. The intensity ratio of the In 4d- and the As 3d-peak is the same before and after deposition, so we conclude that no As has segregated on top of the SrF_2-film. After annealing the film up to 500°C it showed a spotty 1x1-RHEED pattern which points to a three dimensional crystalline film. This was proved by the AFM- and SEM-examination. The intensity of the In 4d- and As 3d-peak in the SRPES-spectrum is increased with respect to the as-deposited film which points also to islanding. The measured spectra are shown in fig. 1.

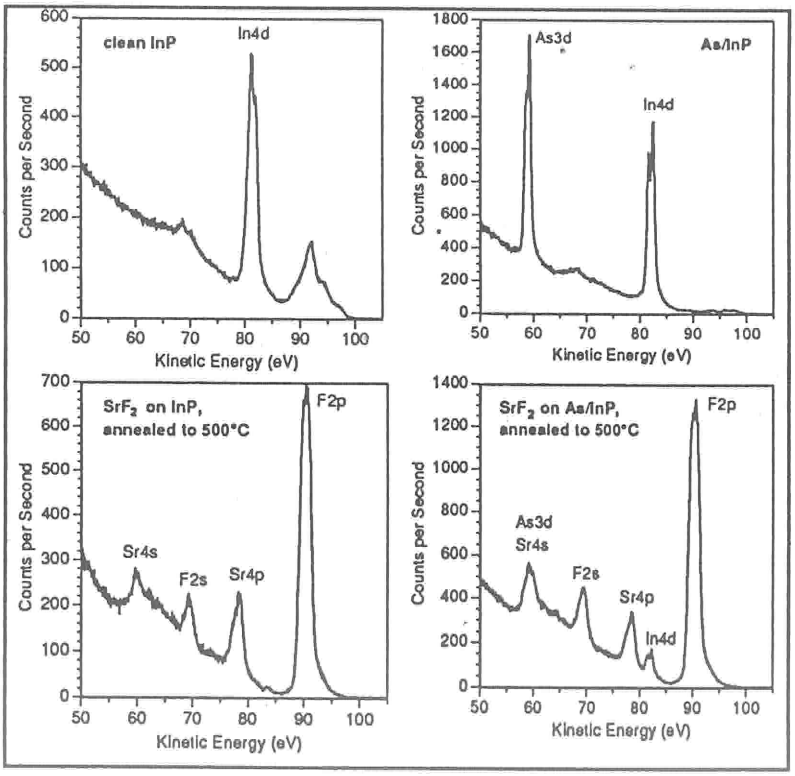

Fig.1: SRPES-spectra before and after deposition of 40 Å SrF_2

We have shown that a controlled modification of the substrate allows to change the morphology of the growing film. It is found that the InAs overlayer remains at the interface. The detailed mechanism for the SrF_2 crystal growth will be discussed. Band bending effects will also be discussed.

References:

[1] M. Copel, M. C. Reuter, E. Kaxiras, and R. M. Tromp: Phys. Rev. Lett. 63 (1989) 632.

[2] M. Oshima, T. Kawamura, S. Maeyama, and T. Miyahara: J. Vac. Sci. Technol. A 6 (1988) 1451

[3] J. M. Moison, M. Bensoussan, and F. Houzay: Phys. Rev. B 34 (1986) 2018.