Kelvin Probe Force Microscopy of KBr Thin Films Epitaxially Grown on InSb(001) Surface

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Kelvin Probe Force Microscopy (KPFM) has been used to study submonolayer KBr films on InSb(001) surface in UHV. The KPFM measurements have been performed with home built signal processing and control modules combined with Park Scientific Instruments VP2 AFM/STM. The InSb(001) substrate surface cleaned by repetitive sputtering (with Ar^+, 700 eV ions) and annealing (to about 450^{o}C) has been adsorbed with KBr molecules from a K-cell at a rate of about 0.8 ML/min at about 370 K. Both, topographic and contact potential difference (CPD) maps have been recorded using the FM mode. For the CPD imaging, the sample was biased with an AC component of amplitude of 1 V and frequency ω in the range of 300÷400 Hz. It has been found that KBr molecules aggregate into monatomic-thick islands elongated in <110> direction. Such island shapes are induced by the structure of InSb(001) surface that is composed of atomic rows running parallel to the <110> direction. High resolution topographic KPFM images display similar stripes, parallel to <110> and separated by about 18 Å one from another, both on KBr islands and on the substrate, however being out of phase. Observed contrast reflects the complex structure of the KBr/InSb interface [1]. The interface is stabilized by the strong bonding between In and Br atoms but there exist three basic inequivalent configurations for the Br atoms and two for K atoms. The contrast may in principle arise from several factors i.e. topographic elevations, chemical interactions, and tip-induced vertical displacements different for atoms resting in different surface sites. Since the monatomic KBr film on InSb is rather smooth [1] we suggest that the observed stripy patterns are the result of different tip induced vertical displacements for different atomic rows. This concept is supported by the energy dissipation maps, acquired simultaneously with topographic images, displaying similar stripy character. From the CPD imaging, it is measured that the local surface potential (work function) of KBr/InSb interface is lower by about 210 mV compare to the bare InSb(001) substrate. The observed features in the CPD images of shapes which correspond to the KBr islands, exhibit size-dependent contrast which likely to be the effect of averaging due to a finite tip size. However, two KBr islands which are separated 4 nm from each other can be easily distinguished in the CPD image.

[1] J.J.Kolodziej, B. Such, P. Czuba, F.Krok, P. Piatkowski, M. Szymonski, Surf. Sci. 506 (2002) 12.