Quasi–van der Waals epitaxy and characterization of PbSe nanostructures on the (0001) surfaces of layered crystals GaSe

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The growth morphology, composition and structure of PbSe nanostructures grown on the atomically smooth clean uncontaminated and oxidized van der Waals (0001) surfaces of GaSe layered crystals were studied by means of atomic force microscopy (AFM), X-ray diffractometry (XRD) and photoelectron spectroscopy (XPS). Using the hot-wall technique the quasi–van der Waals epitaxy of PbSe on nanoporous GaSe layered crystals was investigated. Nanoporous GaSe substrates were fabricated by thermal annealing of layered crystals in molecular hydrogen atmosphere. It was found that the PbSe showed a tendency to form clusters with a square or rectangular symmetry onto the clean low energy (0001) GaSe surface and (001)-oriented growth of PbSe thin films takes place. No crystal faceting of the nanoislands was observed for the PbSe nanostructures grown on the oxidized (0001) GaSe substrates. We demonstrate the growth of faceted square pillar-like PbSe nanostructures on nanoporous GaSe substrates. We exploit the VLS growth with low-melting metal (Ga) catalyst of PbSe crystalline branched nanostructures via surface-defect-assisted mechanism. Stress-induced changes in the tapping-mode AFM images of composite nanostructures consisting of layered nanoporous GaSe matrix and PbSe nanopillars formed in nanoscale cavities on van der Waals (0001) surfaces of GaSe layers were observed. These phenomena may be attributed to the flexoelectric effect in the layered GaSe matrix due to the deformation interaction between the nanoscale pyramidal PbSe inclusions and layered-crystal matrix. Flexoelectric coupling in low-dimensional layered systems can be used as basis for new spintronic, photoelectronic and electromechanical nanodevices [1, 2].

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