Self-assembled nanostructures in mixed III-V and III-nitride layers

The group III arsenides and phosphides crystallize in the zinc-blende (ZB) structure, whereas the III group nitrides have the wurtzitic (WZ) structure. The ZB structure consists of two interpenetrating FCC sub-lattices that are displaced from each other by a/4 <III>, where “a” is the lattice parameter of the layer; the WZ structure also consists of two interpenetrating HCP sub-lattices that are also displaced from each other. In both structures, the group III species occupy one sub-lattice, whereas the group V atoms reside on the second sub-lattice.

The binary arsenides, phosphides and nitrides have discrete band gaps. The binaries are mixed to produce ternary and quaternary layers that have band gaps in between those of the binaries. The question is: are the atomic species distributed at random on their respective sub-lattices? We will show experimentally that they are not. Two types of deviations from randomness are observed in the two material systems: phase separation and atomic ordering. Phase separation is observed in mixed layers that contain atomic species differing in their covalent tetrahedral radii. In arsenides and phosphides, atomic ordering is caused by (2x4) surface reconstruction that biases the occupation of sub-surface sites by atoms differing in their tetrahedral radii. At present, the occurrence of ordering in the nitrides is not well understood.

Phase separation and ordering affects electronic and optical properties of the layers.

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