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Coalescence of ELO layers of InGaAs grown on patterned (111) GaAs by LPE

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$In_xGa_{1-x}As$ (x=0.06) epitaxial lateral overgrown (ELO) layers were grown on (111)B GaAs patterned substrates covered with SiN_x mask by LPE. When the layers with {111}A and {111}B growth coalesced, dislocations got generated. For the coalesced ELO layers in constant touch with the basal SiN_x mask, the surface became concave due to thickness decrease of the layers. This problem of thickness decrease was not present when a big enough void structure was present in the grown InGaAs ELO layers.

1. Introduction: In the ELO layers, problems like crystallographic tilting and generation of dislocations induced by coalescence often occur. ELO and bridge layers of $In_xGa_{1-x}As$ appear outside and inside the trench, respectively, and the most important difference between them is that the ELO layers are always in contact with the SiN_x mask, whereas, the bridge layers are not in contact it. We have analyzed two aspects of the growth of ELO layers of InGaAs on patterned (111)B GaAs substrates: 1. Coalescence of ELO layers with different growth fronts, {111}A and {111}B, and 2. thickness decrease phenomenon in the ELO layers.

2. Experimental: $In_xGa_{1-x}As$ (x = 0.06) layers were grown on two types of patterned (111)B GaAs substrates by LPE, (i) circular-seed-substrates (having 1mm dia. circular window) and (ii) <110> line-seed-substrates (having line opening oriented in the <110> direction) and were analyzed by microscopes.

3. Results and discussion: At the corners of the hexagonal shaped ELO layers grown, defects were found to get accumulated. This was confirmed by the microscopic and etching analyses. During the growth of InGaAs ELO layers, alternate {111}A and {111}B growth fronts appeared and these were parallel to <110> directions. When the coalescence of the neighboring growth fronts of {111}A and {111}B occurs, dislocations get originated and this was confirmed by the AFM observation of deep valley like structures. The coalescing layers of different types, with {111}A and {111} growth fronts, have different thickness and slopes. The thickness decrease phenomenon was found to have taken place in the growth of ELO layers of InGaAs irrespective of the nature of growth fronts i.e. {111}A and {111}B. The surface of the layer was concave when the ELO layer was in contact with the SiN_x mask, on the other hand, when the void structure between the layer and the SiN_x mask existed (bridge layer), the surface of the layer was found to be flat.

4. Conclusions: In the case of InGaAs ELO layers, dislocations were found to be generated when the growth fronts {111}A and {111}B coalesced due to difference of thickness of the layers. When the ELO layers were in touch with the basal SiN_x mask, irrespective of the type of the growth front, the surface was found to be concave due to thickness decrease phenomenon. When there was a void formation, the layer surface was found to be flat as the problem of decrease of thickness was effectively overcome.