<111>A-oriented InP nanowire array grown by self-catalyzed vapor-liquid-solid approach towards stacking-fault-free nanowires

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InP nanowires grown by using a bottom-up vapor-liquid-solid (VLS) approach have been considered as next-generation building blocks for tiny opto-electronic devices. However, these VLS-grown InP nanowires generally have a kind of plane defect, i.e., stacking fault. One potential way to realize stacking-fault-free nanowires is to grow nanowires with <111>A orientation instead of normal <111>B orientation [J. Crystal Growth 287 (2006) 504]. Nevertheless, <111>A-oriented InP nanowires remain challenging to grow. Here we report growth of <111>A-oriented InP nanowires and their structural property by comparing them with <111>B-oriented InP nanowires.

We grew InP nanowires in an MOVPE system via self-catalyzed VLS mode. We used InP (111)A and (111)B substrates to control polar orientation (Fig. 1a, b). Cs-STEM measurements show that the polarities coincided with those of the substrates (Fig. 1c, d). There are numerous stacking faults in <111>B-oriented nanowires (density: > 500 μm-1) but very few in <111>A-oriented nanowires (density: < 14 μm-1). In contrast to stacking faults in <111>B-oriented nanowires, each stacking fault in <111>A-oriented nanowires is found to be accompanied by {111}A and {111}B side facets. These results indicate most stacking faults formed in <111> B-oriented nanowires without side facet formation can be eliminated by reversing their polarity to <111> A orientation.

We have successfully grown a <111>A-oriented InP nanowire array via self-catalyzed VLS mode. The significantly reduced density of stacking faults by polar change indicates that polar orientation control is an effective way to realize stacking-fault-free nanowires. This work was supported by JSPS KAKENHI (21H01834, 23H01792, 23H01888).