X-ray diffraction studies on the orientation patterned heteroepitaxial GaP and GaAsP to assess the domain fidelity

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Orientation patterned (OP) GaP is a quasi-phase matched (QPM) non-linear optical material. OP-GaP has high thermal conductivity, low thermal expansion coefficient and negligible two-photon absorption (2PA) in the 1 – 1.7 μm range when compared with GaAs. Thus, OP-GaP enables efficient pumping with high power near IR laser sources at the wavelength of 1040 nm and 1064 nm to obtain high output power in the mid-IR and terahertz region for sensing, medical imaging, industry and spectroscopy [1,2].

In this paper, OP-GaP and OP-GaAsP have been grown on OP-GaAs templates because the commercially available GaP is expensive and has lower structural and surface quality compared to GaAs [3]. OP-GaP and OP-GaAsP heteroepitaxial layers were grown using hydride vapor phase epitaxy (HVPE). The frequency conversion devices (FCD) require few hundred microns thick OP-GaP layers. However, preserving the domains periodicity from the OP template to epilayers (domain fidelity) is a challenging task. We have reported a non-destructive investigation of these OP heteroepitaxial layers' domain fidelity and the crystalline quality of individual domains using high resolution x-ray diffraction reciprocal space map [4]. Here we report on the effect of thickness of OP-GaP and OP-GaAsP layers on the x-ray rocking curve (XRC) and reciprocal space map (RSM) analysis. It is worth to note that, while increasing the thickness of OP epilayers from few tens of microns to few hundreds of microns, the domains are being inseparable in the XRC and RSM. It may be attributed to the reduction of misorientation between domains with increase in the thickness. In addition, the role of OP-GaAs templates on the crystalline quality, growth rate and domain boundaries of OP-GaP heteroepitaxial layers will be presented.

References

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