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Introduction of InP-Based Light Emitter into GaAs-Based 3D Photonic Crystal by Improved Wafer Bonding of Dissimilar Materials

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We developed improved wafer-bonding techniques for dissimilar materials in order to introduce an InP-based light emitter into a GaAs-based three-dimensional (3D) photonic crystal (PC). Observation of the GaAs/InGaAsP-bonding interface by scanning acoustic microscopy revealed that debonding occurred at approximately 300℃ due to the differing thermal expansion coefficients of GaAs and InP. We calculated thermal stress using a 2D finite-element method and found that it could be reduced by thinning the InP substrate. These results were used to successfully develop a 3D PC incorporating a multiple quantum-well light-emitting structure and artificial defects. Photoluminescence measurements revealed that spontaneous emission within the PC region was reduced due to the complete photonic band gap, while strong emission due to the defect state was observed only within the defect region. These results are important steps towards the realization of novel light-sources, such as zero-threshold lasers, using 3D PCs.

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