

Holonyak *et al.* Respond: Rather than a divergence between the results obtained on quantum-well heterostructures (QWH) grown by metal-organic chemical-vapor deposition (MO-CVD) and molecular-beam epitaxy (MBE), there may actually be some convergence. In the Comment above, Miller and co-workers mention that island growth in MBE QWH's is sensitive to temperature, and becomes worse if the substrate temperature deviates $\pm 50^\circ\text{C}$ from some unspecified temperature T_s . Apparently most of the work, with no observed clustering, that these workers cite involves the use of MBE QWH crystals grown at $\leq 600^\circ\text{C}$. The best MBE QWH laser crystal of which we are aware, however (i.e., the only one to have operated continuously at 300 K), has been grown at $> 600^\circ\text{C}$ ($\sim 650^\circ\text{C}$) and, moreover, operates (at high excitation level, $> 10^3\text{ A/cm}^2$) as a laser 30–40 meV ($\sim \hbar\omega_{L0}$) below the $n=1$ electron-to-light-hole or the electron-to-heavy-hole transitions (8518 and 8567 Å; see Fig. 2 of Tsang *et al.*, Ref. 1; confined-particle transitions unmarked). This behavior agrees with the type of results we have reported for MO-CVD QWH lasers grown at 750°C ,^{2,3} and can be explained by clustering.⁴

All of the work on QWH's [MBE, MO-CVD or LPE (liquid-phase epitaxy)] is sufficiently new, and totally sensitive and dependent upon the crystal-growth process and choice of experimental parameters, so that it is not established yet in any great detail what T_s and other experimental conditions are optimum for each growth process. Probably all of these crystal-growth processes will be subject to clustering for certain substrate temperatures, growth rates, and choice of crystal compositions (x in $\text{Al}_x\text{Ga}_{1-x}\text{As}$). For example,

more of a problem with clustering, at certain temperatures, might exist near the direct-indirect transition ($x \approx x_c \sim 0.45$ for $\text{Al}_x\text{Ga}_{1-x}\text{As}$). As we have shown,⁴ however, one solution to the problem of clustering in $\text{Al}_x\text{Ga}_{1-x}\text{As}$ is simply to substitute AlAs coupling and isolation barriers in $\text{Al}_x\text{Ga}_{1-x}\text{As-GaAs}$ QWH's. This permits also certain freedom in choice and manner of QWH crystal growth.

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