Pressure-Dependent Photoluminescence of a GeSn/SiGeSn Single Quantum Well at 10 K

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The 10 K photoluminescence (PL) properties of a GeSn/SiGeSn single quantum-well (SQW) heterostructure are measured as a function of hydrostatic pressure applied using a diamond anvil cell (DAC) from 0 to ~0.5 GPa. With increasing pressure, the PL peak exhibits a consistent blueshift with a clear reduction in intensity beyond ~0.5 GPa due to PL quenching. The PL peak energy increased linearly with pressure, resulting in a pressure coefficient of approximately 48 meV/GPa. By fitting the PL energy shift against strain calculated using the Murnaghan equation, the hydrostatic deformation potential is evaluated as −3.5 ± 0.1 eV.

The strain in the GeSn/SiGeSn structure is evaluated using high-resolution X-ray diffraction (XRD) and reciprocal space mapping (RSM) along both (004) and (224) directions. These measurements allowed precise determination of in-plane and out-of-plane lattice constants for the quantum well, buffer, and barrier layers. Using these lattice parameters, the hydrostatic and shear strain components are calculated for each layer in the heterostructure, enabling determination of the band edge alignment as a function of strain. The results provide insights into band structure engineering in GeSn/SiGeSn QWs and demonstrate their tunable optical properties under external pressure.