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Delayed photoluminescence in three-dimensional silicon/silicon germanium nanostructures LEONID TSYBESKOV, NIKHIL MODI, SELINA MALA, New Jersey Institute of Technology, J.-M BARIBEAU, X WU, D. J. LOCKWOOD, Institute for Microstructural Sciences, National Research Council of Canada
— In three-dimensional (3D), SiGe nano-island multi-layers separated by nanometer-thick Si layers with the enhanced local strain field visualized by transmission electron microscopy (TEM), we find unusual low temperature photoluminescence (PL) dynamics. The PL detected at 1350 nm rises practically instantly and decays with a lifetime faster than 20 nanoseconds. In contrast, the PL detected at 1550 nm has a rise time of longer than 3-4 microseconds, and it decays with a characteristic lifetime which changes from 10 microseconds to milliseconds. The proposed model considers recombination of excitons bound to SiGe/Si interface as a mechanism responsible for the fast PL at 1350 nm. The observed slow rising PL with a peak near 1550 nm is associated with Auger ionization of SiGe clusters and separation of electrons and holes followed by carrier/exciton diffusion within Si layers toward a longer wavelength luminescence sites. These sites are associated with SiGe cluster areas containing a higher Ge concentration, and they are detected by analytical TEM.

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