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Impact of Alloy Fluctuations on Radiative and Auger Recombination in InGaN Quantum Wells[1] CHRISTINA JONES, CHU-HSIANG TENG, University of Michigan, QIMIN YAN, Temple University, PEI-CHENG KU, EMMANOUIL KIOUPAKIS, University of Michigan — Light-emitting diodes (LEDs) based on indium gallium nitride (InGaN) are important for efficient solid-state lighting (2014 Nobel Prize in Physics). Despite its many successes, InGaN suffers from issues that reduce the efficiency of devices at high power, such as the green gap and efficiency droop. The origin of the droop has been attributed to Auger recombination, mediated by carrier scattering due to phonons and alloy disorder. Additionally, InGaN exhibits atomic-scale composition fluctuations that localize carriers and may affect the efficiency. In this work, we study the effect of local composition fluctuations on the radiative recombination rate, Auger recombination rate, and efficiency of InGaN/GaN quantum wells. We apply k.p calculations to simulate band edges and wave functions of quantum wells with fluctuating alloy distributions based on atom probe tomography data, and we evaluate double and triple overlaps of electron and hole wave functions. We compare results for quantum wells with fluctuating alloy distributions to those with uniform alloy compositions and to published work. Our results demonstrate that alloy-composition fluctuations aggravate the efficiency-droop and green-gap problems and further reduce LED efficiency at high power.

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