Si homojunction infrared LED based on the dressed photon-assisted process

Tadashi Kawazoe
Department of Electrical Engineering and Information Systems, Graduate School of Engineering, The University of Tokyo, 2-11-16 Yayoi, Bunkyo-ku, Tokyo 113-8656, Japan
Email: kawazoe@ee.t.u-tokyo.ac.jp

A highly efficient silicon light emitting diode (LED) driven by a dressed photon was fabricated. The device emitted light in a wide photon energy region of 0.73–1.24 eV (wavelength 1.00–1.70 μm). The total power of the emitted light with 11 W of electrical input power was as high as 1.1 W. The external power conversion efficiency of the emitted light was 1.3%, the differential external power conversion efficiency was 5.0%, the external quantum efficiency was 15%, and the differential external quantum efficiency was 40%. The dependency of the emitted light power density on the injected current density clearly showed a characteristic reflecting the two-step phonon-assisted transition process. The dressed photons are generated at the inhomogeneous domain boundary of a dopant in a homojunction bulk Si crystal[1]. To fabricate this device, a forward current was made to flow through a Si p-n junction to anneal it. During this process, the device was irradiated with near-infrared light, producing stimulated-emission light using a two-step dressed photon-assisted process triggered by the optical near field, and the annealing rate was controlled in a self-organized manner. This modified Si p-n junction by the dressed photon is also applicable to an optical and electrical relaxation oscillator [2], a novel photodetector for the wavelength of 1.3 μm[3], and an infrared laser [4]. In the presentation, I review these Si photoelectric conversion devices using a dressed photon.

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References

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Tadashi Kawazoe received Ph.D. degrees in physics from University of Tsukuba, Tsukuba, Japan, in 1996. He has studied optical nonlinearities in quantum dots at the Institute of Physics, University of Tsukuba. Since 2000, He has studied optical devices and fabrication based on an optical near-field interaction. In 2007, he joined the University of Tokyo as a projected associated professor. Form 2010, he has been a projected researcher at the department of electrical engineering and information systems, graduate school of engineering, The University of Tokyo. His current research interests are in the nanophotonic device.

Dr. Kawazoe is a member of the Japan Society of Applied Physics and the Physical Society of Japan.