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Photonic Crystals for Society 5.0
— Photonic-Crystal Lasers —

Susumu Noda

Kyoto University
Kyoto 615-8510, Japan
Phone: +81-75-383-2315, E-mail: snoda@kuee.kyoto-u.ac.jp

Abstract

In this plenary talk, I will describe the progress of photonic crytals, especially for smart mobility and production in the forthcoming Society 5.0, by focusing on photonic-crystal lasers.

Almost two decades have passed since the realization of complete three-dimensional photonic crystals at optical wavelengths [1,2]. During these years, the manipulation of photons by photonic crystals has progressed tremendously. For example, the concept of confining photons to a very small modal volume has been established [3,4] and nanocavity *Q*-factors have exceeded 10 million [5], enabling platforms for strong light-matter interaction and quantum information processing.

Photonic crystals also allow a broad-area manipulation of photons, by which semiconductor lasers, so-called photonic-crystal lasers (see Fig.1) with a high-power and high-beam quality (namely, a high brightness) have been realized [6-11].

Photonic crystals even enable thermal emission control, by which the issues of conventional thermal emission devices such as their extremely broad emission spectra and slow response speed have been fixed, and an evolution of thermal emission device technology has been achieved [12,13].

In this plenary talk, I will focus on photonic-crystal lasers, which are important for smart mobility (LiDAR) and smart production (direct semiconductor laser processing) in the forthcoming Society 5.0 [14]. I will first describe why the photonic crystal lasers are important for such applications from the viewpoint of brightness, which is a figure of merit that expresses how intensely a laser beam can be focused, or how narrowly the beam diverges [11]. Then, I will show that the brightness of photonic crystal lasers has now exceeded 300MWcm-2sr-1 and is approaching 1GWcm-2sr-1, owing to newly developed double-lattice photonic crystal structures (see Fig.1 inset) [11]. I will then describe two-dimensional electronic beam-scanning operation of photonic crystal lasers, as well as an extension to GaN semiconductor systems (in the blue-violet regime).

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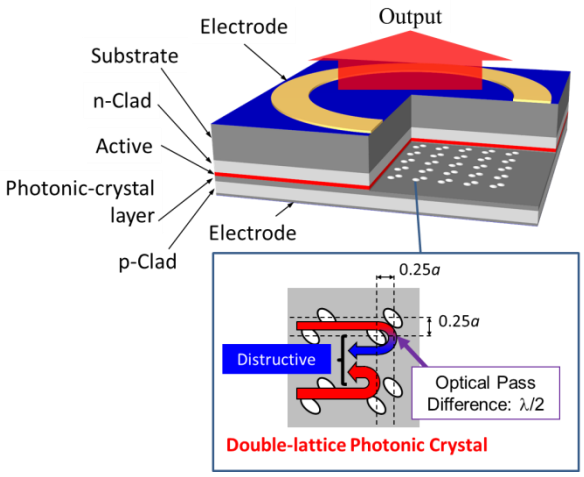

Fig.1. Schematic of photonic crystal laser. Inset shows double-lattice photonic crystal structure, which has been developed recently [11].

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