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Strong Optical Filed Intensity Improvement Introducing InGaAsP Quantum Wells in InP Nanocavity

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ABSTRACT: This paper presents the optical characteristics of a quantum well doped InP nanocavity. The resonance wavelength of the nanocavity and the optical field intensity is calculated before and after presence of the quantum wells. The resulting huge filed intensity of about 1.2×10^{8} respect to the incident field is the effect of quantum wells placed in vicinity of center of nanocavity.

Keywords: *Nanocavity, Quantum well, Photonic crystal*

INTRODUCTION

Nanocavities or nano resonators based on photonic crystals structures have attracted attentions of researchers due to their capabilities to concentrate and improve optical fields in very small spaces of nanometer sizes [1-4]. The unique ability of the optical nanocavities to efficiently tune their resonance properties by varying the structural parameters of the nanostructures make them promising devices in all optical and optoelectronic systems. The performance of the PC nanocavities is based on trapping and enhancing the optical field of light within the cavity. This enhanced field with defined resonance wavelength can be applied in diverse applications such as optical sources, lasers, nonlinear optics and etc [5-6]. In this paper, we present the effect of introducing InGaAsP quantum well lasers to the central part of the InP nanocavity; regarding the changes in resonance wavelength and intensity of optical field.

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RESULTS AND DISCUSSION

The designed structure of the InP nanocavity is presented in Fig. 1. The geometrical parameters have been defined in order to lead the nanocavity to resonate at the wavelength of $\lambda = 1.55$ μm. Finite difference time domain (FDTD) based calculation tools applying perfectly matched layer (PML) boundary condition have been utilized to simulate the optical-resonance properties of the nanocavity.

InP nanocavity confines the incident field within the core area (more strongly around the central part) and highly enhances it at the resonance wavelength due to the optical resonance effect. Fig. 2 shows the opti-

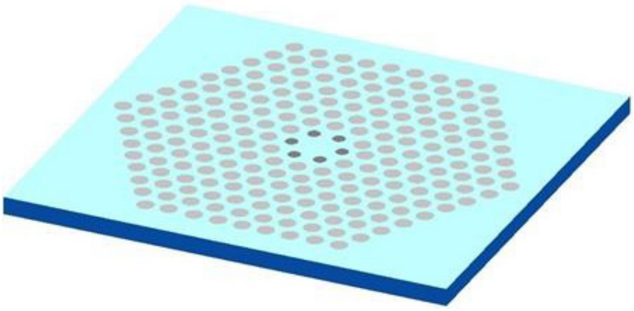

Fig. 1. Schematic of the structure of nano cavity.

cal field intensity (resonance spectrum) respect to the input source that has been selected as an x-polarized electric dipole (with the highest value at at the wavelength of λ= 1.55 μm).

Fig. 2 illustrates that the designed InP nanocavity enhances the exciting optical field about 300 times (concentrated in core area of the cavity). Introducing InGaAsP quantum wells in the vicinity of the central part of the nanocavity provides a gain region where recombination of the excited electron-holes excited by incident source emits more photons into the nanocavity modes.

Fig. 3 demonstrates the enormous improvement of the optical field within the structure of Quantum wells doped nanocavity in which the optical field of incident light experiences much more enhancement about 1.2×10^8 times. It should be noted that the structural and geometrical parameters of quantum wells have been selected in order to preserve the resonance wavelength at λ = 1.55 μm.

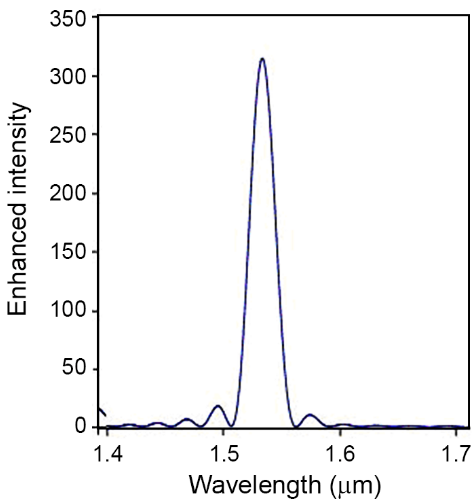

Fig. 2. Optical Field Intensity improvement at resonance wavelength (InP nanocavity).

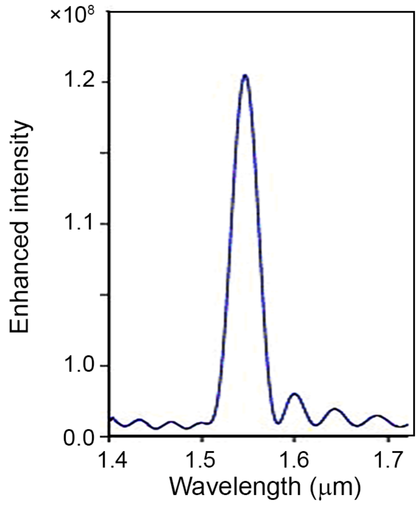

Fig. 3. Optical Field Intensity improvement at resonance wavelength (InGaAsP quantum wells nanocavity).

CONCLUSIONS

This study investigated the effect of InGaAsP quantum wells introduced in the central part of the InP nanocavity. The obtained huge field intensity enhancement is due to photons emitted into the cavity modes. The presented structure is an appropriate candidate for dielectric nanolaser and optical source applications.

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