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利用形態　　:共同研究
利用課題名（日本語）　　:

Program Title (English)　　:GaN-based Microdisk Cavity Laser with Plasmonic Enhancement

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1. 概要（Summary）

Microdisk lasers feature low-loss, high-quality whispering
gallery modes that offer the potential for ultra-low threshold lasing that is not limited by challenges in mirror fabrication. With the effects of the microdisk cavity being observed in GaN, a comparison between GaN microdisks with other conventional III–V semiconductors, say GaAs, can be made in order to provide a guideline for future GaN microdisk lasers. The obvious and attractive distinction of the GaN based microdisk is the working wavelength range in the blue and ultraviolet. In our research, we studied on the sample with the structure of GaN-based blue laser grown in SINANO, fabricating its nano-structure with different nano-pattern to get microdisk laser. Then we could combine the device with metal particles on the top or the side wall of the structure to create surface-enhanced plasmon for the signal enhancement.

2. 実験（Experimental）

【利用した主な装置】

超高精度電子ビーム描画装置(EBL, ELS-F125-U, Elionix); ヘリコンスパッタリング装置 (MPS-4000C1/HC1, ULVAC); 高分解能電界放射型走査型電子顕微鏡 (JSM-6700FT, JEOL).

【実験方法】

The GaN-based blue laser were grown in SINANO. The nano-hexagonal structures of microdisk of GaN laser was design and and fabricated of different sizes and shapes using High-resolution electron beam lithography (EBL, ELS-F125-U, Elionix); Helicon sputtering system (MPS-4000C1/HC1, ULVAC), and characterized by FE-SEM (JSM-6700FT, JEOL).

3. 結果と考察（Results and Discussion）

The LD structure is shown as Fig.1, which is grown by by metal organic chemical vapor deposition (MOCVD), composed of a 1000nm n-type $Al_{0.08}Ga_{0.92}N$/GaN cladding layer, a 300nm n-type GaN layer, a 100nm undoped lower $In_{0.06}Ga_{0.94}N$ N-waveguide layer, a 35nm MQWs active region, a 100nm undoped upper $In_{0.03}Ga_{0.97}N$ P-waveguide layer, a 20nm p-type $Al_{0.2}Ga_{0.8}N$ EBL, a 500nm p-type $Al_{0.08}Ga_{0.92}N$/GaN cladding layer. The MQWs consist of two 2.5 nm undoped $In_{0.16}Ga_{0.84}N$ well layers and three 10 nm n-type GaN barrier layers.

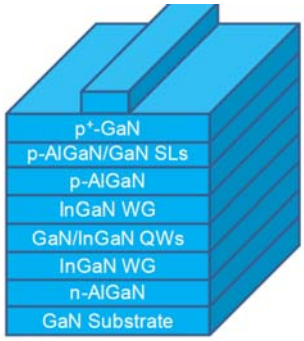

Fig. 1. Schematic structure of GaN laser diode fabricated for present study.

Based on the structure, the nano-hexagonal GaN microdisk arrays with different sizes will be fabricated. The arrays' light confinement are designed on the basis of a numerical analysis of two-dimensional finite difference time-domain method (2D-FDTD). Nano-fabrication of mask-patterns needed subsequently are being prepared by a combination of electron beam lithography (EBL) and related etching process. After that the scanning electron microscopy (SEM) images of the hexagonal GaN microdisk arrays will be used for the characterization.

4. その他・特記事項（Others）

Main collaborators: Quan Sun and Hiroaki Misawa (RIES-Hokkaido University).

5. 論文・学会発表（Publication/Presentation）

N/A

6. 関連特許（Patent）

N/A