【Grant-in-Aid for Specially Promoted Research】

Science and Engineering (Engineering)

Title of Project : Physics of highly polarized semiconductors and their application to deep ultraviolet light emitting devices

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Research Area : Electronic materials/Electric materials
Keyword : Electrical and electronic materials

【Purpose and Background of the Research】

This proposal is aimed at expanding the application of nitride-based deep-ultraviolet (DUV) light emitting diodes (LEDs) not only to low power processes, such as the distinction of counterfeit bills, printing, and sterilization, but also to high-power processes, such as water purification in a filtration plant.

Currently, the project members are seeking a novel concept not only to control polarization charges and drift current, but also to make the most of the polarization charges and electric field used for the injection of more holes into the active layer. The novel concept in principle is a newly developed band engineering in semiconductor device with an inclusion of the polarization effects. Nitride semiconductors having strong polarization have aroused academic curiosity as "polarized semiconductor" devices. The project will surely provide a considerable amount of information for developing new devices.

【Research Methods】

The project members will focus on the following points.

-Growth of high-quality and DUV transparent bulk AlN growth by using needle crystal as a seed and HVPE method

-Fabrication of low resistive and highly transparent graphene electrode for p-AlGaN

-Development of polarized semiconductor physics for device design

Final goal is the understanding and establishment of design rule for polarized semiconductor devices and the realization of high output power DUV LEDs for large scale water purification plant, superfine lithography, printing, air purification, and energy storage by hydrogen generation.

【Expected Research Achievements and Scientific Significance】

The project will provide watt-class power palm-top DUV light sources. Such light sources are expected to be developed as germicidal and purification applications in the medical, agricultural, and environmental fields, resulting in much higher security and safety in human society. Examples of application are summarized in Fig.1.

This project is also focused on establishing the new physics called "device physics on polarized semiconductors". Another important scientific significance is to utilize graphene as a transparent electrode for p-type AlGaN.

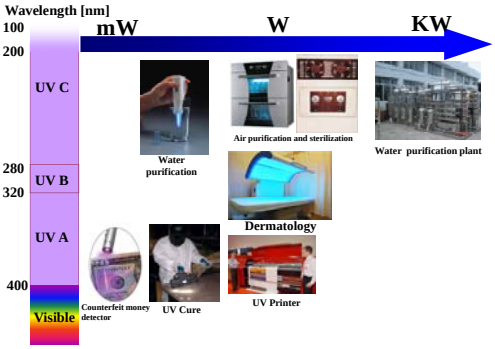

Fig. 1 Expected applications of solid-state UV/DUV light sources with different output powers and emission wavelengths.

【Publications Relevant to the Project】

・T. Takeuchi, S. Sota, H. Amano et al., “Quantum-Confined Stark Effect due to Piezoelectric Fields in GaInN Strained Quantum Wells”, Jpn. J. Appl. Phys., 36, L382-L385(1997).

・C. Pernot, M. Kim, H. Amano et al., “Improved Efficiency of 255-280 nm AlGaN-Based Light-Emitting Diodes”, Appl. Phys. Exp., 3, 061004-1-3(2010).

【Term of Project】 FY2013-2015

【Budget Allocation】 280,400 Thousand Yen

【Homepage Address and Other Contact Information】

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