課題番号 : F-12-TT-0040
支援課題名（日本語） : MBE による InAs 量子構造の作製
Program Title（in English） : Fabrication of InAs quantum structures with molecular beam epitaxy
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概要（Summary）：

The improvement of the solar cell efficiency has been an ongoing hot topic in recent years. High efficient solar cells are required to lower the cost-performance ratio. Novel concepts, such as the intermediate band solar cell have been proposed [1]. The intermediate band solar cell concept aims to reduce absorption losses of infrared photons by absorption and subsequent upconversion in intermediate states, which are embedded in bulk material such as GaAs or AlGaAs. InAs quantum dots have been widely used to realize intermediate states in bulk material. We recently studied the highly efficient upconversion in InAs disk-like quantum structures which already form in early stages of InAs deposition [2]. This program aims to fabricate a novel IB solar cell using InAs disk-like structures. Spectroscopic analysis of photocurrent generation due to upconversion of infrared is intended to understand the details of this new concept.

実験（Experimental）：

We used molecular beam epitaxy (facility: modified EIKO) to fabricate a single junction solar cell with intermediate states provided by InAs disk-like quantum structures. For our purpose an InAs layer with deposition amount below critical thickness for quantum dot formation was embedded in AlGaAs, which provides a high barrier. This is important to separate the photocurrent contribution of the disk-like structures from that of the GaAs substrate. This active region was embedded in the i region of a p-i-n junction of GaAs. A second sample without InAs was grown for reference measurements.

結果と考察（Results and Discussion）：

Photocurrent measurements were conducted from room temperature to cryogenic temperatures. Additionally, photoluminescence measurements were performed at low temperatures to verify the energy states formed in our samples. We could verify the photocurrent generation due to upconversion in the disk-like InAs quantum structures and obtained evidence of a strong voltage dependence of the upconversion efficiency. This result gives important clues on how the disk-like InAs quantum structures can be applied to real solar cell devices.

その他・特記事項（Others）：

・今後の課題

In future work we have to optimize the doping concentration to control the electric field in the active region. Additionally we require producing ohmic electrical contacts to obtain a quantitative voltage dependence of the upconversion efficiency in InAs disk-like quantum structures.

・参考文献

[1] A. Luque and A. Marti, Phys. Rev. Lett. 78 (1997) 5014.
[2] D. M. Tex and I. Kamiya, Phys. Rev. B 83 (2011) 081309(R).

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