



YAGONA P-N O‘TISHLI GaAs QUYOSH ELEMENTI SAMARADORLIGINI QUYOSH KONSENTRATSIYASIGA BOG‘LANISHI

Nazarova Nasibaxon Muxtorbek qizi

Xiva shahar 1-son ixtisoslashtirilgan maktab-internati, o‘qituvchi

Jumaboyev Bexzod Quronboy o‘g‘li

Urganch davlat universiteti

nasibaxonnazarova895@gmail.com

Annotatsiya: Ushbu ishda yuqori samaradorlikka ega galliy arsenid (GaAs) asosidagi quyosh elementlarining konsentratorli tizimlarda ishlash samaradorligi tadqiq qilindi. GaAs quyosh elementlarining yuqori narxi ularni aynan konsentratsiyalangan yorug‘lik sharoitida qo‘llashni iqtisodiy jihatdan maqsadga muvofiq qiladi. Yuqori konsentratsiyada to‘yinish jarayoni va rekombinatsiya jarayonlarining kuchayishi va samaradorlikning pasayishi muammosini bartaraf etish maqsadida vertikal strukturaga ega yagona p–n o‘tishli GaAs quyosh elementi taklif qilindi va uning volt-amper xarakteristikalari Sentaurus TCAD dasturi yordamida modellashirildi. Modellash jarayonida strukturaning kengligi $H = 5 \mu\text{m}$ deb olingan bo‘lib, yoritish manbai sifatida AM1.5d quyosh spektri ($1 \text{ sun} = 1000 \text{ W/m}^2$) qabul qilindi. Tadqiqot natijalari vertikal GaAs elementlarining yuqori konsentratsion sharoitlarda samaradorlikni barqaror ushlab qolish imkoniyatiga egaligini ko‘rsatdi.

Kalit so‘zlar: GaAs quyosh elementlari; Konsentratsiyalangan yorug‘lik; Vertikal struktura; Sentaurus TCAD; Volt-amper xarakteristika; Samaradorlik; p–n o‘tish

EFFICIENCY DEPENDENCE OF A SINGLE P–N JUNCTION GAAS SOLAR CELL ON SOLAR CONCENTRATION

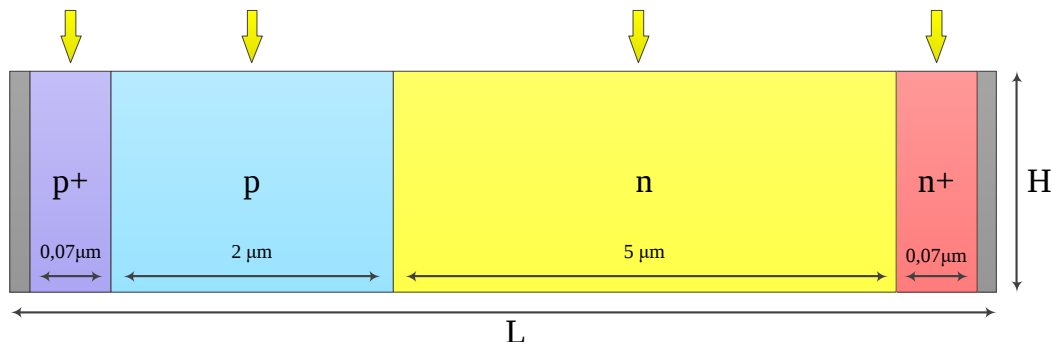
Abstract: This study investigates the performance of gallium arsenide (GaAs) solar cells under concentrated sunlight conditions. Although GaAs solar cells achieve 27.6% efficiency at 255 suns, their efficiency drops to about 24% at nearly 1000 suns due to saturation and enhanced recombination losses. To overcome this limitation, a single p–n junction vertical GaAs solar cell structure is proposed and simulated using the Sentaurus TCAD software. The model considers a device width of $H = 5 \mu\text{m}$ and illumination based on the AM1.5d solar spectrum ($1 \text{ sun} = 1000 \text{ W/m}^2$). The results demonstrate that the vertical structure can maintain higher efficiency and improved stability under elevated solar concentration levels.

Keywords: GaAs solar cell; Solar concentration; Vertical structure; Single p–n junction; Sentaurus TCAD; Efficiency.

GaAs quyosh elementlari yuqori narxlarga ega bo‘lganligi uchun, konsentratorli sistemalarda ulardan foydalanish samaraliroq xisoblanadi [1]. Hozirgi vaqtda 255 ta quyoshda 27,6% samaradorlikka ega bolgan GaAs quyosh elementi (QE) asosidagi batareyasini shakllantirishga erishilgan [2]. Ammo bu quyosh elementida 1000 ga yaqin

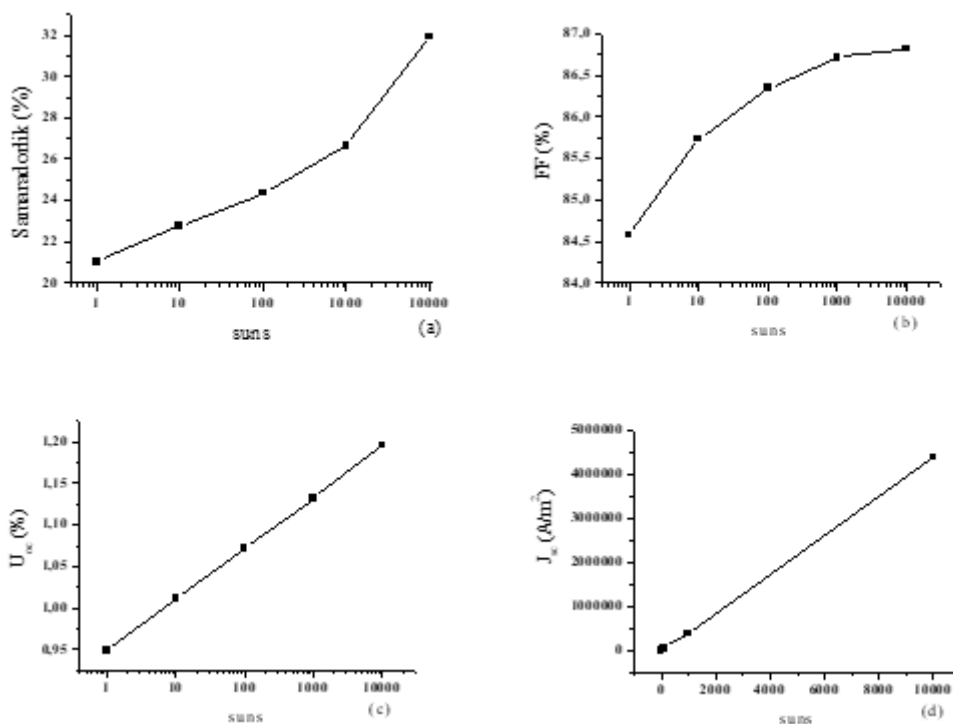


quyoshda o‘lchangan samaradorlik atigi 24% samaradorlik qayd etilgan [3]. Yani quyosh konsentratsiyasi ortishi bilan samaradorlik ortib to‘yinishga erishib kamayishni boshlagan. Quyosh konsentratsiyasi ortishi bilan samaradorlikning buday kamayishini oldini olish uchun vertikal konsentratorli QE taklif qilingan. Ko‘rilayotgan ishda Sentaurus TCAD dasturi yordamida yagona p-n o‘tishli vertikal GaAs quyosh elementining volt-amper xarakteristikasi modellashtirilgan. Uning 2D strukturasi 1-rasmda keltirilgan. Strukturaning kengligi $H = 5\mu\text{m}$ qilib tanlab olingan. Yoritish sifatida AM1.5d quyosh standart qo‘llanilgan, $1\text{ suns} = 1000\text{ W/m}^2$ [4].



1 – rasm. Vertikal yagona o‘tishli GaAs quyosh elementini 2D strukturasi. H kengligi, L uzunligi.

Ko‘rilayotgan QE da samaradorlik 10000 quyosh konsentratsiyasigacha xam monoton ravishda 21 % dan 31,9 % gacha oshganligini aniqladik (2-rasm). To‘ldirish koeffitsienti 84,58 % dan 86,82 % gacha monoton ravishda, salt yurish kuchlanishi chiziqli ravishda 0,93 V dan 1,196 V gacha, qisqa tutashuv toki chiziqli ravishda $374,2\text{ A/m}^2$ dan $4,39\text{e}+6\text{ A/m}^2$ gacha oshganini ko‘rish mumkin. Natijalardan vertikal QE laridan konsentratorli sistemalarda foydalanish yuqori samara berishini aytyshimiz mumkin.



2 – rasm. (a) samaradorlik, (b) to‘ldirish koeffitsienti, (c) salt yurish kuchlanishi, (d) qisqa tutashuv toki zichligini sunsga bog‘lanish grafiklari.



ADABIYOTLAR:

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