

YAGONA P-N O‘TISHLI GaAs QUYOSH ELEMENTI SAMARADORLIGINI P QATLAMNING TURLI KONSENTRATSIYALARIDA QUYOSHLAR KONSENTRATSIYASIGA BOG‘LANISHI

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Annotatsiya: Ushbu ishda vertikal yagona p–n o‘tishli GaAs quyosh elementining samaradorligi quyosh nuri konsentratsiyasiga bog‘liq holda Sentaurus TCAD dasturi yordamida modellash tirildi. An‘anaviy gorizont al strukturalarda samaradorlik 1000 suns dan so‘ng kamayadi, holbuki taklif etilgan vertikal struktura uchun samaradorlik 10 000 suns gacha barcha p-soha legirlanish darajalarida ortib borishi kuzatildi. Natijalar vertikal GaAs quyosh elementlarining yuqori konsentratsiyali fotovoltaik tizimlar uchun istiqbolli ekanligini tasdiqlaydi.

Kalit so‘zlar: GaAs quyosh elementi; Vertikal struktura; Quyosh konsentratsiyasi; Sentaurus TCAD; Samaradorlik; p–n o‘tish.

DEPENDENCE OF SINGLE P–N JUNCTION GaAs SOLAR CELL EFFICIENCY ON SOLAR CONCENTRATION AT DIFFERENT P-LAYER DOPING LEVELS

Abstract: In this work, the efficiency of a vertical single p–n junction GaAs solar cell was simulated using the Sentaurus TCAD software under varying solar concentration levels. While conventional horizontal GaAs solar cells experience efficiency degradation beyond approximately 1000 suns, the proposed vertical structure demonstrates a continuous increase in efficiency up to 10 000 suns for all considered p-layer doping concentrations. The results confirm that vertical GaAs solar cells are promising for high-concentration photovoltaic applications.

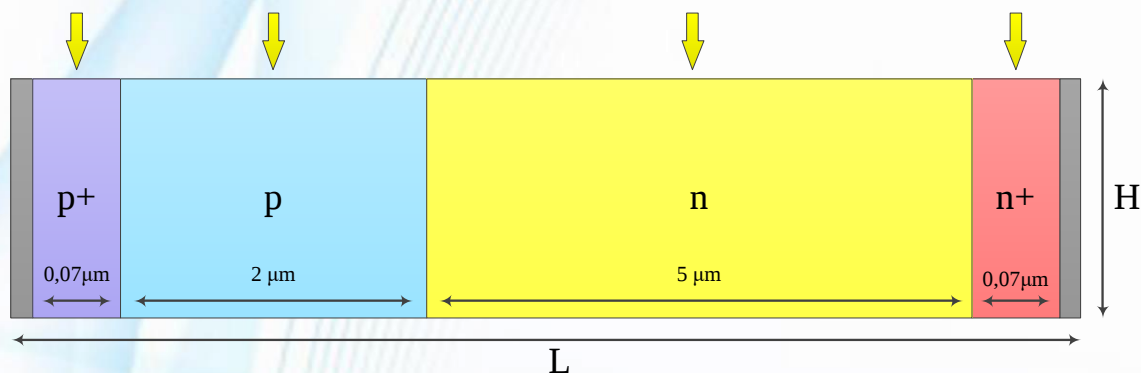
Keywords: GaAs solar cell; Vertical structure; Solar concentration; Sentaurus TCAD; Efficiency; p–n junction.

Energiya ishlab chiqarishning eng ekologik sof texnologiyalaridan biri quyosh batareyasi texnologiyasidir. Bu an‘anaviy yoqilg‘i o‘rnini bosuvchi rivojlanib borayotgan va tobora muhim bo‘lib borayotgan qayta tiklanadigan energiya manbai xisoblanadi. Quyosh batareyasi texnologiyasi yorug‘lik energiyasini fotovoltaik effekt orqali elektr energiyasiga aylantirishga asoslangan texnologiyadir.

Quyosh batareyalarini tashkil qiladigan quyosh elementlari (QE) [1] turlari juda ko‘p, shular qatorida konsentrlangan QE larini belgilab olish mumkin. Bu QE larining quyosh konsentratsiyasi ortishi bilan samaradorligi ortadi. Ammo quyosh konsentratsiyasi ortishi bilan qandaydir quyosh konsentratsiyalarida samaradorlik to‘yinib pasaya boshlaydi. Shu

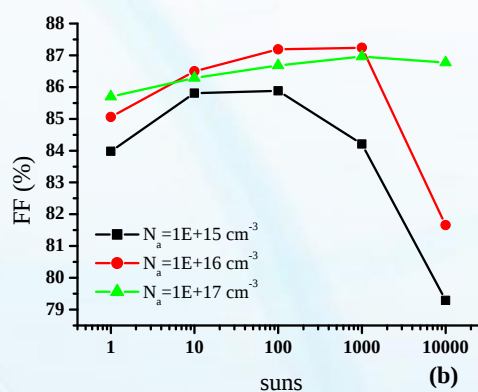
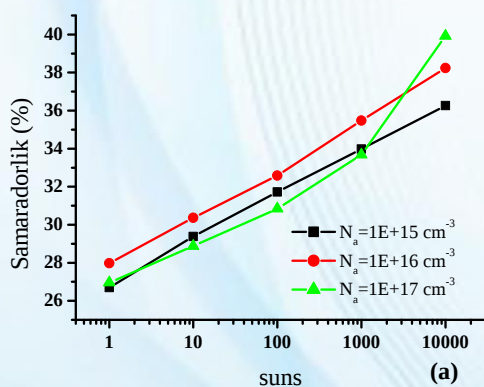
kamchiligini to‘g‘irlash uchun QE ning turli strukturalari taklif qilingan, jumladan vertikal QE lari ishlab chiqilgan. Shu sababli shunday strukturali QE larini turli xossalarini o‘rganish dolzarb masalalar qatoriga kiradi.

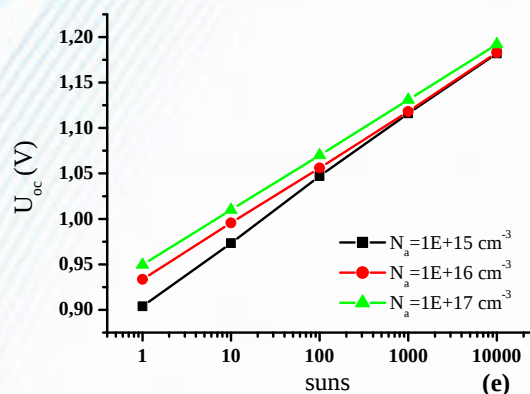
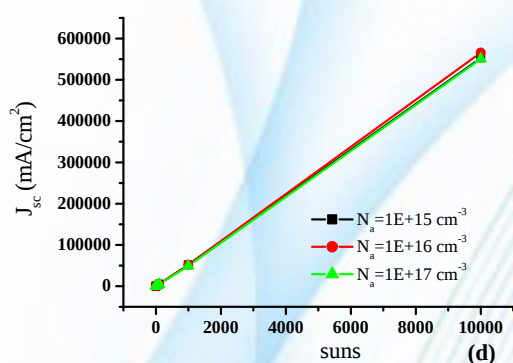
Ko‘rilayotgan ishda Sentaurus TCAD dasturi yordamida, vertikal yagona o‘tishli GaAs quyosh elementi asosiy parametrlarining p soha turli konsentratsiyalarida, quyoshlar konsentratsiyasiga bog‘lanishi ikkilik o‘lchamda modellashtirildi (1-rasm). Strukturaning balandligi $H = 5\mu\text{m}$ qilib tanlab olingan. Yoritish sifatida AM1.5d quyosh standarti qo‘llanilgan va unda 1 Quyosh quvvati 1000 W/m^2 qilib olingan[2]. P qatlam legirlanish darajasi $1\text{E}+15\text{ cm}^{-3}$, $1\text{E}+16\text{ cm}^{-3}$, $1\text{E}+17\text{ cm}^{-3}$ qiymatlarda qaralgan. Bunda n qatlam konsentratsiyasi $4\text{E}+16\text{ cm}^{-3}$



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

ga teng. Ma’lumki gorizontal quyosh elementlarida odatda taxminan 1000 quyosh konsentratsiyasidan keyin samaradorlik kamaya boshlaydi [3]. Modellashtirish natijalari ko‘rsatadiki QE ning birlik yuzasiga tushayotgan yorug‘lik energiyasini qiymati ortishi bilan samaradorlik monoton ortadi. Biz ko‘rib chiqayotgan QE srukturasida 10 000 sunsgacha samaradorlik barcha p soxa legirlanish darajalarida ortishi kuzatilgan (2-rasm).





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

2-rasmdan ko‘rinib turibdiki, samaradorlik, qisqa tutashuv toki jichligi, salt yurish kuchlanishi 1 dan 10 000 Quyoshgacha chiziqli ravishda ortgan, to‘ldirish koeffitsienti monoton ravishda ortgan 1000 sunsdan keyin kamayishi kuzatilgan. 2(a) rasmdan ko‘rinib turibdiki p qatlam konsentratsiyasi uchun eng optimal qiymat $1E+16 \text{ cm}^{-3}$ ga teng.

ADABIYOTLAR:

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