PENGARUH SUHU ANIL DAN KONSENTRASI DOPING SESIUM KLORIDA TERHADAP SIFAT OPTIK DAN KINERJA SEL SURYA PEROVSKITE BERBASIS $CsPbBr_{(3-x)}Cl_x$

SKRIPSI

Diajukan untuk memenuhi Sebagian syarat untuk memperoleh gelar Sarjana Sains
Program Studi Fisika Kelompok Bidang Kajian Fisika Material

Oleh

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PROGRAM STUDI FISIKA

FAKULTAS PENDIDIKAN MATEMATIKA DAN ILMU PENGETAHUAN ALAM

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ABSTRAK

PENGARUH SUHU ANIL DAN KONSENTRASI DOPING SESIUM KLORIDA TERHADAP SIFAT OPTIK DAN KINERJA SEL SURYA PEROVSKITE BERBASIS $CsPbBr_{(3-x)}Cl_x$

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Penelitian ini mempelajari pengaruh suhu anil dan konsentrasi doping sesium klorida (CsCl) terhadap sifat optik dan kinerja sel surya perovskite (PSC) berbasis $CsPbBr_{(3-x)}Cl_x$. Film perovskite disintesis menggunakan metode *spin coating* dengan variasi suhu anil 200°C, 225°C, 250°C, dan 275°C, serta konsentrasi doping CsCl sebesar 0%, 2%, 4%, dan 8% molar relatif terhadap prekursor Br^-. Karakterisasi *X-Ray Diffraction* (XRD) menunjukkan bahwa peningkatan suhu anil memperbaiki kristalinitas hingga optimum pada 250°C dengan ukuran butir rata-rata 772,25 nm, sedangkan doping CsCl hingga 2% meningkatkan ukuran butir menjadi 814,87 nm. Pergeseran puncak difraksi ke sudut 2θ yang lebih besar pada sampel terdoping menunjukkan penyusutan kisi akibat substitusi ion Br^- oleh ion Cl^-, dengan konstanta kisi menurun dari 5,79513 Å (0%) menjadi 5,79250 Å (2%). Spektrum UV-Vis menunjukkan peningkatan absorbansi pada suhu anil 250°C dan doping hingga 4%, sedangkan PL menampilkan intensitas maksimum pada 250°C dan 2% doping yang mengindikasikan penurunan cacat non-radiatif. Analisis SEM mengungkapkan bahwa kondisi optimum pada 250°C menghasilkan butiran besar dan seragam dengan cakupan permukaan hampir penuh. Pengukuran *current–voltage* (IV) pada pencahayaan standar AM 1.5G (100 mW/cm²) menunjukkan *device* terbaik untuk variasi suhu anil dicapai pada 250°C dengan Jsc = 4,80 mA/cm², Voc = 1168,47 mV, FF = 69,09%, dan η = 3,88%. Untuk variasi doping, kondisi optimum diperoleh pada doping CsCl 4% dengan Jsc = 5,58 mA/cm², Voc = 1176,63 mV, FF = 75,61%, dan η = 4,96%. Hasil ini menegaskan bahwa suhu anil 250°C merupakan kondisi terbaik untuk semua karakterisasi yang dilakukan, serta optimasi konsentrasi doping sesium klorida pada tingkat yang tepat mampu meningkatkan kualitas kristal, morfologi, dan sifat optoelektronik perovskite, sehingga berimplikasi pada peningkatan kinerja PSC.

Kata kunci: *perovskite solar cell*, doping anion halida, suhu anil

ABSTRACT

EFFECT OF ANNEALING TEMPERATURE AND CESIUM CHLORIDE DOPING CONCENTRATION ON THE OPTICAL PROPERTIES AND PERFORMANCE OF $CsPbBr_{(3-x)}Cl_x$*-BASED PEROVSKITEE SOLAR CELLS*

This study investigates the effects of annealing temperature and cesium chloride doping concentration (CsCl) on the optical properties and performance of $CsPbBr_{(3-x)}Cl_x$ *based perovskitee solar cells (PSCs). Perovskitee films were synthesized via the spin coating method with annealing temperatures of 200°C, 225°C, 250°C, and 275°C, and CsCl doping concentrations of 0%, 2%, 4%, and 8% molar relative to the* Br^- *precursor. X-Ray Diffraction (XRD) revealed that increasing annealing temperature improved crystallinity up to an optimum at 250°C, achieving an average grain size of 772.25 nm, while CsCl doping up to 2% increased the grain size to 814.87 nm. Diffraction peak shifts toward higher 2θ values in doped samples indicated lattice contraction due to partial substitution of* Br^- *ions by smaller* Cl^- *ions, with lattice constants decreasing from 5.79513 Å (0%) to 5.79250 Å (2%). UV-Vis spectra showed enhanced absorption at 250°C and doping up to 4%, while PL spectra displayed maximum emission at 250°C and 2% doping, suggesting reduced non-radiative defects. Scanning Electron Microscopy (SEM) revealed that optimum conditions at 250°C produced large, uniform grains with nearly full surface coverage. Current–voltage (IV) measurements under standard AM 1.5G illumination (100 mW/cm²) indicated that for annealing temperature variation, the best device was obtained at 250°C with Jsc = 4.80 mA/cm², Voc = 1168.47 mV, FF = 69.09%, and η = 3.88%. For doping variation, the optimum was achieved at 4% CsCl doping with Jsc = 5.58 mA/cm², Voc = 1176.63 mV, FF = 75.61%, and η = 4.96%. These findings confirm that an annealing temperature of 250°C provides the best results for all characterizations performed, and that appropriate halide anion doping can further enhance crystal quality, morphology, and optoelectronic properties, thereby improving PSC performance.*

Keywords: Perovskitee solar cell, halide anion doping, annealing temperature

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