The effect of surface roughness of substrates on the performance of polycrystalline cadmium sulfide/cadmium telluride solar cells

Balashangar, K., Thanihaichelvan, M., Ravirajan, P., Mahanama, G.D.K., Dissanayake, M.A.K.L., Colegrove, E., Dhere, R.G., Sivananthan, S.

Abstract

The cadmium sulfide (CdS)/cadmium telluride (CdTe) heterojunction is a promising material combination for the development of cost efficient solar cells to meet the world's future energy demand. This study examined the effects of the surface roughness of six different layers, such as FTO, SnO2 buffered FTO, thick and thin CdS layers deposited on these buffered and unbuffered FTO, on the photovoltaic performance of the corresponding CdS/CdTe solar cells. The morphologies of these surfaces were examined by atomic force microscopy (AFM). The short circuit current densities and fill factors of the devices were improved significantly when the SnO2 buffer layer was introduced between the FTO and CdS layer. AFM images showed that surface roughness of the FTO coated glass substrates decreased when a buffer layer was present on FTO. The short circuit current densities and hence the external quantum efficiencies were improved further when the thickness of the CdS layer was reduced. This was attributed to the reduced filtering effect of the CdS layer. The optimized device showed an external quantum efficiency of more than 85% at the maximum absorption wavelengths of CdTe and an overall power conversion efficiency of more than 14.5% under an air mass (AM) 1.5 irradiation (100 mW cm-2, 1 sun).