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Improve of Efficiency in Silicon Thin-Film Solar Cells by Optimizing Front TCO and Back Reflector

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The surface textured ZnO:Al TCO(Transparent Conducting Oxide) films has been considered to be one of the most significant parameters for improving device quality of microcrystalline silicon(μc -Si:H) thin-film solar cells. Since the thickness of light absorbing layer in a pin μc -Si:H thin-film solar cell is very thin (less than 5 μm), the light trapping within the intrinsic absorbing layer by front TCO and back reflection layer(usually back contact) should be maximized in order to increase the generation of electron-hole pairs. The front ZnO:Al films act as scattering incident light, by which the travel length of incident light is prolonged within the light absorbing layer. The ZnO layer as a back reflector with metal electrodes (Ag or Al) has low absorption in order to provide enhanced internal reflection of light that does not absorbed to thin-film silicon active layer.

In this paper, ZnO:Al films are prepared by rf magnetron sputtering method on glass substrate and chemically etched in 1% HCl solution to make rough surface. The Ar pressure and substrate temperature are dominant parameters both to determine electro-optical properties of as-deposited ZnO:Al films and to control surface morphology of chemically etched films. The operation properties of μc -Si:H thin-film solar cells prepared on ZnO:Al films with various surface morphologies are discussed with etching behavior with different sputtering conditions. And various back reflectors was incorporated to find optimum light trapping for silicon based thin-film solar cells.