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Design, Fabrication and Characterization of n-Si Columnar Structures for Solar Cell Applications

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Highly doped (10^{18} atoms/cm^{-3}) n-type silicon structured thin films and flat surface deposited onto aluminum surface by e-beam deposition technique using Kurt J. Lesker equipment. Silicon films' thicknesses were about 400nm for all samples. Structured thin films were deposited at 80° to form slanted structures with no rotation and at 80° with 25rpm to form vertical columnar structures. Then highly conductive and transperant PEDOT:PSS (Heraeus-Clevios) was coated onto silicon structured thin films and flat surface. First PEDOT:PSS was droped onto surface and left for 1min. then it was spin coated with 2000rpm/min twice.
Columnar structures possess lower reflectance value in UV-VIS spectroscopy which means they have higher absorbance so we can use these structures both for solar cell application and other opto-electronic devices as anti-reflection coating to increase efficiency and other PV parameters such as fill factor, open circut voltage and short circut density.
Also columnar strucutres have hydrophilic surface due to the high porosity that characteristic eases the distribution of PEDOT:PSS hole conductor polymer on surface and provide better distribution and larger p-n junction interface area. Flat silicon has 98° while columnar structures possess 71° and 61° contact angle.
Cross-sectional SEM images shows that columnar structures with PEDOT:PSS have better distribution and larger surface area due to the hydroplicity and porosity while flat surfaces possess relatively smaller junction area and non-homogenous distribution.
AFM images of flat surface and vertical columnar structures fabricated in 1μmx1μm area show that columnar structures have higher surface roughness compared to the flat surface.
PEDOT:PSS exhibits high transparency in UV-VIS spectroscopy which means light can pass through it and reach the silicon absorber layer to generate electrons and holes.

Keywords
GLAD
Structured Thin Films
Silicon
PEDOT:PSS