Silicon thin films with N-type electrical conductivity for solar cell applications

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Abstract

Statement of the Problem: The swift progress in the photovoltaic sector, centered on crystalline silicon solar cells, has spurred the emergence of novel technologies. These advancements aim to enhance the efficiency of produced solar cells while simultaneously curbing the consumption of this crucial element. However, advancing new technologies employing solar cells necessitates additional research. A pivotal factor that could markedly expedite progress in this scientific domain is broadening the scope of solar cell applications at diminished production expenses. Consequently, thin-film solar cells have emerged as a viable alternative to silicon solar cells. Their principal benefit lies in the reduced direct cost of semiconductor materials, with a crucial advantage being the ability to manufacture them on diverse substrates, including flexible ones such as glass, metal foils, and polymers. The latest advancements in thin-film technology predominantly rely on amorphous silicon, enabling the production of solar cells with an efficiency of approximately 14% through multi-junction designs. Traditionally, the application of the CVD method and its derivatives is common, necessitating high temperatures and handling of hazardous gases. In addition, this solution limits the range of substrates used. The plasma-assisted magnetron sputtering method could be used to reduce the high temperature limitations. The article presents the results of research on the possibility of depositing silicon thin films with N-type conductivity. Those type of layer deposited by magnetron sputtering can be used in thin-film solar cells technology. The thin films were deposited on a silicon substrate with P-type conductivity using different substrate temperatures and deposition times.

Conclusion & Significance: All deposited thin films were characterized by an amorphous structure. The increase in substrate temperature resulted in uneven layer growth and the roughness of the deposited thin films increased. Moreover, higher substrate temperature decreased the deposition growth rate. The high transparency of the thin films was maintained even for a thickness of about 90 nm and was over 80% in the range of 350-900 nm. Tests performed using the Sherescan device in the four-point probe showed a change in the type of conductivity only above 90nm.

Image

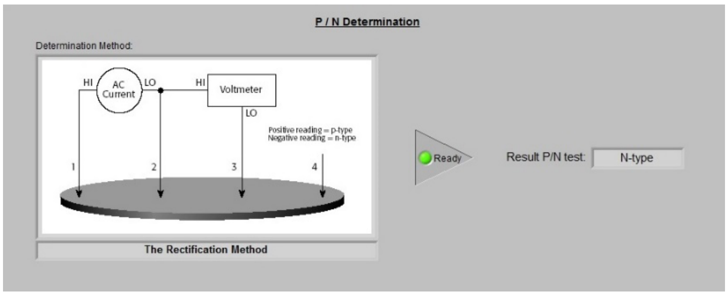

Figure 1. Measurement of the conductivity type of a silicon thin film deposited by PVD using the Sherescan device

Recent Publications

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2. Drabczyk K., Kulesza-Matlak G., Drygala A., Szindler M., Lipiński M., Electroluminescence imaging for determining the influence of metallization parameters for solar cell metal contacts, SOLAR ENERGY 126 (2016), 14-21 DOI: 10.1016/j.solener.2015.12.029
3. Aberle A.G. Thin-film solar cells. Thin Solid Films 517 (2009), 4706–4710 DOI: 10.1016/j.tsf.2009.03.056
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5. Haug F.J.., Ballif C. Light management in thin film silicon solar cells. Energy & Environmental Science 8 (2015), 824-837 DOI: 10.1039/c4ee03346a)
6. Haschke j., Amkreutz D., Korte L. Towards wafer quality crystalline silicon thin-film solar cells on glass. Solar Energy Materials & Solar Cells 128 (2014), 190-197 DOI: 10.1016/j.solmat.2014.04.035
7. Godinho V., Ferrer F.J., Fernandez B., et.al. Characterization and Validation of a-Si Magnetron-Sputtered Thin Films as Solid He Targets with High Stability for Nuclear Reactions. ACS Omega 6 (2016), 1229–1238 DOI: 10.1021/acsomega.6b00270

Photograph

Biography

Dr Marek Szindler conducts research in the field of engineering and technical sciences. In his scientific work, he deals with the production and research of thin layers, nanostructures and nanocomposites used in optics, electronics, photovoltaics and medicine. Passivating and anti-reflective nanolayers deposited using ALD and sol-gel methods are used on eyeglass lenses, silicon solar cells and in implantology. Synthesized nanoparticles, nanowires and nanocomposites are used in dye-sensitized photovoltaic cells integrated with buildings (BIPV and BAPV). He is the supervisor of the LabTech Student Scientific Club operating at the Silesian University of Technology..