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Characterization of an ICP Enhanced Chemical Vapor Deposition Process for Crystalline Silicon PERC Solar Cell Passivation Layers

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To increase the photovoltaic efficiency of crystalline Si-based solar cells a surface passivation layer can be applied (so called PERC-structure). Typically aluminum oxide or an aluminum oxide / silicon nitride layer stack is deposited. The proposed paper will deal with the plasma properties/reactions and the deposition process as applied in an industrial Si-wafer coating machine and is split in three parts: At first the deposition process using an inductively coupled plasma source will be discussed. The plasma runs a chemical vapor deposition process (PECVD) with trimethylaluminum/oxygen or silane/ammonia gases. To understand the plasma excitation in more detail the inductively coupled source was modeled using either Monte Carlo-particle in cell or FEM based plasma calculation tools. Using argon as working gas the results from the different plasma models will be shown and compared to experimental results obtained by Langmuir probe measurements. In the second part spectroscopic plasma monitoring investigations of the trimethylaluminium/oxygen or silane/ammonia PECVD will be discussed. Emission lines from the different plasma species were identified in the wavelength range of 200 to 1100nm and their intensities monitored as function of the plasma power and the concentration of the PECVD gases. The decomposition of the gases and the formation of new plasma species were observed; also plasma effects induced by the plasma ignition will be discussed. In the third part the achieved passivation and their relation to the PECVD details will be presented. Using shiny etched monocrystalline Si-wafers a thickness of 3nm aluminum oxide is sufficient for a perfect passivation of the surface.
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