INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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Programme of Study	:	Ph.D.

Thesis Title: **Synthesis and characterization of silver nanoparticles for light trapping application in thin film solar cells**

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Thesis Submitted to the Department/ Center	:	Department of Physics
Date of completion of Thesis Viva-Voce Exam	:	12-04-2024
Key words for description of Thesis Work	:	Silver nanoparticles, solid state dewetting, light trapping, thin film solar cells

SHORT ABSTRACT

In the present thesis, silver nanoparticles have been synthesized by solid-state dewetting of the precursor silver films deposited at different deposition conditions (deposition time, rf power, substrate temperature) using rf sputtering technique. Surface morphology and growth dynamics of silver nanoparticles are studied using atomic force microscopy (AFM) with advanced statistical analysis. Height-height correlation function (HHCF) and power spectral density function (PSDF) are extracted from AFM data, and scaling exponents α_{local}, β, 1/z and α are determined using analysis. A direct correlation between morphology and the localized surface plasmon resonance (LSPR) properties is observed. The microstructure influence on dielectric function and plasmonic properties of silver nanoparticles (Ag NPs) is studied using spectroscopic ellipsometry (SE). Dielectric function and plasmonic properties of Ag NPs are investigated from spectroscopic ellipsometry (SE) data using a quite unique model in terms of the combination of different oscillators: Drude-Lorentz model along with two Gauss oscillators to account for intraband, interband transitions and different modes of localized surface plasmon resonance (LSPR) of Ag NPs. The influence of the substrate temperature on the growth of Ag NPs and their several properties like localized surface Plasmon resonance (LSPR), photoluminescence, and Raman spectroscopy is studied. Enhancement in PL peak intensity and Raman peak intensity is found to be in accordance with the LSPR of Ag NPs. Both simulation and experimental studies on single junction hydrogenated amorphous silicon (a-Si:H) thin film solar cells is done prior to the implementation of Ag NPs as a plasmonic back reflector in (a-Si:H) thin film solar cells. The effect of emitter layer (a-Si:H (p)) doping and absorber (a-Si:H (i)) layer thickness is studied. Further, simulation results are compared with the experimental results. A good match between simulation and experiment results is obtained. As an application part of this thesis, the role of silver nanoparticles as plasmonic back reflector for light trapping application in hydrogenated amorphous silicon (a-Si:H) thin film solar cells is explored. Excellent light trapping by plasmonic back reflector in solar cells is observed. A broadband enhancement in quantum efficiency is shown by a-Si:H thin film solar cells fabricated on the plasmonic back reflector with a gain of 47% in short circuit current density (J_{sc}) as compared to the flat back reflector. As a result, the improvement in the performance of the a-Si:H thin film solar with plasmonic back reflector is observed corresponding to an efficiency (η) of 8.4% against 5.6% efficiency of the a-Si:H thin-film solar cell with flat back reflector respectively.