Characterization of innovative Si-based thin films for photovoltaic applications

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In the last decades, single-crystalline silicon solar cells have achieved a record efficiency of 26.7% and contribute more than 90% to global PV market due to high-quality ingot growth processes and solar cell technology. Further device advances rely on innovated surface passivation and interface control. One way is employing amorphous silicon (a-Si:H) as passivation layer. Nitrogen or oxygen incorporation within a-Si:H could overcome its parasitic light absorption [1,2]. Despite the importance of these materials in different fields [3,4], the influence of N and O inclusion on electron-hole recombination processes at surfaces and interfaces is still not clear.

The present contribution aims to characterize a-SiO_x and a-SiO_xN_y layers and their surface passivation properties. The layers have been deposited by PECVD adding increasing fractions of N_2O or CO_2 gas to the SiH_4 plasma. Structural and optical properties, light induced electronic transitions and minority carrier lifetimes have been investigated by Fourier-transform infrared spectroscopy, spectral ellipsometry, surface photovoltage spectroscopy and photo conductance decay.

This combination of several methods has allowed us to understand how adding N_2O or CO_2 during deposition affects interface properties. A flux ratio increase causes disorder in the amorphous network and microvoid formation, with consequent reduction of minority carrier lifetimes. The optical band gap becomes larger than the one of pure a-Si:H layers, capable to reduce parasitic absorption.

The introduction of N_2O and CO_2 during deposition of a-Si:H is beneficial as it improves the optical gap, but also detrimental as high flux ratios lead to an increased surface recombination and a reduced minority carrier lifetime.

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