Photo-induced tunneling current microscopy on amorphous silicon films covered by metal-SiH$_2$ overlayers: Experiment and simulation

Thomas Kontermann$^{1,2}$, and Stefan Kontermann$^1$

$^1$Institute of Experimental Physics, Universität des Saarlandes, D-66041 Saarbrücken, Germany
$^2$Physikalisches Institut der Universität Heidelberg, Philosophenweg 12, 69120 Heidelberg, Germany

The photo-induced tunneling current microscopy (PITCM) on amorphous silicon (a-Si:H) films covered by metal-SiH$_2$ overlayers is presented. The setup of the experiment is described and the measurement results are discussed. It is shown that the tunneling current is strongly influenced by the metal-SiH$_2$ overlayers and that the interaction with the a-Si:H film can be used to study the microstructure of the a-Si:H film. The results are compared with theoretical simulations and a model for the tunneling current is proposed.

**Abstract**

Recent developments in photovoltaics have led to the emergence of silicon-based thin-film solar cells as a promising technology for low-cost and large-scale production. In this contribution, we present the results of a systematic study of the effect of metal-SiH$_2$ overlayers on the photo-induced tunneling current in a-Si:H films. The measurements were performed using a custom-made setup that allows for high-resolution imaging of the a-Si:H film surface. The results show that the tunneling current is strongly influenced by the metal-SiH$_2$ overlayers and that the interaction with the a-Si:H film can be used to study the microstructure of the a-Si:H film. The results are compared with theoretical simulations and a model for the tunneling current is proposed.

**Keywords**

Amorphous silicon, tunneling current microscopy, metal-SiH$_2$ overlayers, photovoltaics.

**Introduction**

Thin-film silicon solar cells have gained significant attention due to their potential for low-cost and large-scale production. In recent years, there has been a growing interest in the use of amorphous silicon (a-Si:H) as the active material in these devices due to its high flexibility and low-cost production. However, a major challenge for a-Si:H-based solar cells is the limited open-circuit voltage ( Voc ) and fill factor ( FF ) compared to crystalline silicon (c-Si) solar cells. One of the main reasons for this is the presence of defects in the a-Si:H film that act as recombination centers, leading to a decrease in the efficiency of the device.

**Results and Discussion**

The results of the study show that the metal-SiH$_2$ overlayers have a significant impact on the tunneling current in a-Si:H films. The tunneling current is found to be strongly influenced by the thickness and composition of the metal-SiH$_2$ overlayers. The interaction with the a-Si:H film is shown to be mediated by the localized surface plasmon (LSP) resonances of the metal-SiH$_2$ overlayers.

**Conclusion**

In conclusion, the results of this study provide new insights into the effect of metal-SiH$_2$ overlayers on the photo-induced tunneling current in a-Si:H films. The findings are important for the development of new photovoltaic technologies based on a-Si:H and can lead to improvements in the efficiency and stability of these devices.