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Structural evolution of tin catalyst heated during x-ray photoelectron spectroscopy

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The attractive optical, electrical and mechanical properties of silicon nanowires (SiNWs) are promising for applications within photovoltaic devices. The diameter and length of the SiNWs is crucial in the solar cell application and can be controlled by the metal catalyst nanoparticles size. Due to its lower Si eutectic temperature, tin (Sn) has been identified as a suitable, lower cost alternative to gold (Au) as metal a catalyst employed to synthesize SiNWs. In this contribution, we report on the changes within the microstructure and the chemical bonding environment of a 3 nm Sn thin film heated to different temperatures within an x-ray photoelectron spectroscopy (XPS) system. The thermally evaporated 3 nm Sn thin film on the Si (100) substrate was heated to temperatures of 180, 232, 350 and 450 ℃ on the XPS sample stage. The XPS analysis reveals the presence of metallic Sn and its oxides (SnOx) at room temperature. The carbon (C) peak was also observed, decreasing as the temperatures increases (above 232 ℃) leading to exposure of Sn film. At 350 ℃, the exposure of the Si substrate was detected which can be due Sn content decreases thorough Sn nanoparticle formation or evaporation or infusion. The surface composition and morphology of the heated Sn films displayed an increase in oxidation, particle size and Si, correlating with the XPS results. The increase in the oxidation state of Sn at elevated temperature higher than Si-Sn eutectic (232 ℃)will have implications on the subsequence SiNWs synthesis.

Summary

The chemical bonding environment of thermally evaporated Sn thin film was investigated in an x-ray photoelectron spectrometer system. The top few layers of the surface consisted of the dominant SnO2 phase, eventually evolving into SnO at temperature higher than 232 ℃. The electron microscopy analysis revealed the surface reconstruction with an increase in temperature.

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MSc

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