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Enhancement of physical properties of stain-etched porous silicon by integration of WO_3 nanoparticles

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Abstract

In this work, we report on the passivation of porous silicon (PS) by tungsten trioxide (WO_3) nanostructured thin films deposited via dip-coating of PS in tungsten hexachloride and water/ethanol solution. Structural analysis by Fourier transform infrared spectroscopy showed a partial disappearance of SiH_x and Si-O-Si peaks after WO_3 thin film deposition on the PS due to the replacement of H atoms by WO_3. Additionally, PS/WO_3 sample revealed weakly intense peaks which can be ascribed to O-W-O and W=O bridging bonds. Morphological analysis by atomic force spectroscopy showed the coverage of the PS surface by a nanostructured thin film of dense WO_3 nanoparticles with a size ranging from 40 to 60 nm. The photoluminescence signal intensity of PS/WO_3 samples presents a continuous increase as a function of the immersion time in the precursor solution. This is attributed to a better decoration of the PS surface by WO_3 nanoplatelets and a decrease of surface recombination velocity (200 x 10^2 cm/s for untreated silicon, 137 x 10^2 cm/s for PS and 99 x 10^2 cm/s for PS/WO_3samples). Hence, a ~ 50 % improvement in the effective lifetime of minority carriers is obtained. Moreover, the deposited WO_3 contributed not only to the passivation of PS, but acted as an antireflection layer which enhanced the optical properties of PS by reducing the reflection of light. These obtained results confirmed the benefits of using WO_3 thin film as passivation/antireflection coating for possible solar cell application.

Keywords: Porous silicon; Passivation; Tungsten oxide; Photoluminescence; Surface recombination velocity; Minority carrier lifetime.