Nanostructured surfaces

Development and characterization of complex nanostructured Si surfaces with omnidirectional light absorption for solar cells

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To increase the light absorption of monocrystalline photovoltaic converters the pyramidal structures are widely used. However, such microstructured surfaces are not able to reduce reflectance below 10%. At the same time, the antireflecting layers are applied to reduce light reflection of microstructured surface, but they cause a harmful interference of incident photons leading to a narrowing of the solar spectrum of absorbed photons. As a result, reflection is reduced only in a narrow range of the spectrum of solar radiation. In this regard, the nanotexturing of Si surface is widely studied to reach maximum values of the absorption coefficient and to reduce reflection in a wide spectral range improving the efficiency of solar cells. In our previous works we showed that Si nanowire (SiNW) arrays formed on Si wafer could suppress light reflection and trap light efficiently. However, such structures are effective the best under direct sunlight illumination, and could not face the sun at the appropriate angle from morning to evening. The use of sun-tracking systems for the purpose of receiving direct light illumination is not costeffective for practical applications. In this work, we investigated technological features of vertically aligned and specifically oriented SiNWs formation in terms to develop the photosensitive nanostructured Si surfaces with omnidirectional light absorption over an extended solar spectral range and improved electrical characteristics. In this regard, we designed the complex Si structures which composed of Si pyramids obtained by conventional alkali chemical etching, and SiNWs prepared on the side faces of pyramids by metal-assisted chemical etching. We show that these structures exhibit better omnidirectional light-trapping ability by multiple reflections. From another hand, such nanostructured surfaces with enhanced optical characteristics will find a wide variety of significant applications in solar cells, photodetectors, and optoelectronic devices.