ABSTRACT

Nowadays, besides the trends of innovating high technical products to take human life to the top luxury comfortable life, scientists have paid much attention to solving two problems: shortage of energy and environmental pollution. Solar cell, an electric device which can directly convert light to electricity, is a novel product to solve both problems. The ways to improve solar cell efficiency and decrease its cost are the most concerning for scientists in this field.

The purpose of my study is to increase solar cell efficiency by improving the passivation quality and transparency of passivation layers formed by catalytic chemical vapor deposition (Cat-CVD), aiming at application to back-contact crystalline silicon (c-Si) solar cells. Passivation layers play important roles in realizing high-efficiency solar cells because they can reduce optical loss caused by the reflection of coming sun-light and electrical loss caused by the recombination of photo-generated carriers on c-Si surfaces. To meet this purpose, my study aims to improve the passivation quality and transparency of Cat-CVD anti-reflective silicon nitride (SiN_x) films.

I have succeeded to obtain Cat-CVD high-transparency SiN_x films with high-passivation quality on n-type c-Si surfaces, and to significantly improve the passivation quality by doping phosphorous (P) on a n-type c-Si surface. This doping is performed by exposing a c-Si surface to P-related radicals generated by the catalytic cracking of PH_3 (Cat-doping), called P Cat-doped layer, before the passivation with the Cat-CVD SiN_x single layer. By using the SiN_x/P Cat-doped layer structure, an extremely low surface recombination velocity (SRV) is obtained to be 2 cm/s on flat c-Si wafers. A SRV of 6.7 cm/s is also obtained for textured c-Si wafers, which are essential for high-performance solar cells due to its ability of lowering optical reflectance and enhancing light trapping inside c-Si absorber. For SiN_x/P Cat-doped layer/c-Si textured samples, optical reflectance less than 10% in visible range can be achieved.

The obtained results indicate that Cat-CVD have potential application in passivation technique for high-efficiency solar cells, particularly for n-type back-junction solar cells. Based on the remarkable results for the passivation of n-type c-Si surfaces, I will investigate the application of these passivation layers to n-type back-contact solar cells. The solar cells which will be realized in my research have several advantages as below:

High transparency and high passivation quality by using SiN_x/P Cat-doped layers.

No shading effect by metal grids on the front side.

Fabrication processes at low temperature (< 200 °C).

By these advantages, the solar cells with the highest efficiency ever should be expected.

Keywords: Catalytic chemical vapor deposition (Cat-CVD), Phosphorus Cat-doping, surface recombination velocity, silicon nitride (SiN_x), passivation quality.