Nanostructured surfaces

Effective lifetime of minority carriers in black silicon nano-textured by cones and pyramids

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Nano-textured black silicon has extremely low surface reflectance, in some cases below 1%, in a broad range of wavelengths and incident angles even with a simple antireflective coating. We calculated the effective lifetime of minority carriers in black silicon by the solution of the diffusion equation using models, methods and boundary conditions for the minority carrier distribution in macroporous and single crystalline silicon [1]. Black silicon surface consists of cones and pyramids, which we divide into elementary cylinders. The distance between cylinder centers is 0.13 micron, the cylinder diameter is 0.11 micron, and the cylinder height is 0.5 micron according to [2].

Dependences of the effective lifetime of minority carriers on diameter and height of the cone and pyramid base were calculated for the diameter of the cone base D_c 0.11 micron. The effective minority carrier lifetime in the black silicon wafer with cones is higher than the effective minority carrier lifetime on the surface with pyramids. Experimental data for cones are in good correlation with calculations of the effective lifetime of minority carriers. The same lifetime one can obtained for pyramids at 7-8 times lower the base square and 1.4 times lower heights in comparison with cones. The surface lifetime reduced three times faster in the n-type polished and black silicon due to high volume and surface lifetime.

1. *Karachevtseva L., Onyshchenko V., Sachenko A.* Photocarrier transport in 2D macroporous silicon structures // Opto-electronics review. – 2010. –**18**, № 4. – P. 394–399.
2. *Plakhotnyuk M., Davidsen R., Stenbæk M., Malureanu R., Stamate E., Hansen O.* Lifetime of Nano-Structured Black Silicon for Photovoltaic Applications / Proceedings of 32nd European Photovoltaic Solar Energy Conference and Exhibition. IEEE. – 2016. – P.764–767.