Investigation of SiC based antireflection coatings for Si solar cells by numerical FTDT simulations

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Amorphous silicon-based thin layers (SiO_2, SiN, a-SiC:H, and so on) for antireflection coatings, diffusion barriers, passivation layers have been broadly researched in the solar cell industry [1]. Such advantages of hydrogenated amorphous silicon carbide as a wide forbidden zone, excellent coefficient of thermal expansion, which corresponds to silicon wafers, relatively good thermal and mechanical stability [1,2], the possibility of being used as an antireflection and passivating layer simultaneously, make it an important material for use in solar cells. One of the key factors negatively affecting the efficiency of solar cells is the reflection of incident light. The use of antireflection coatings can significantly increase the amount of light involved in the generation of an electron-hole pairs, which in turn increases the efficiency of solar cells. Due to the effective refractive index n ranging from 2.560 to 2.832 and ease of synthesis [3], SiC has a high potential for use in antireflection coatings.

In this paper, a series of simulations of SiC based antireflection coatings was carried out. The reflections of a single SiC layer, double-layer SiC-MgF_2 coating and triple-layer SiC-ZnS-MgF_2 coating in the range of wavelength from 300 to 800 nm was compared. The optimization of the results showed that the double-layer structure reaches a minimum reflection of 0.006% at the level of 737 nm. Moreover, in the interval from 475 to 800 nm, the reflection does not exceed 1%. Subsequently, the double-layer structure was compared with more classical combinations of ZnS-MgF_2 and TiO_2-SiO_2. As the simulations show, SiC-MgF_2 antireflective coating achieves better results indicating its high prospective for future application.

References

[1] Joung Y.-H., Kang H.I., Kim J.H., Lee H.-S., Lee J., Choi W.S. SiC formation for a solar cell passivation layer using an RF magnetron co-sputtering system. Nanoscale Res. Lett. 2012. 7(1):22.
[2] Nussupov K.Kh., Beisenkhanov N.B., Bakranova D.I., Keiinbay S., Turakhun A.A., Sultan A.A. Low-temperature synthesis of α-SiC nanocrystals. Physics of the Solid State. 61 (12). 2019. 2473-2479.
[3] Choyke W.J., Patrick L. Refractive Index and Low-Frequency Dielectric Constant of 6H SiC, Journal of the Optical Society of America. 58 (3). 1968. 377-379.