Multilayer structures with the rare earth metal fluoride films based on porous silicon

N.V. Latukhina[1], D.A. Lizunkova[1], I.A. Shishkin[1]

[1]*Samara National Research University, Moskovskoye shosse 34, Samara, Russia, 443086*

Abstract
In this work we report the results of experimental researches of photosensitive structure properties. The each structure have the layers of porous silicon, generated on the surface of single crystal silicon plates, and DyF_3 or ErF_3 cover on it. The experiments include the current-voltage and capacitance-voltage measurements. The conducted researches demonstrate that DyF_3 or ErF_3 covers improve photo-electric characteristics

Keywords
porous silicon, current-voltage characteristics, capacitance-voltage characteristics

1. Introduction

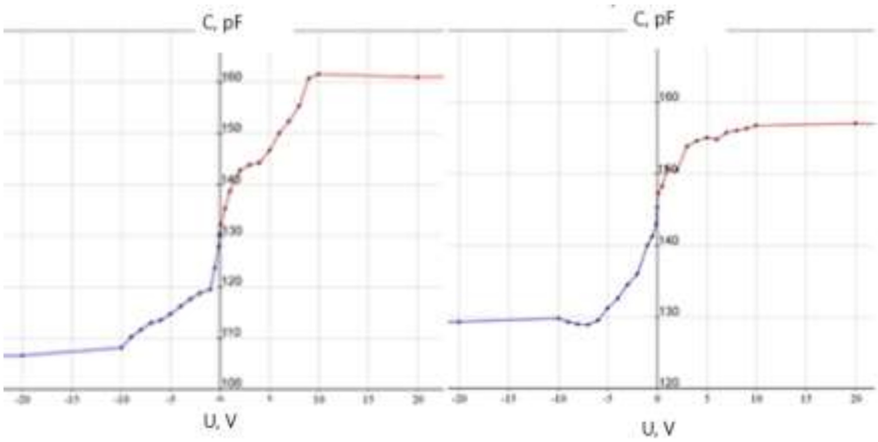
Porous silicon has a simple manufacturing technology and a wide range of electrical and optical properties, which makes it promising for use in various devices, in particular, efficient solar cells [1]. The advantages of the obtained porous layer are a high degree of absorption of incident light on the surface, which reduces the rate of recombination of surface charges. However, the combined effect of the porous layer and the interference coating on the properties of solar cells has not been studied. The effect of surface recombination can be significantly reduced if a dielectric coating of a rare-earth element fluoride, which has passivating properties on the silicon surface, is applied to the surface. This work presents the results of studies of the current-voltage and capacitance-voltage characteristics of multilayer structures created on silicon substrates with a textured surface.

2. Experiment

The formation of a porous layer occurred during the anodic etching of silicon in aqueous-alcoholic solutions of hydrofluoric acid. Small (0.2 - 0.5 μm) p-n-junctions were made on the working surface in photosensitive structures. Aluminum contacts, films of dysprosium fluoride, erbium fluoride were deposited on the surface of the porous layer by thermal evaporation in a vacuum. The characteristics were measured at room temperature by probe methods.

3. Results and discussion

Figure 1 (a, b) shows the capacitance-voltage dependences of samples with a porous layer deposited on substrates with a textured surface, coated with dysprosium fluoride (T1, Fig. 1, a) and erbium fluoride (Fig. 1, b). ...). The samples have approximately the same porosity (T1 32.9%, T2 30.7%), the thickness of the dielectric films is also approximately the same (0.77 μm), so their characteristics are very similar. The curves have a shape characteristic of metal-oxide-semiconductor structures with two saturation points and a noticeable drop in capacitance. Areas of abrupt changes in capacitance are located symmetrically in both negative and positive voltage values. They are symmetrical about the ordinate axis, the enrichment area starts from + 10B, the inversion area starts from -10B. Films of dysprosium fluoride and erbium fluoride effectively bind charge centers on the surface of porous layers of all studied types.



a) b)

Figure 1: Capacitance-voltage curves of samples with a porous layer made on substrates with a textured surface, with coatings of dysprosium fluoride (a) and erbium fluoride (b)

Figure 2 shows the current-voltage curves of textured samples with p-n junction and coatings of dysprosium fluoride (Tn1, Tn3), erbium fluoride (Tn2, Tn4) and control samples (Tn5, Tn6) without coatings. The porosity of the Tn1 sample was 26.8%, Tn2-28.1%, Tn3-7.5%, and Tn4-6.8%.

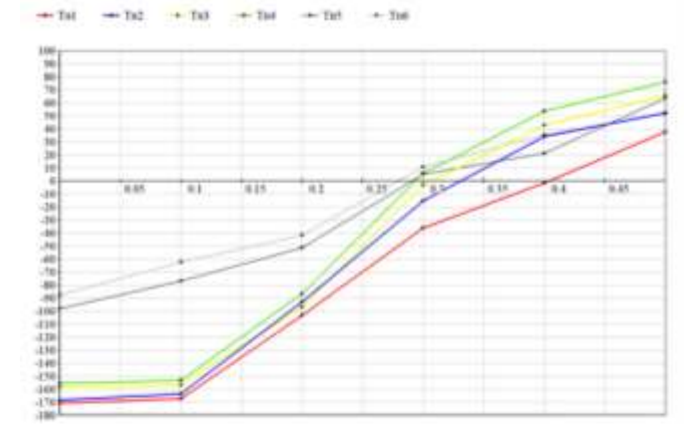


Figure 2 Current-voltage curves of textured samples with p-n junction and coatings of dysprosium fluoride (Tn1, Tn3), erbium fluoride (Tn2, Tn4) and control samples (Tn5, Tn6) without coatings

Comparison of current-voltage curves of samples with and without coatings confirms the conclusion that the charge centers on the porous surface are reduced under coatings of erbium fluoride and dysprosium fluoride. The largest short-circuit current results in a Tn1 sample etched horizontally on a textured surface with a p-n junction and a DyF_3 coating, which indicates the lowest recombination of charge carriers

4. Conclusion

Therefore this technology allows you to create photosensitive structures with high photoelectric parameters that can be controlled by changing the modes of production. The usage of this structure in solar cells will allow to raising considerably conversion efficiency of solar energy in the electrical

5. References

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