

Photoluminescence Efficiency of the Si – Nanocrystalline CdTe Composite

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When CdTe nanocrystals (NCs) is introduced into Si, the photoluminescence (PL) of Si is enhanced due to the formation of a heterojunction, which ensures the injection of charges into the bulk of Si. We have studied the dependence of the PL intensity of the “porous Si (*p*Si)–CdTe NCs” composite on the *p*Si surface morphology and the conditions for depositing a colloidal solution of CdTe NCs on the porous surface of *n*-type silicon wafers oriented in the (100) direction. *p*Si layers were formed by electrochemical etching to form pores 2.5 μm in diameter, 20-30 μm deep, and 10⁶ cm⁻² in density, or by chemical etching to form smaller, larger diameter pores with lower density and a spongy surface.

The PL spectra were measured at room temperature, radiation was excited by a xenon lamp, and the signal was recorded by a FEU-100. The deposition was carried out in several stages with intermediate washing of the surface.

The measurements showed that during the deposition of CdTe NCs in *p*Si with a small pores diameter (2.5 μm), the radiation efficiency per unit surface area turned out to be lower than for a matrix with larger pores, i.e. NCs penetration occurs more efficiently in pores with a large diameter.

This is probably due to the incomplete filling of pores due to the difficulty of penetration of CdTe NCs into smaller pores due to the presence of an adsorption layer of a stabilizer on the NCs surface, which is used in the colloidal synthesis of NCs to increase the resistance to aggregation and sedimentation.

The cause of incomplete filling of small pores can also be the appearance of an electrostatic field due to the presence of a charge on the surface of CdTe NCs. When applying a colloidal solution of CdTe NCs on a spongy surface, the increase in intensity was not large enough, despite the degree of porosity exceeding the previous cases. This may be due to insufficient exchange of charge carriers between the components of the system. A study is being made of the possibility of removing the stabilizer shell from the surface of CdTe NCs, which will increase the number of NCs embedded in *p*Si pores. Another positive effect of the removal of the shell may be the elimination of the reason for some decrease in the radiation yield from CdTe NCs. To achieve this goal, 5–10% isopropyl alcohol, which dissolves the surface layer of thioglycolic acid, was added to the colloidal solution of CdTe NCs during precipitation. The use of this technique made it possible to increase by a factor of 5 the PL efficiency of the *p*Si–CdTe NCs system, in which the *p*Si layer was formed by electrochemical etching. The authors see the prospects of work in this direction.