# The electroluminescence from $p^+$-nanostructured Si – $n$-Si (100) heterojunctions

**N. Bagraev [1], L. Klyachkin [1], R. Kuzmin [1], A. Malyarenko [1], V. Mashkov [2]**

[1] *Ioffe Physical-Technical Institute of the Russian Academy of Sciences, St. Petersburg*
[2] *St. Petersburg State Polytechnical University, St. Petersburg*

Monday
Tuesday
Wednesday
Thursday
Friday

The goal of the present work was to study the electroluminescence from novel heterojunctions that represent the p-type nanostructured Si (ns-Si) heavily doped with boron on the n- Si (100) wafer. These heterojunctions were prepared on the n-type Si (100) surface within frameworks of the planar diffusion silicon technology. It is well-known that the generation of excess fluxes of the silicon self-interstitials and vacancies occurs during the formation of an oxide overlayer on the Si (100) wafer. The fluxes have the preferred crystallographic directions along <111> and <100> axes, respectively, which allow the formation near the Si-$SiO_2$ interface the nanostructured layer produced by a set of self-interstitial microdefects confining longitudinal ultra-narrow, 2 nm, silicon quantum well (Si-QW) [1]. After preliminary oxidation, photolithography and etching, the non-equilibrium short-time boron diffusion from the gas phase should be carried out to passivate the dangling bonds and to transform the Si (100) wafer with the ns-Si layer into the ns-Si/Si $p^+n$ heterojunctions. The high concentration of boron introduced during this process was controlled by the SIMS method and appeared to be equal to the value of $5 \times 10^{21}$ $cm^{-3}$. The ns-Si/Si $p^+n$ heterojunctions have been shown to represent the p-type Si-QW confined by wide band gap heterobarriers heavily doped with boron on the Si (100) wafer [1].

Room temperature electroluminescence from the heterojunctions studied was observed from visible to far infrared spectral range. The nanostructured silicon layer heavily doped with boron appeared to participate in the generation of visible light as a result of direct interband optical transitions in the 2 nm silicon microdefects. Highly linearly-polarized infrared electroluminescence, 1.16 µm, is originated from the heterointerface between the nanostructured barrier heavily doped with boron and the n-type Si (100) wafer. The intensity and degree of the linear polarization as well as the spectral shape of this infrared electroluminescence were studied as a function of temperature, excitation levels and the lateral voltage applied in the plane of the p+-n junction. The last one causes the quenching of the high degree of the linear polarization and the intensity of the electroluminescence. Intensive light emission in far infrared region seems to be started from the intraband optical transitions in nanostructured silicon layer. The results obtained show that the ns-Si/Si $p^+n$ heterojunctions are able to exhibit a great potential for realizing the fully silicon-compatible optoelectronic devices in different spectral ranges.

[1] N.T. Bagraev, E.Yu. Danilovsky, W . Gehlhoff, L.E. Klyachkin, A.A. Kudryavtsev, R.V. Kuzmin, A.M. Malyarenko, V.V. Romanov, Journal of Modern Physics **2**, 256 (2011).