ANNEALING EFFECT ON CATHODOLUMINESCENSE OF ARTIFICIAL OPALS INFILLED WITH SILICON

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Silicon is known to be the basic material of contemporary solid- state electronics. Therefore, investigation of structure and physical chemical properties of silicon nanoclusters is highly important. In the present work, artificial opals consisted of 250 nm diameter close-packed amorphous silica spheres have been filled with silicon using thermal CVD technique. As-filled silicon basically was an amorphous type. Then the samples were annealed. The changes of the cathodoluminescent (CL) spectra of the samples before and after annealing were investigated.

For that two deferent methods of annealing were used. The first method was the annealing at 800oC in air at a common pressure of 0.1 Torr for 2 h. In another case the local heating of opal in vacuum 10-6 Torr as a result of interaction between the electron beam (diameter 1 k) and a sample was used as the annealing of the opal in vacuum. This method permits to observe the change of CL property during the measurement. As the electron current increases from 10 nA to 100 nA (electron energy 15 keV) local heating of a sample changes from 100 oC to 800 oC.

CL spectra of opals have been studied in the visible and near IR ranges (from 1eV to 4,5eV). The change of the CL spectra was measured using the beam currents ranged from 0,1nA to 150nA and the electron energy 15keV. In the same time we had the possibility to change the time of interaction of the electron beam with the samples. The CL spectra were obtained in deferent regimes: stationery electron beam, deflection electron beam and time-resolution regime.

The CL spectrum of opal infilled with amorphous silicon in the IR range has a broad weak band with maximum at 1.3eV. The annealing at air leads to the shift and increase of the intensity of this band. The measurement of the CL properties after the interaction with electron beam of high power shows the several stages of the CL spectra change: the appearance of the CL bands at 1.4, 1.7eV; the decrease of its intensities. The final spectrum is the same that one after annealing at air. We relate the broad band at 1.3eV with CL of the amorphous silicon, the bands at 1.35eV, 1.5, and 1.7eV with CL of Si nanocrystals. The Raman measurements also confirms the formation of Si nanocrystals.