CATHODOLUMINESCENT STUDY OF SILICON NANOCRYSTALLITES BURIED IN SiOx LAYERS

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The search for new composite materials is very important in creating new solid-state devices. In this case, a silicon-based material with nanoscale crystallites is very attractive because of theirs unique electrical and optical properties, and luminescence in the visible UV and IR ranges. There are various routes to synthesize the systems consisting of SiO2 matrix and silicon nanocrystallites. In this paper silicon nanocrystallites buried in SiOx layers were studied.

The SiOx samples were prepared by reactive Si deposition. Electron beam evaporation and radio frequency plasma cells were used as silicon and oxygen sources, respectively, and the x parameter in SiOx was estimated from the deposition conditions to be from 1.6 to 2.0.

CL properties of SiOx layers were studied in visible and near IR ranges (from 1eV to 4,5eV). The CL spectra were obtained in the regime of the stationary electron beam and electron beam modulation. We were able to make time-resolution spectra with the time delay from 20 s up to few seconds. The composition of layers was verified by electron probe microanalysis (EPMA). The structure of the SiOx layers (the size of Si nanocrystals) was investigated by TEM. Spectra, results of CL investigation and the composition of layer were compared with the properties of thermal silicon oxide on silicon of the same thickness (250nm).

The EPMA showed that the composition of these SiOx composition of SiOx layers changed from SiO2 to SiO1,6. The sizes of the silicon nanocrystals in SiO1.6 layers determined by TEM were 5-7nm, in SiO1.9 the Si nanocrystals were about 3-7nm. In SiOx (x 2) no silicon clusters were founded but TEM image showed the formation of local areas with density higher that the usual density of thermal SiO2. The similar areas were founded in the layers SiO1,9 near the Si clusters. CL studies of these layers in NIR range showed the bands at 1.5 -1.6eV for the layers SiOx (x=1,6 1,7). The SiOx layers SiOx (x¿1.8) have no emission in NIR had no bands in IR range (1.2-1.8eV). The CL studies of these layers in the visible range showed that all the layers have had the blue CL emission. But the energy position of this band depends on of the layer composition. All SiOx layers have the intensive band at 3.0-2.8eV. (The thermal silica has the intensive band at 2.7eV) The band at 2.8-3.0 is very intensive for SiOx layers with x 2, and it is weak for the layers with x=1.6-1.7. We are relating this band to the structural defects in SiO2, formed due to oxygen deficits.