Hot-electron Injection Type Thin-film EL Devices

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Hot-electron injection thin-film electroluminescent (HEI-EL) devices have been fabricated on p-type Si substrates. In these devices, the hot-electrons in SiO_2 layer injected from p-type Si are re-injected into the active layer to excite EL centers.

In p-Si-SiO_2 structure, the electrons excited by avalanche effect are accelerated towards Si-SiO_2 interface and gain energy enough to surmount or tunnel the SiO_2 energy barrier. The transportation of electrons in SiO_2 layer is studied by measuring the emitted luminescence intensity in the course of anodic oxidation of Si.

The EL characteristics of HEI-EL device is found to be similar to that of the conventional EL devices. The HEI-EL device shows a maximum luminance of over 1000 cd/m^2 and a maximum luminescent efficiency of 1.14 lm/W. However, the threshold voltage with an active layer thickness of 300nm is observed to be about 40V, a lower value than that of conventional EL devices. The threshold voltage of HEI-EL devices is decreased by 15V when p/n substrates (a p-layer formed on n-type substrate) are used, because the minority carrier, electrons, in p-layer are supplied from n-layer.

The accumulated electrons at the Si-SiO_2 interface, which affect the EL characteristics of HEI-EL devices, can be swept DC bias voltage applied between the n^+ layer formed as a guard ring and the substrate. This results for 30 times higher luminance increment when the bias voltage is 4V under constant driving voltage of 47V.