Growth and Luminescent characteristics of ZnO epitaxial thin film on Si substrate

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ZnO is a direct transition type semiconductor with an energy band gap of about 3.37eV at room temperature, and shows an exciton emission with a peak at about 3.3eV. Moreover, the exciton emission is stable even at room temperature, because the binding energy of the exciton is about 60meV. Therefore, ZnO is expected as a material for light emitting device showing near ultraviolet emission. So far, ZnO epitaxial thin film has been grown on a sapphire substrate. in this study, the epitaxial growth of the ZnO thin film on Si substrate was tried to realize the device with low driving voltage, low cost and integrated multi-function.

When ZnO is grown on Si substrate directly, ZnO epitaxial film cannot be obtained, because an oxide layer is formed in the surface of the Si substrate at an early stage of the growth. So, in this study, firstly a ZnS epitaxial film was grown on Si(111) substrate, then the ZnO epitaxial film could be successfully grown in the ZnS epitaxial film. Moreover, it was found by thermal analysis in this study that ZnS is rapidly oxidizes to ZnO in oxygen atmosphere. Therefore, the ZnO epitaxial film could be also successfully grown by the oxidation of the ZnS epitaxial film grown on the Si substrate at 700 to 800oC in oxygen atmosphere. The orientation relation is (0002).[11$\bar{2}$0]ZnO//(111),[1$\bar{1}$10]Si. Although both films showed the exciton emission with a peak at about 375nm (3.3eV), the intensity from the latter was stronger than that from the former. It was shown from the experimented results and thermodynamic calculation that the oxidation reaction from ZnS to ZnO is taken place by one step reaction. Moreover, it was also shown that the formation of n-type ZnO film is available by the oxidation of Ga or Al-doped ZnS film