Reduced-stress GaN epitaxial layers grown on Si(1 1 1) by using a porous GaN interlayer converted from GaAs

Abstract

This paper reports the reduced-stress GaN epitaxial growth on Si (1 1 1) using a porous GaN interlayer which is formed from GaAs layer by a novel nitridation process. Initially a 2 μm thick GaAs layer is grown on a Si(1 1 1) substrate by MBE. Then, a GaN buffer layer of 20 nm thick is grown on the GaAs layer at 550°C in a MOVPE reactor. The GaAs layer capped with the GaN buffer layer is annealed in NH3 to 1000°C. Through this process, a porous GaN layer is formed beneath the GaN cap layer. An epitaxial GaN layer is grown on the GaN buffer layer at 1000°C in the MOVPE reactor. The epitaxial layer grown on the porous-GaN/Si(1 1 1) structure is found to have no cracks on the surface. In contrast, an epitaxial layer grown on the GaAs layer nitrated without a cap layer many cracks are found in the epilayer and the layer is sometimes peeled off from the substrate. It is found that the surface morphology of the GaN/porous-GaN/Si(1 1 1) sample is markedly improved by employing a 40 nm-thick interlayer grown at 800°C in addition to the above processes. A PL spectrum with a high intensity ratio between the excitonic emission and the deep yellow emission is obtained for the GaN/porous-GaN/Si(1 1 1) sample. E2 peak position in Raman scattering spectrum also shows a reduced stress for the GaN epilayers grown on the porous-GaN/Si(1 1 1).