Improvement in performance of optoelectronic devices due to the introduction of attractive substrates

1. Epitaxial growth of nitride semiconductors on ZnO substrate

We have focused on ZnO substrates which has the same crystalline structure as GaN and lattice constant near GaN. The lattice constant of ZnO perfectly coincides with $In_{0.17}Ga_{0.83}N$. This substrate can be expected to be supplied to the market with lower cost than that of sapphire because of its fabrication method. A surface of ZnO substrate has been reported to be attacked with atmosphere during metalorganic vapor phase epitaxy. For growing high quality epitaxial films, we have developed the growth technique through the buffer layer for protecting the ZnO surface. We also aim to fabricate vertical type devices because we can use n-type ZnO substrates.

2. Epitaxial growth of nitride semiconductors on $ScAlMgO_4$ substrate

We also have developed the epitaxial growth technique on $ScAlMgO_4$ (shortly called SCAM) substrates with the lattice-constant near GaN and the almost same temperature dependence of the thermal expansion coefficient as GaN. We can fabricate SCAM substrates with atomic flat surface from an SCAM boule by only cleavage without any cutting by any saw and polishing. because of SCAM can be cleaved along c-plane.

3. Epitaxial growth of nonpolar and semipolar nitride semiconductors

The conventional devices consisted of nitride semiconductors have been fabricated on (0001) plane (sometimes called c-plane or Ga-polarity). The huge polarization field along c-axis degrades the efficiency of light-emitting devices. For improving this efficiency, we have epitaxially grown nonpolar and semipolar nitride semiconductors. Our purpose is to realize blue, green and red light-emitting-diodes (LEDs) with high efficiency.

4. Improvement of crystalline quality by introduction of surfactant and selective growth

Nitride semiconductors, which are epitaxially grown on different substrates consisted of different materials, have to consequently coexist defects and strain caused by mismatch of lattice-constant and thermal expansion coefficient. In addition, becomes rough because of the growth under no thermal equilibrium conditions. For obtaining nitride semiconductors with the smooth surface and decreasing defects, we have proposed the epitaxial growth techniques for nitride semiconductors with a several kinds of surface planes by introduction of surfactant and selective growth [*2] [*3].