X-RAY STUDIES OF III-V NATIVE OXIDE/GAAS INTERFACE

Abstract

by

Seong-kyun Cheong

Three x-ray techniques have been employed to study wet-thermal native oxides of AlGaAs on GaAs. For these materials, a knowledge of the role of As at the interface is important for understanding Fermi-level pinning and is a central issue in efforts to develop high performance III-V MOSFET devices. This study is focused on how the As is incorporated at the interface, the interfacial strain, and related local structural parameters.

X-ray absorption fine-structure spectroscopy (XAFS) was used to determine the site of residual As in wet-oxidized $Al_{0.96}Ga_{0.04}As$. In a ~0.5 μm oxide film removed from its GaAs substrate, the remaining As atoms were found to be coordinated with oxygen in the form of amorphous As oxides, with a mixture of ~80% As^{3+} and ~20% As^{5+} sites. These two sites are locally similar to As_2O_3 and As_2O_5. Through this measurement, no evidence of interstitial or substitutional As, As precipitates, or GaAs was seen, implying that less than 10% of the As atoms are in these forms.

To characterize the oxide structure in both the oxide film and the interfacial region, x-ray reflectivity and reflection-mode XAFS experiments were performed for a thin (300 Å) oxidized $Al_xGa_{1-x}As$ (x = 0.96) film grown on GaAs. X-ray reflectivity studies showed that the composition of the surface oxidized film is not homogeneous as a function of depth. Reflection-mode XAFS, which uses the total external reflection of x-rays to confine an x-ray beam to the interfacial region, provided details of the local environment of As atoms at the interface of the oxide/GaAs. Analysis through this technique revealed that As atoms are in the form of mixed As oxides, with the local environment appearing to resemble As_2O_3 and As_2O_5 in the interfacial region, which is consistent with the above observation from the isolated oxide film.