

[I-1]

Surface Analysis of Sulfur-Treated GaAs

신 장 규

경북대학교 전자공학과

Sulfur treatments have recently been reported which electrically passivate GaAs surfaces. From the variety of experimental results reported on sulfur-treated GaAs surfaces, it is clear that the treatments can improve the surface electronic properties. This paper presents the results of an investigation of the chemistry of GaAs surfaces after various sulfur treatments including ammonium sulfide and sodium sulfide liquid solutions and hydrogen sulfide gas. Auger electron spectroscopy(AES) and x-ray photoelectron spectroscopy(XPS) have been used to determine the surface chemical composition and bonding. Different wet chemical etches and substrate heating temperatures were used in order to vary the chemical composition of the GaAs surface from Ga-rich to As-rich. The As/Ga ratio ranged from 0.48 to 5.98.

Ammonium sulfide and sodium sulfide solutions etch the GaAs leaving near-stoichiometric or slightly As-rich surfaces free of elemental As or oxides. Similar surfaces result from etching with NH_4OH and exposing to H_2S . Samples etched with HCl and $\text{H}_2\text{SO}_4 : \text{H}_2\text{O}_2 : \text{H}_2\text{O}$ and exposed to H_2S are As-rich due to the presence of elemental As. The amount of the elemental As decreases rapidly with temperature and is undetectable for temperatures above 200°C in a H_2S ambient.

Sulfur bonds to both Ga and As surface atoms, whichever are available as a result of substrate processing. Only one bonding state is observed for either Ga-S or As-S bonding independent of the sulfur treatment process. In addition, sulfur bonds to both elemental As and substrate As with the same binding energy and similar concentration. For most samples, the sulfur coverage is less than a monolayer although samples heated at 350°C in a H₂S ambient show more than a monolayer sulfur coverage.

References

1. C. W. Wilmsen, K. M. Geib, J. Shin, R. Iyer, D. L. Lile, and J. J. Pouch, "The sulfurized InP surfaces," *Journal of Vacuum Science and Technology*, B7(4), 851 (1989).
2. J. Shin, K. M. Geib, C. W. Wilmsen, and Z. Lilliental-Weber, "The chemistry of sulfur passivation of GaAs surfaces," *Journal of Vacuum Science and Technology*, A8(3), 1894 (1990).
3. K. M. Geib, J. Shin, and C. W. Wilmsen, "Formation of S-GaAs surface bonds," *Journal of Vacuum Science and Technology*, B8(4), 838 (1990).
4. J. Shin, K. M. Geib, and C. W. Wilmsen, "Sulfur bonding to GaAs," *Journal of Vacuum Science and Technology*, B9(4), 2337 (1991).