# B—6—6 Hydrogen Plasma Etching of III-V Compound Semiconductor Surfaces

R. P. H. Chang, C. W. Tu, C. C. Chang, S. Darack, and A. R. Schlier
Bell Laboratories
Murray Hill, New Jersey 07974, U.S.A.

One of the most important steps in studying the surface chemistry or in fabricating devices is surface preparation. In this talk results on hydrogen plasma etching of III-V compound semiconducting surfaces are discussed. The main advantage for using hydrogen plasma for surface cleaning is that the removal of surface contaminants proceeds via chemical reactions and that the hydrogen gas is more compatible with ultrahigh vacuum systems than other etchant gases. Using a combination of analytical techniques-spectroscopic ellipsometry, Auger spectroscopy, and scanning electron microscopy (SEM), the etch rates, the surface composition and morphology have been studied in detail. With a very low power density (15 mW $cm^{-3}$) of hydrogen plasma, the surface hydrocarbon contamination could be removed without affecting the substrate. At higher power levels and low base pressure ($\leq 5\times10^{-8}$Torr), native oxides could be etched away. It is found that for III-V compound semiconductors the etch rate for the semiconductor is comparable to its native oxide, while Si etches nearly 30 times faster than $SiO_2$. The plasma etched (and air exposed) GaAs surfaces have a Ga/As concentration ratio nearly equal to that of the air cleaved GaAs surface. Similar results have also been obtained for GaSb. The surface chemistry of InP (as well as GaAs) in the hydrogen plasma was found to be critically dependent on the amount of residual water vapor in the plasma tube. When the base pressure in the tube was high ($10^{-6}$Torr), the plasma oxidized the surface instead of etching the native oxides. Hydrogen plasma etched InP shows surface segregation and is rich in In. The etch rates of the semiconductors and their oxides vary by several orders of magnitude from compound to compound as determined from ellipsometry and SEM. Applications using hydrogen plasma etching will also be discussed.