Chemical Functionalization of GaAs Surfaces

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GaAs is one of the most technologically important semiconductors, and its direct bandgap and high carrier mobility make it a highly desirable material for photovoltaic and photoelectrochemical devices. However, the control of surface chemistry necessary for effective device performance is currently only accessible by expensive epitaxy techniques, and expanded means of chemical passivation are an area of great interest.

We have examined the chemistry of the GaAs(111)A surface modified with HCl (aq.), PCl_3 and PEt_3. These surfaces have been studied by high-resolution soft x-ray photoelectron spectroscopy. XPS confirms the presence of Cl and P, respectively, on the treated surfaces. The high-resolution data also allows us to evaluate the presence of both surface oxides and As^0, which has been implicated as an important electronic trap state at GaAs surfaces. Both HCl and PCl_3 are able to completely remove surface oxides of both Ga and As. Treatment of HCl etched surface with PEt_3 also gave an almost entirely oxide-free surface. The electronic passivation of these chemically modified surfaces was evaluated by photoluminescence intensity measurements.