SENSORS UNLIMITED, INC.

1995 IEEE WORKSHOP ON CCDs AND ADVANCED IMAGERS
(APRIL 20-22, DANA POINT, CA)

Near-Infrared Imaging Applications With InGaAs

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Indium gallium arsenide ($In_xGa_{1-x}As$) is a direct bandgap III-V compound semiconducting material whose alloy composition (x) can be adjusted to absorb and detect light from the ultraviolet out past 3 μm. Useful alloys include x=0.53 (lattice-matched to InP bulk substrates to detect light from 0.9μm to 1.7 μm), x=0.70 (compositionally graded on InP substrates to detect 1.2-2.2μm light) and x=0.82 (compositionally graded on InP to detect 1.5-2.6μm light). We have measured and correlated lattice parameter, photoluminescence, chemical composition, white-light and detector cutoff wavelengths for a series of lattice-matched InAsP/InGaAs alloys with cutoffs ranging from 1.9 to 2.6μm. Novel crystal growth techniques can be employed to allow these materials to detect light as short as 0.4μm and also to be fabricated as "3-color" detectors whereby one detector structure can detect all three wavelength range described above. A "3-color" camera, based on this material will be described. Detectivities in the range of 10^{11}-10^{13} $cm(Hz)^{1/2}/W$ have been measured.

InGaAs has also been employed to make JFET switches on the same InP substrate as the detector devices. A two-dimensional monolithic array of InGaAs detectors with JFET switches and readouts have been constructed and will be described. A new JFET structure, designed to reduce leakage current, will be described. Our relatively unsuccessful experience with $In_{0.53}Ga_{0.47}As$ CCDs will also be described.

A novel material innovation that will be described here is the use of **ternary** bulk-grown substrates that have been used to fabricate long-wavelength lasers and detectors. The larger (and variable) lattice-parameter of ternary InGaAs allows 2μm detectors to be made without the need for compositional grading-which introduces crystal defects-that is required with binary InP substrates. Similarly, by using InAsP substrates to make strained-layer lasers, emitting wavelengths can be extended beyond that possible with InP.

Much of the above work has been supported over the last several years by NASA Jet Propulsion Lab under SBIR programs.

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