LOW TEMPERATURE PROCESSES FOR MICRO OPTO–ELECTRO–MECHANICAL SYSTEMS ON HgCdTe INFRARED DETECTORS

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Next generation infrared focal plane arrays (IRFPAs) are expected to require significantly enhanced functionality over existing systems. Such functionality includes the facility to operate at higher operating temperatures, the ability to do on-pixel processing of data, polarisation discrimination and dynamic spectral selectivity. The outstanding detector properties of HgCdTe and its well developed process technology make it an ideal basis on which to build next generation IRFPAs. By combining HgCdTe IR detectors with MEMS-based tuneable Fabry-Perot resonators, it is proposed to develop IR detectors that are tuneable over approximately one octave with spectral linewidths $\Delta\lambda / \lambda < 0.01$. This has required the development of a generic, low-temperature surface micromachining technology suitable for fabrication of MEMS-based tuneable HgCdTe infrared optical detectors.

The process relies on low-temperature deposition of a sacrificial layer and low-temperature PECVD deposited SiN_x. The entire process is accomplished with a thermal budget of <125ºC for <1 hour. While low-temperature PECVD deposition of SiN_x is well known, it generally results in highly compressively strained films that are unsuitable for use as free-standing MEMS structures due to buckling and membrane collapse. The deposition tooling and process conditions developed allow conformal deposition of SiN_x with accurate stress control from tensile to compressive. The Young's modulus of the SiN_x material is ~110GPa and has been determined by nanoindentation and microcantilever studies. Internal stresses have been measured using microbidges and wafer bending. Zero net stress is readily and reproducibly obtained with very small (<25MPa/μm) stress gradient through the thickness of the SiN_x. Low stresses are required so that the large mirror displacements needed to tune a Fabry-Perot over one octave wavelength in the infrared (typically of the order of 1 – 2 μm) can be achieved using voltages compatible with silicon VLSI processes used for the read out and control circuitry in large IRFPAs.

In addition, low-temperature, low-stress mirrors based on SiO/Ge Bragg reflectors have been developed. Actuation of the tuneable Fabry-Perot filter is accomplished electrostatically, and has required the development of low temperature Ge deposition technologies that result in low absorption conductive Ge layers.

This paper will give a review of the technology developed, and will summarise the achievements-to-date.