



## Sensitive GaInAs/InP QWIPs grown on silicon

Quantum-well infrared photodetectors (QWIPs) are of interest for many commercial, industrial and military applications. At present most QWIPs are grown on GaAs and InP substrates, and complicated fabrication processes are used to hybridize the QWIP focal plane array with the silicon-based read-out integrated circuit (ROIC). QWIPs grown directly on Si substrates make monolithic integration with the Si-based ROIC possible. However, the major obstacle to this is the large lattice mismatch between Si and III-V material, which creates a high density of threading dislocation in the epitaxial layer.

A number of growth techniques have been utilized to grow GaAs and InP on Si. A team at Northwestern University, Illinois has published work on an *in situ* thermal annealing technique that reduces the

dislocation density in a 6  $\mu\text{m}$  epitaxial InP buffer grown on a GaAs-coated Si substrate by LP-MOCVD (*Phot. Tech. Lett.* 2000 14(3) 372). The annealing process was performed between room temperature and 550°C for every 1  $\mu\text{m}$  InP growth. Twenty periods of a GaInAs/InP QWIP structure were grown on top of the thick InP buffer.

The performance of a QWIP-on-Si device was compared with that of a QWIP-on-InP. The large dark current of the QWIP-on-Si was due to the presence of threading dislocations, and a small blue-shift was observed in the spectral response curve for the QWIP-on-Si relative to that of the QWIP-on-InP. A record high detectivity of  $2.3 \times 10^9 \text{ cmHz}^{1/2}/\text{W}$  was achieved for the reported QWIP-on-Si detector and, compared with the GaAs/AlGaAs QWIP-on-Si, the GaInAs/InP QWIP-on-Si showed much better detector performance. A comparison of QWIP-on-Si detectors with different InP buffer thicknesses indicates that there is an optimum thickness for the InP buffer layer on Si that gives the best detector performance.