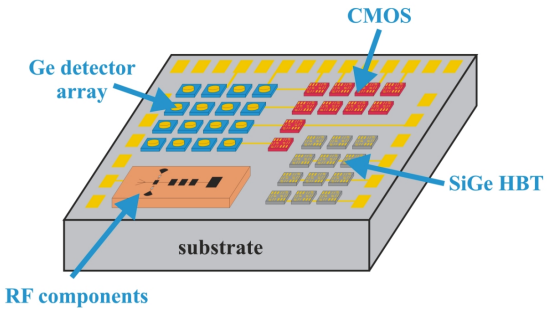
High Speed Broad Band SiGe Detectors on Si

Universität Stuttgart
Institut für Halbleitertechnik

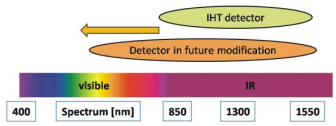
BACKGROUND and BASICS

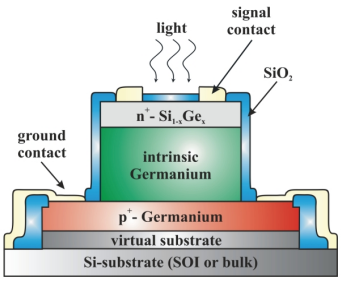
Photonics and optoelectronics play an essential role in many areas of communication and information technology. In the last years a rapid development of optical functions integrated on Si has advanced. This silicon based optoelectronics integrated with microelectronics will open new opportunities, e.g. high speed fiber communication, on chip optical interconnects for high clock frequencies, cost effective solutions for fiber to the home or near infrared detectors for automotive driver assistance.

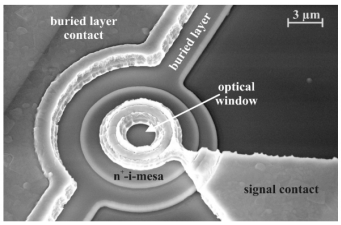


CONCEPT and SOLUTION

The germanium detector layers are grown with molecular beam epitaxy (MBE) on top of a silicon-on-insulator (SOI) substrate. The photodetectors are realized as mesa diodes. The device process comprises two mesa etching steps.
The incident light is absorbed in the complete p-i-n structure and generates carriers in all layers. However for a fast photodetector only the fast carriers from the depletion layer are of interest because diffusion from the undepleted layers is slow. For high external quantum efficiency the main part of the light should be absorbed in the intrinsic layer.
To solve these problems several approaches could be made. Diffusion is suppressed by the high doping (in the range of 1020 cm-3) of the buried layer and top contact (Auger recombination) and by the strong recombination at the misfit dislocation network in the virtual substrate.
Quantum efficiency is improved by using a SiGe alloy in the top layer, which also pushes the optical bandwidth more in the visible regime and a pure Ge absorption layer with a small penetration depth. SOI substrate performs as a mirror for certain wavelengths.

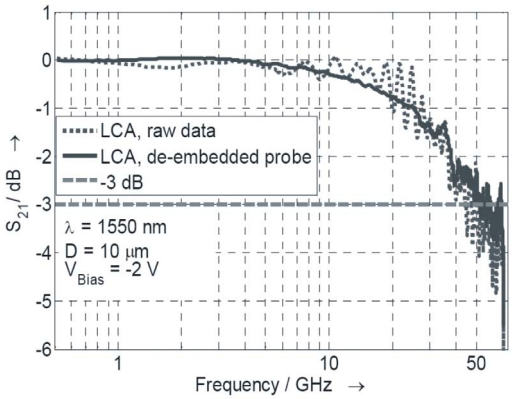






STATUS and OUTLOOK

The institute developed integrated high speed broad band Ge detectors on Si or SOI with a band width up to 49 GHz, but the potential is higher, beyond 100 GHz. At this time this is the fastest integrated Ge detector. High speed performance of the detector is obtained by absorption in the depletion layer where high electric fields accelerate the carriers to saturation velocity and by avoiding slow carrier diffusion



Contact:
Prof. Dr. habil. J. Schulze / Dr. M. Oehme, Pfaffenwaldring 47, 70569 Stuttgart,
Phone: +49 (0)711-685-68003, schulze@iht.uni-stuttgart.de / www.iht.uni-stuttgart.de