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New materials and fabrication for APDs, SPADs and SiPMs

Thursday 23 May 2013 09:00 (1h 30m)

The "new materials"that will be discussed in this lecture are depositions of pure boron and pure gallium, given the names PureB, PureGa and PureGaB. It may seem out of place to speak of boron as a novice in silicon technology since it has always been, and still is, the most commonly used p-dopant. Nevertheless, it is now recognized that boron, deposited by chemical-vapor deposition (CVD) in its pure form, exhibits both electrical and processing properties that make it a useful and unique supplement to the long list of materials already playing a role in silicon device integration. In particular, extremely shallow junctions for p+n diodes can be fabricated with PureB as the anode. To underline the unique behaviour of these junctions the lecture begins with an introduction to the device physics of truly ultrashallow junctions followed by the basics of the junction formation process.
At the moment, the most prominent application is for PureB Si photodiodes that are sensitive right up to the front-entrance window that can be made with PureB down to 2 nanometers thin. Therefore these photodiodes are particularly interesting for the detection of very low-penetration-depth radiation such as DUV/VUV/EUV light and charged particles such as low-energy electrons. Their performance has been shown to surpass that of other existing technologies on points such as internal/external quantum efficiency, dark current, degradation of responsivity. At the same time they readily lend themselves to detector integration schemes that allow low parasitic resistance and capacitance as well as the on-chip combination with other electronic elements. Focus will be placed on the special requirements for integration as SPADs.
Similarly outstanding results have been achieved with a pure-gallium deposition capped with a PureB deposition (PureGaB), also when applied to Ge devices. Infrared Ge-on-Si photodiodes with photon-counting capabilities at room temperature have been demonstrated in this PureGaB technology. All in all, the PureB/PureGaB diodes perform better than other ultrashallow junction technologies. The reasons for this will be highlighted while we walk through the applications to detectors/imagers that now span the whole electromagnetic spectrum going from terahertz –IR –visual –DUV/VUV/EUV –X-rays through to electron detectors.

Brief biography of the speaker

Lis K. Nanver has a masters degree from the University of Aarhus, Denmark, and PhD degrees from ENST, Paris, France, and Delft University of Technology, The Netherlands. She has throughout her carrier been involved in many different aspects of research on silicon device integration and now heads a research group on this subject at TU Delft, where she is a professor. Her main research interests are new devices and integration processes, mainly for RF, microwave, or smart sensor applications. She has pioneered several new ultrashallow diode technologies using techniques such as epitaxy by chemical-vapor or metal-induced solid-phase deposition and excimer laser processing. She also developed a substrate transfer technology for true two-sided contacting of devices that has been instrumental in the development of new RF/microwave adaptive circuit concepts. In the last few years the research on new pure-dopant CVD processes for creating extremely shallow diodes has resulted in several leading-edge applications such as high-linearity silicon-on-glass varactor diodes, Si photodiode detectors for low penetration-depth beams and low-leakage Ge-on-Si photodiodes. For the Si detector work her group has received the 2010 IEDM Roger Haken Award.

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