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First Insights into the Super-gq Depfet: An Improved High Performance Sensor with Increased Gain and Sub-electron Noise Level Capabilities.

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In recent years, DePFET (Depleted P-channel Field Effect Transistor) based sensors have been deployed for various applications, including particle tracking at Belle II experiment and for X-ray spectroscopy on board the planetary science mission BepiColombo. Future applications include real-time imagers for transmission electron microscopes (TEMs) and X-ray imaging spectroscopy on board the ATHENA satellite. These sensors have been customized to meet specific application requirements, delivering high frame rates, accurate position resolution, Fano-limited energy resolution, or maximized dynamic range for TEMs. In essence, DePFETs operate as p-channel field-effect transistor built upon a high-resistive, fully depleted silicon substrate. By placing a deep-n implant below the transistor channel, a potential minimum for electrons is being created and a internal gate is formed. Charge generated in the bulk is collected in this internal gate, whereby the conductivity of the transistor is modulated and the number of signal electrons can be determined.
Recently, the super-gq DePFET technology was developed. Here, a significant improvement of the signal to noise ratio is achieved by decoupling the sizes of internal and external gate. By adding an n-implant that is added to the source side of the device only in a small region below the channel, limiting the internal gate to this area. With respect to simulations, this enables a considerable increase in charge gain by a factor of three (1.7 nA/e-) and white noise of less than 1 e- ENC, while at the same time limiting impact ionization near the drain end of the channel. These improvements make super-gq DePFETs potentially capable of reaching sub-electron noise levels.
A test production of this and other technologies such as Quadropix, Infinipix and RNDR DePFETs was recently completed. Initial measurements have been carried out and provide first insights into the improvement of amplification, noise and the physical verification of the concept.

Collaboration

Role of Submitter

I am the presenter

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