Exploring bipolar junction and electron-channel field-effect devices using diamond

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(With Timothy Grotjohn, Zetian Mi, John Albrecht, Jung-Hun Seo etc.)

Diamond has superior electronic and thermal properties which render it a potential semiconductor candidate for high-performance devices fulfilling the need of future power electronics and RF power electronics. However, diamond also has some intrinsic drawbacks in comparison to conventional semiconductors. One of the major drawbacks is its deep donor energy levels. As a result, only p-type channel field-effect transistors have been mainly explored in diamond as of today. To explore the bipolar junction transistor applications using diamond, one possible approach is to combine n-type conventional semiconductors with p-type diamond. To form heterogeneous abrupt junctions, semiconductor grafting was used to first form GaAs/diamond n-p junctions. On top of that, npn diamond-collector transistors were attempted. Considering that electron channel has been very difficult form in diamond due to the deep donor energy levels, we proposed to form electron-channel in diamond by exploiting polarization charge transfer doping from nitrides based on semiconductor grafting. In this talk, the most recent developments in diamond-collector bipolar transistors and electron transfer doping in diamond will be presented and the technical challenges will be discussed.