Highlights

ACTIVITY E Advanced materials and techniques for organic electronics, biomedical and sensing applications 2020

Benchmarking β-Ga_2O_3 Schottky Diodes by Nanoscale Ballistic Electron Emission Microscopy

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Monoclinic beta-phase gallium oxide (β-Ga_2O_3) is an ultrawide-bandgap semiconductor, intensively studied as a viable candidate for next-generation power electronics, optoelectronics, and extreme environment electronics. Schottky contacts to β-Ga_2O_3 are of paramount importance to this end; however, they are not yet fundamentally understood. Intrinsic sources of interfacial disorder, including oxygen-related defects and extrinsic fabrication factors, are thought to greatly determine the properties of such contacts, for example by originating Fermi level pinning and causing patches with different Schottky barrier heights (SBHs). Ballistic electron emission microscopy (BEEM) is used to probe band bending and interfacial inhomogeneity at the nanoscale for prototypical Au/ and Pt/(100)β-Ga_2O_3 single crystal Schottky barrier diodes. It is shown that SBH fluctuations amount to 40–60 meV under vacuum, occurring over length scales of tens of nanometers. Furthermore, a remarkable SBH modulation of ≈0.2 eV takes place upon exposure of devices from vacuum to ambient air. Such findings—better obtained by BEEM than by macroscale approaches—point to the existence of an ubiquitous inhomogeneous interfacial layer, controlling band bending and ambient sensitivity via oxygen ionosorption and interface redox chemistry. This study ascribes a key role to interfacial oxygen vacancies, and has practical implications for transport modelling and interface engineering.

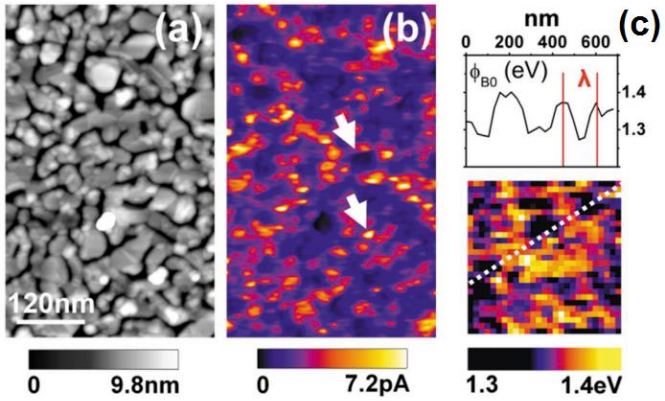

Fig. 1: a) STM topography and b) BEEM map acquired simultaneously over a representative Au region of the Au/(100)β-Ga_2O_3 Schottky junction (I_T =36nA, V_T= −1.95 V, T = 296 K). The arrows highlight two localized spots with high BEEM contrast. (c) Spatially resolved map of the local Schottky barrier height ϕ_{B0}. Along the dash line, ϕ_{B0} fluctuates over a length scale λ as large as ≈200 nm.