Direct band structure measurements of a buried δ-layer

Jill A. Miwa[1], Philip Hofmann[1], Michelle Y. Simmons[2] and Justin W. Wells[3]

[1] *Department of Physics and Astronomy, Interdisciplinary Nanoscience Center (iNANO), Aarhus University, 8000 Aarhus C, Denmark.*
[2] *Centre of Excellence for Quantum Computation and Communication Technology, School of Physics, University of New South Wales, Sydney, NSW 2052, Australia.*
[3] *Department of Physics, Norwegian University of Science and Technology (NTNU), N-7491 Trondheim, Norway.*

We directly measure the band structure of a buried two dimensional electron gas (2DEG) using angle resolved photoemission spectroscopy [1]. The buried 2DEG is formed several nanometers beneath the surface of p-type silicon (001), because of a dense δ-layer of phosphorus n-type dopants which are placed there. Although the δ-layer is deeply buried, relative to the photoelectron mean free path, photoemission is still possible at very low kinetic energies, or when a resonant enhancement is invoked.

Here we present direct measurements of the band structure of the buried 2DEG using angle resolved photoemission spectroscopy (ARPES). Our measurements confirm the layer to be metallic and give direct access to the Fermi level position, as well as facilitating a direct comparison with calculations. In addition, we report the dependence of the band structure on properties such as dopant confinement and temperature, and discuss the resonant enhancement mechanism which facilitates such measurements.

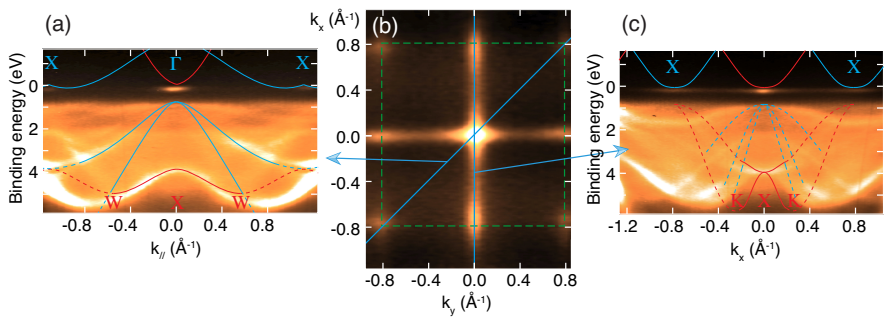

Figure 1: Measured band structure **a,c** and Fermi surface **b** of δ-doped Si(001), with band structure calculations from Ref. [2] overlaid. *Adapted from Ref. [1].*

[1] Jill A. Miwa, Philip Hofmann, Michelle Y. Simmons and Justin W. Wells. Phys. Rev. Lett. *(accepted)*, arxiv.org/abs/1210.7113
[2] M. Rohlfing, P. Krüger, and J. Pollmann. Phys. Rev. B, **48**:17791, 1993.