Interface properties of Ohmic contacts to n-GaAs

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Ohmic contacts with low resistivity are needed for most electronic and photonic devices to transmit electric current into a semiconductor structure with low losses. Au/Ge/Ni-based stacks are known to provide ohmic contact to n-GaAs with proper post-annealing [1-3]. To better understand the detailed formation mechanisms behind this ohmic contact, we have combined surface scientific and electrical characterization methods to study the simple Au/Ni/n-GaAs stack. We aim to elaborate the role of Ni and Au in the contact formation in the absence of Ge as a dopant.

We observe linear IV behaviour of Au/Ni/n-GaAs stack after post-annealing for 1h at 450 °C in ultra-high vacuum. However, characterizing these contacts with TLM is not possible, as we observe a very low voltage drop between the contacts. We interpret that the difficulties in TLM characterization are due to the surface of the semiconductor and not the contacts themselves, as IV measurements made through a n-GaAs sample from Ni/Au front contact to a Ni back contact show a linear current-voltage dependence.

After additional post-annealing for 1h at 450 °C in NH_3 atmosphere, we observe in IV characterization that the resistance between Ni/Au contacts at the n-GaAs sample front has increased. XPS depth profiling reveals a strong out-diffusion of Ga through the metal stack. We propose that these results can be interpreted by an annealing-enhanced upward band bending at the metal/n-GaAs interface (i.e. Schottky type) which enables electrons' tunneling also into a hole conductive channel at the oxidized n-GaAs surface between the contacts.