Electroluminescence and crystal phases in hybrid metal-GaAs nanowire devices

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The manipulation of light below the diffraction limit, including the development of light sources with nanoscale emission spots, attracts much attention in the scientific community owing to its potential significant impact on sensing, microscopy, and even computation and communication technologies at large.

We demonstrate electrical modulation of electroluminescence up to 1 GHz in nanoscale point-sources, obtained in hybrid metal−GaAs nanowires embedding two sharp axial Schottky barriers.[1] Devices are obtained via the formation of Ni-rich metallic alloy regions in the nanostructure body thanks to a technique of controlled thermal annealing[2] of Ni/Au electrodes.

To accurately investigate the metallic phase nano-domains, devices are fabricated onto a 50 nm SiN membrane and electron diffraction tomography is performed. This allows to identify the occurrence of the Ni_xGaAs (x≈3) crystal structure.3,[4] Possible mechanisms of Ni incorporation underlying the observed phenomenology are discussed.[5]

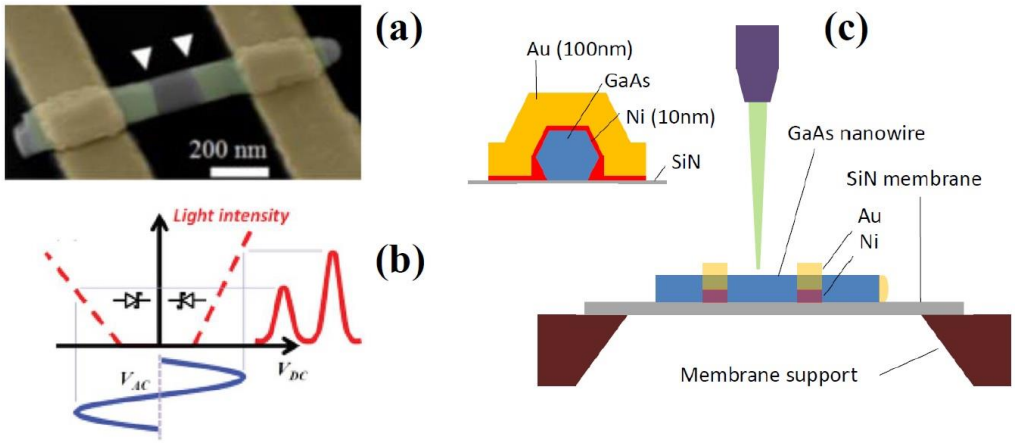

Figure 1. ***(a)*** *Scanning electron micrograph of one of the studied devices: n-doped GaAs NWs were deposited onto SiO_2/Si and contacted by two Ni/Au 300 nm wide electrodes. Ni-rich metal alloys were induced by a suitable thermal annealing (green overlay).* ***(b)*** *Sketch of device time-response in the presence of a large bias excitation alternatively driving both the Schottky barrier in the reverse breakdown regime.* ***(c)*** *Simplified sketch of the device and of the experimental setup. The SiN membrane, transparent to electrons, is supported by a thicker silica membrane with a central hole allowing the electrons to pass through the sample, which can be tilted.*

References

[1] M. Mongillo *et al*, *ACS Nano* **5** (2011), 7117.
[2] F. Rossella *et al*, *Nano Lett.* **16** (2016), 5521.
[3] J. David *et al*, *Acta Cryst.* A**72** (2016), s3285521.
[4] J. David *et al*, *Nano Lett., 2017, 17 (4), 2336–2341*