Linear photoresponse in nanowires with GaN/AlN heterostructure

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Nanowire-based photodetectors are promising candidates for flexible electronics, and on-chip optical interconnects. In the UV spectral region, GaN is a natural candidate for spectrally-selective photodetectors. However, a general feature of nanowire (NW) photoconductors (also for other material systems such as ZnTe, ZnO, InP, CuO or GaAs) is that the output photocurrent scales sublinearly with the input laser power, limiting applications requiring the quantification of the radiant fluence [1,2].

We show that for GaN nanowire photodetectors with embedded AlN heterostructures the dependence of the output photocurrent on the input laser power can be linear for those nanowires with a diameter below a certain threshold (80 nm in our design). This limit corresponds to the total depletion of the nanowire stem due to the Fermi level pinning at the sidewalls. We explain the nonlinearity in partially depleted nanowires as due to a nonlinear variation of the diameter of their central conduction channel under illumination. We compare our experimental results with theoretical calculations, which provide a view of the electric fields within the structure and into surface effects. From this comparison we can explain the behavior of the photocurrent and its dependence on the nanowire diameter [3].

References
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[2] F. González-Posada, *et al.,* Nano Lett. **12,** 172 (2012).
[3] M. Spies *et al.,* Nanotechnology (2018) (10.1088/1361-6528/aab838).

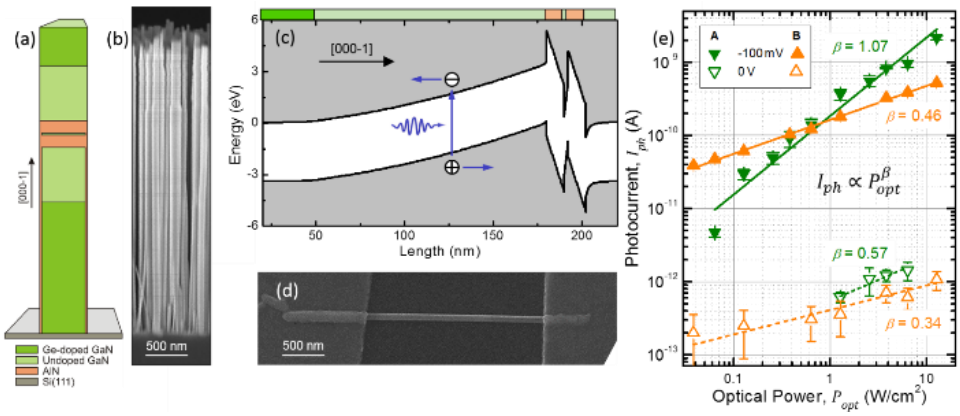

Figure 1. (a) Scheme, (b) SEM image and (c) band diagram of the heterostructured NWs. (d) SEM image of a contacted single NW. (e) Typical photoresponse of NWs with a diameter <80 nm (**A**) and >80 nm (**B**) under bias and at zero bias. Under reverse bias, **A** nanowires are linear (β ≈ 1) whereas **B** nanowires are sublinear (β < 1).