Light polarization control by H-assisted strain modulation in GaAsN/GaAs heterostructures

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Defect engineering via the spatially controlled formation of N-H complexes in *dilute nitrides* allows for modulating the electronic and structural properties of the host material in the growth plane [1]. In the work presented here, the surface of a $GaAs_{1-x}N_x$ (x=0.8%) sample was patterned by electron beam lithography with H-opaque Ti wires (width w=500 nm), oriented at different angles (0°, 22.5°, 45°, 67.5°, and 90°) with respect to the [110] crystallographic direction. After hydrogenation and Ti removal, a spatial modulation of both *band-gap energy* and *strain fields* was obtained in the growth plane.

Polarization-resolved *micro-photoluminescence* (μPL) measurements evidence a high *degree of polarization* (ρ) of the light emitted from single wires, due to the H-induced strain anisotropy [see Fig. 1(a-c)]. Further, the polarization angle is found to rotate with the wire orientation, suggesting a potential for light-polarization control via strain engineering. Also, ρ is maximum (minimum) for wires oriented at 0° and 90° (at 45°), highlighting the influence of the underlying crystal on the selection rules governing light emission from the wires.

Finally, atomic force microscopy (AFM) shows that the wires protrude by ~2 nm above the hydrogenated barriers [see Fig. 1(d-f)], due to the lattice distortion induced by the strain anisotropy. This could be useful for X-ray optics applications based on the *Berry-phase effect*, *i.e.*, on the giant translation undergone by X-rays traversing a deformed medium [2].

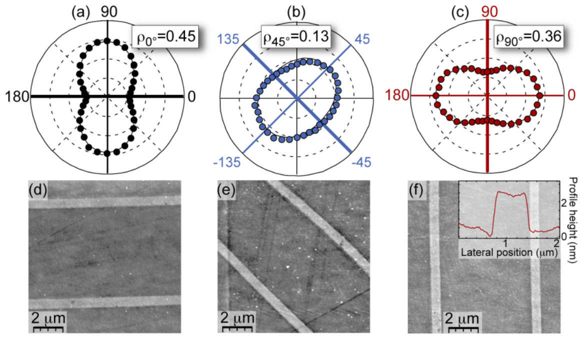

Figure 1. (a-c) Intensity (at T=10 K) of the μPL signal of single GaAsN wires (oriented at 0°, 45°, and 90° with respect to the [110] crystallographic direction), plotted as a function of the angle between the polarization vector and the [110] axis. The listed values of the degree of linear polarization (ρ) were obtained from the fitted curves, displayed as solid lines in the figure. (d-f) AFM images of the GaAsN wires. The contrast between the wires and the hydrogenated barriers is due to the ~2 nm protrusion associated with the H-induced strain anisotropy [see inset of panel (f)].

[1] R. Trotta *et al.*, Adv. Funct. Mater. **22**, 1782 (2012) and references therein.
[2] Y. Kohmura *et al.*, Phys. Rev. Lett. **110**, 057402 (2013) and references therein.