# Highly effective gating of graphene on GaN nanopillars and epilayers

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In this communication we present results of highly effective graphene gating using GaN epilayers (EPI GaN) as well as vertically aligned GaN nanopillar structures (GaN NP). In the EPI GaN a 100 nm thick layer of undoped GaN preceded by a 3 µm thick layer of highly conductive GaN was grown on a sapphire substrate (Fig. 1a inset). 200 nm diameter thick GaN NP were etched in EPI GaN by plasma method [1]. Four-layer graphene (FLGr) was used as a top contact to the GaN structures. Current-voltage characteristics show Schottky-like characteristics for a reverse biased voltage up to -5 V in both samples (Fig. 1a). Raman spectra measured for these structures show a strong shift of the G band as a function of gate bias (Fig. 1b, c). In graphene on GaN NP a blueshift up to 1.4 $cm^{-1}$ is observed while for graphene on EPI GaN a redshift of up to 9.6 $cm^{-1}$ is present (Fig. 1d). Furthermore, the G band in graphene on EPI GaN clearly splits, which suggest different carrier concentrations of subsequent graphene layers in the FLGr structure (Fig. 1b). Our results suggest that graphene on EPI GaN is p-doped, while n-doping is characteristic for graphene on GaN NP. Interestingly, a substantial Raman shifts occurs in our Schottky diode structures at one order of magnitude smaller voltages than for graphene deposited on SiO2 substrates in capacitator type devices [2]. These obtained gating efficiency is comparable to the results for solution-gated graphene. This strongly suggest that the diode junction is located directly near the graphene layers [3]. Thus, graphene gating is effective at very low voltages which is highly promising for further electron-phonon studies as well as possible applications like nano LEDs.

## REFERENCES

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## FIGURES

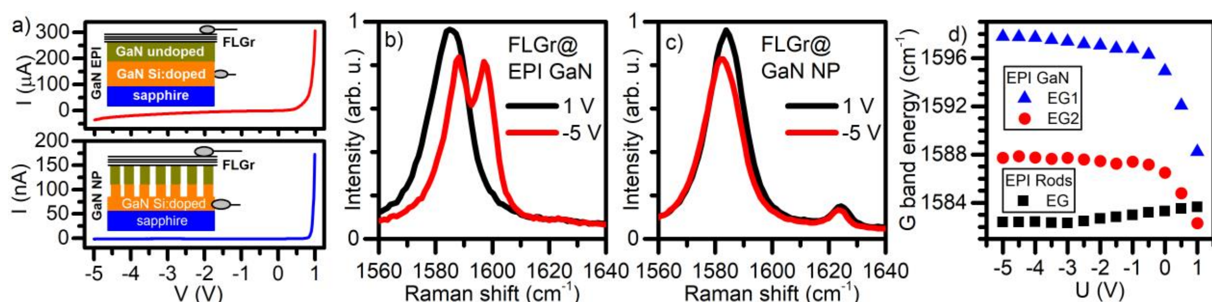


**Figure 1:** a) IV characteristics; insets present sample schemes. Graphene G band measured in samples: b) EPI GaN, c) GaN Rods, d) dependence of G band energy on diode voltage.