Highlights

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Tunable Schottky barrier and high responsivity in graphene/Sinanotip optoelectronic device

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We demonstrate tunable Schottky barrier height and record photo-responsivity in a new-concept device made of a single-layer CVD graphene transferred onto a matrix of nanotips patterned on n-type Si wafer. The original layout, where nano-sized graphene/Si heterojunctions alternate to graphene areas exposed to the electric field of the Si substrate, which acts both as diode cathode and transistor gate, results in a two-terminal barristor with single-bias control of the Schottky barrier. The nanotip patterning favors light absorption, and the enhancement of the electric field at the tip apex improves photo-charge separation and enables internal gain by impact ionization. These features render the device a photodetector with responsivity (3 A W^{-1} for white LED light at 3 mW cm^{-2} intensity) almost an order of magnitude higher than commercial photodiodes. We extensively characterize the voltage and the temperature dependence of the device parameters, and prove that the multi-junction approach does not add extra-inhomogeneity to the Schottky barrier height distribution. We also introduce a new phenomenological graphene/semiconductor diode equation, which well describes the experimental I–V characteristics both in forward and reverse bias.

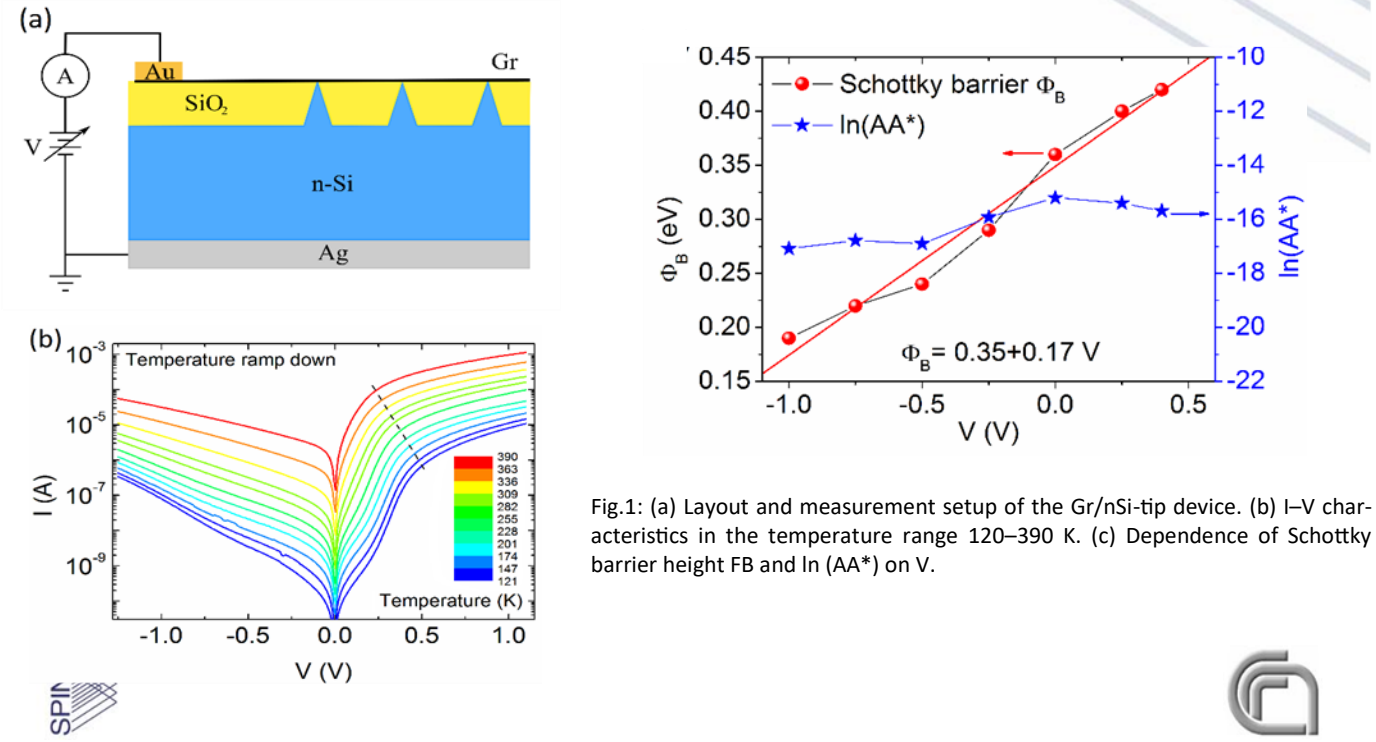

Fig.1: (a) Layout and measurement setup of the Gr/nSi-tip device. (b) I–V characteristics in the temperature range 120–390 K. (c) Dependence of Schottky barrier height FB and ln (AA*) on V.