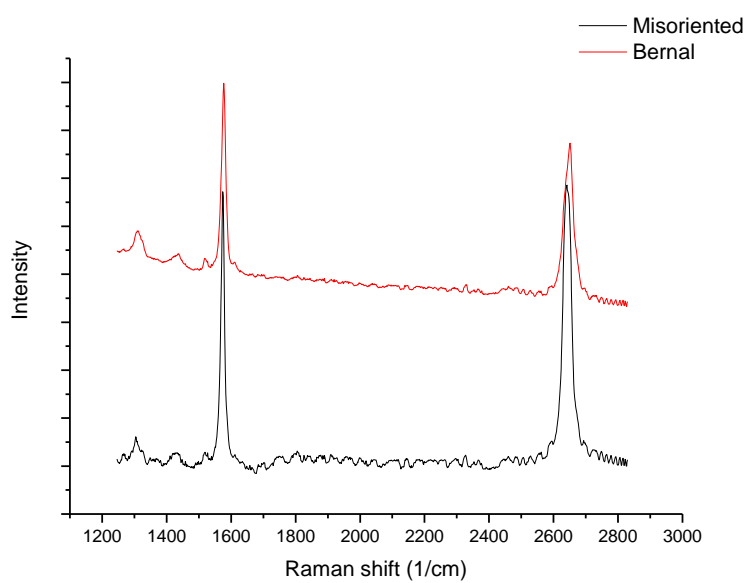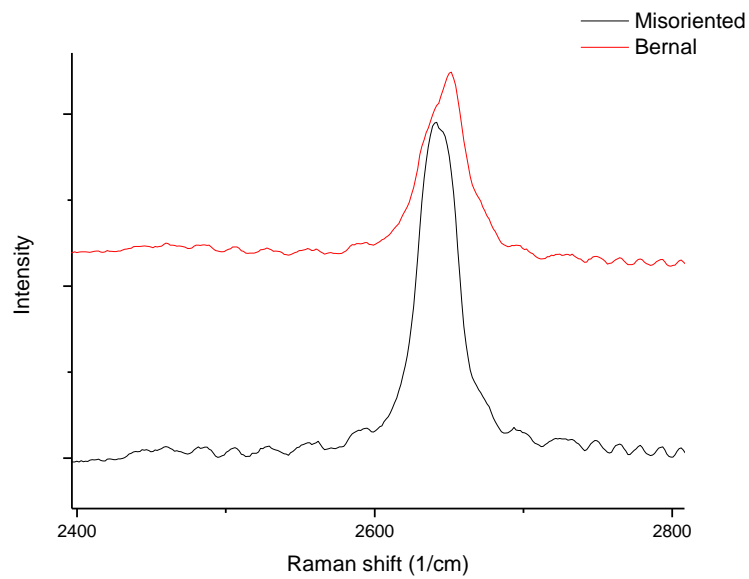# Supplementary information

Figure S1: Raman spectra of the two types of bilayer graphene, measured at 633 nm excitation.
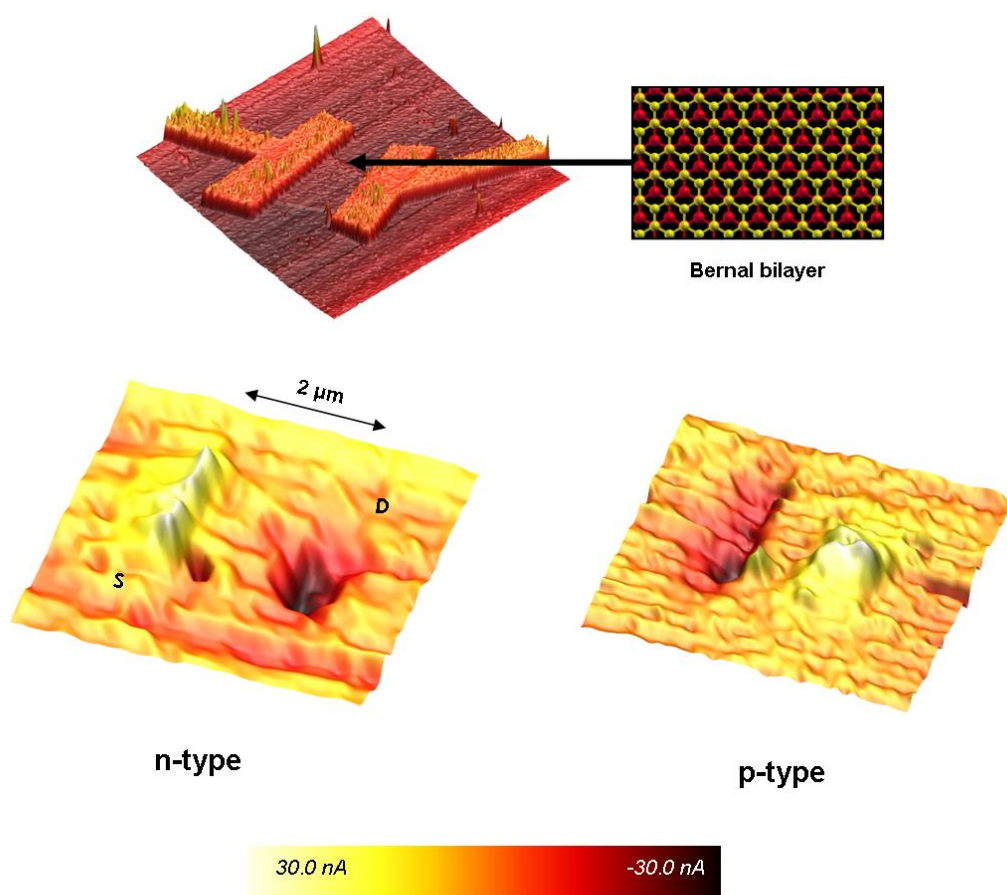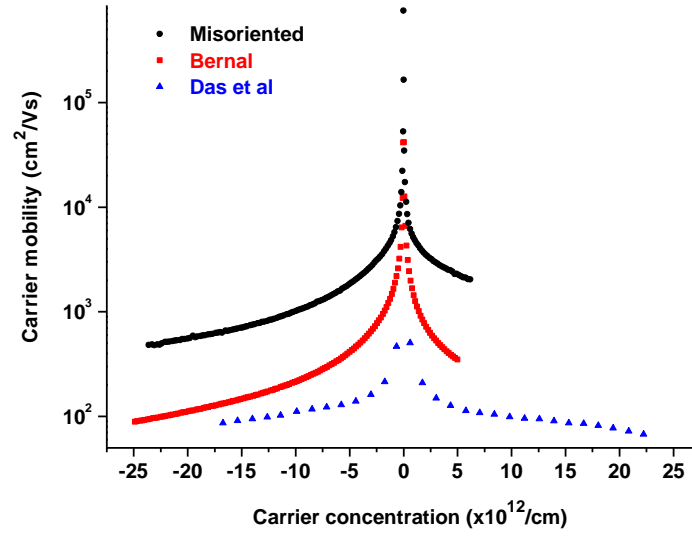
(a)

(b)

Figure S2: Photocurrent measurements of Bernal bilayers in electrochemical top-gated configuration, including an AFM image of the sample before top-gating.

Bernal bilayer

2 μm

D

S

n-type

p-type

30.0 nA   -30.0 nA

Figure S3: Comparative plots of the calculated carrier mobilities for the top-gated configurations.

The carrier mobilities of the misoriented and Bernal-stacked bilayer devices were estimated by applying the Drude model $\mu = (ne\rho)^{-1}$. The plotted data represent the best values obtained within our sample ensemble. The misoriented bilayer device shows a higher mobility when compared to both Bernal-stacked bilayers and monolayers (taken from Das *et al.*, Nature Nanotechnology **2008**, *3*, 210), suggestive of electrostatic screening of the charged impurities on the substrate by the bottom graphene layer.