Bilayer Graphene Electromechanical Systems

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Abstract

Both graphene and bilayer graphene are outstanding electromechanical systems. Their electronic and mechanical properties – as well as their coupling – are widely tunable. To the best of our knowledge, simultaneous mechanical spectroscopy and measurement of electronic transport – via radio-frequency (RF) mixing – has not been realized in bilayer graphene. We present data showing clear electromechanical resonances in three suspended bilayer devices whose lengths range from 1 to 2 microns.

We first describe the low-temperature current annealing of the devices which is crucial to achieving the transconductance (I-V_G) necessary to implement an RF mixing method. We describe our RF mixing circuit and data. We measure clear mechanical resonance ranging from 50 to 140 MHz. We show that we can smoothly tune the resonance frequencies of our bilayer resonators with mechanical strain applied via a backgate voltage (see Fig. 1). We measure quality factors up to 4000. We briefly discuss the effects of RF driving power on the dispersion of the mechanical resonance. We show initial data of the bilayer mechanical resonance as a function of magnetic field as the fermi level of the charge carrier crosses several quantum Hall phase transitions. We aim to study the non-linear mechanics of these oscillators, and their energy dissipation mechanisms – both in zero magnetic field and in the quantum Hall regime.

Figure

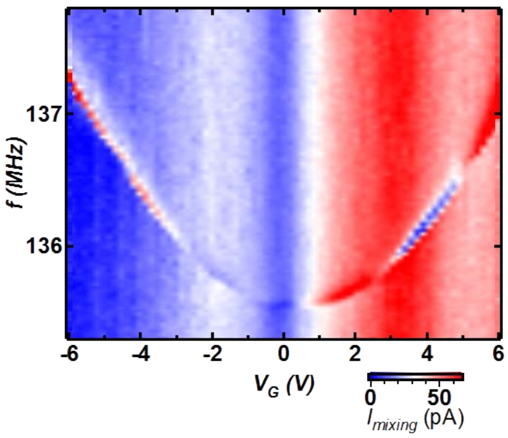

Fig 1. Amplitude of the RF mixing current (I_{mixing}) in a suspended bilayer graphene resonator as a function of the frequency (f) and backgate voltage (V_G). A clear mechanical resonance is visible, and its frequency is gate tunable.