Gate Tuning of Optical Fabry-Perot Cavities with Suspended Multilayer Graphene Mirrors

Antoine Reserbat-Plantey, Laëtitia Marty, Nedjma Bendiab and Vincent Bouchiat

Institut Néel, CNRS-UJF-INP, BP 166, 38042 Grenoble cedex 9, France
antoine.reserbat-plantey@grenoble.cnrs.fr

Graphene based membranes provide ideal materials to implement semi transparent mirrors that can be electrostatically actuated [1, 2] and which motion can be optically detected [1]. We fabricate micron-scaled optical cavities composed of a multi-layer (MLG) graphene cantilevers free-standing over an oxidized silicon wafer. Reflectometry and Micro-Raman characterization is performed by scanning a laser probe over the cantilever. Thickness variations within the MLG/Silica gap induce equal spacing interference fringes in both the reflected and Raman scattered waves. Spatial variations within interference patterns allow to spatially split all Raman modes emitted by both MLG and Silicon substrate. The cavity finesse of the resulting Fabry-Pérot-like interferometer can reach about 6 and is in agreement with simulation involving graphite based semi-reflecting membrane of similar geometry. The MLG membrane is connected to a gold gate electrode that allow to apply an electric field within the cavity and tune the cavity thickness with nanometer precision. Intensity of the reflected light and Raman lines exhibit quadratic dependence upon the applied gate voltage while G and 2D Raman modes show a softening in frequency as well. We discuss the use of such devices for implementing devices that allow the measurement of Casimir force.

References

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[2] C. Chen, S. Rosenblatt, K. Bolotin, W. Kalb, P. Kim, I; Kymissis, H. Stormer, T. Heinz, and J. Hone. Performance of monolayer graphene nanomechanical resonators with electrical readout. Nature Nanotech, **4** (12) :861–867, 2009.

Figures

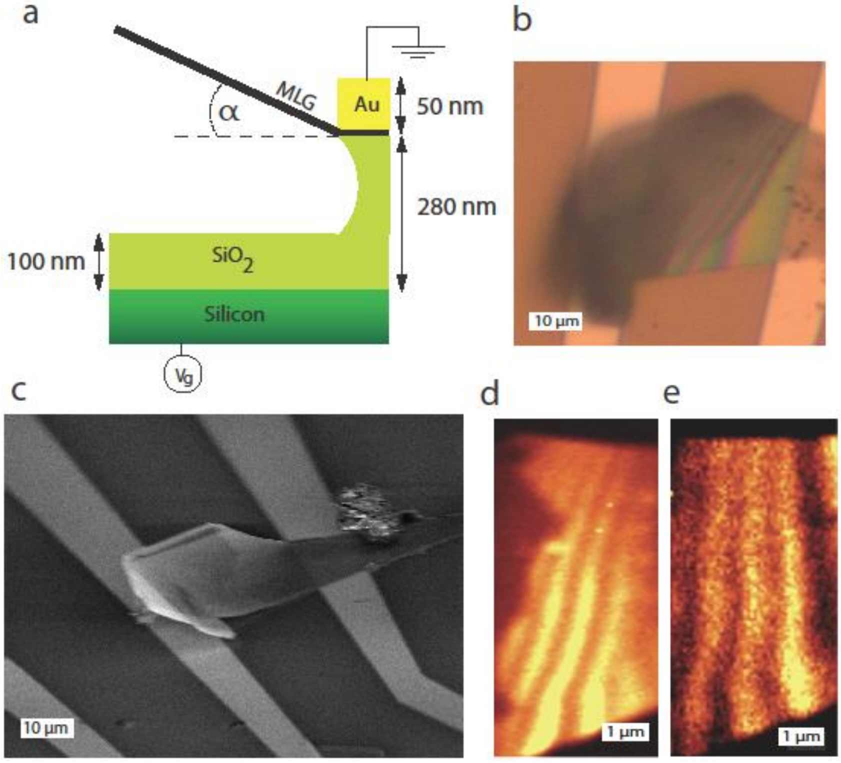

Figure 1 : (a) : Schematics cross-section of a MLG optical cavity showing the air-wedge obtained by partial underetch of silica. (b) : Optical micrograph acquired under white light irradiation of sample A showing iridescence effects. The left part of the flake sticks-up and thus show some blur due to off-focus. (c) : SEM micrograph of sample A. (d) : Raman map of MLG G mode intensity. (e) : Raman map of MLG 2D mode intensity

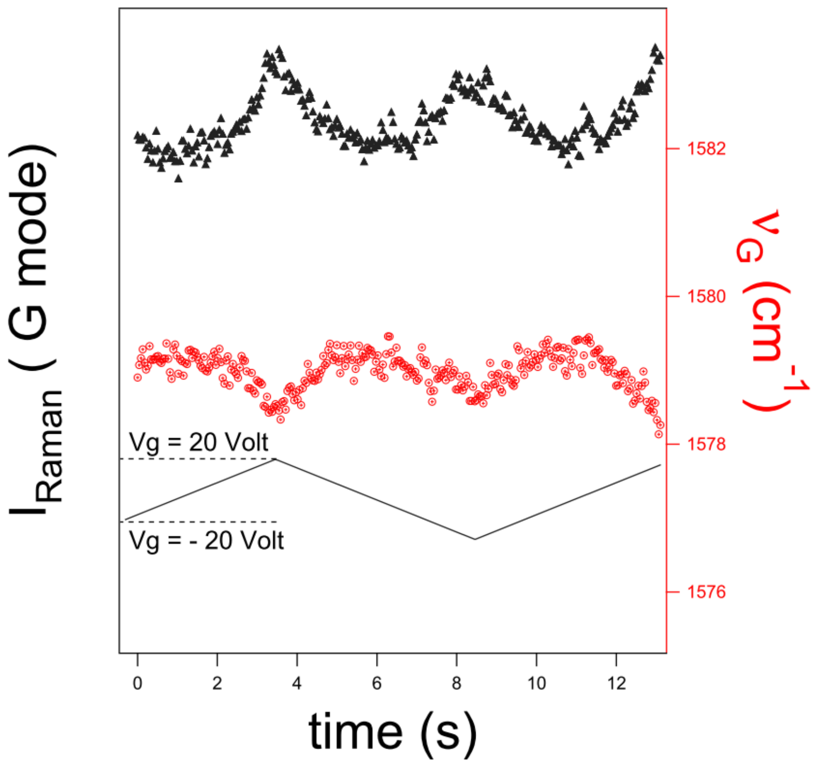

Figure 2 : dark triangles: Raman Intensity (left axis: arbitrary units) of E_{2G} phonon mode (G band) as a function of time. Red circles: E_{2G} phonon frequency (right axis: cm^{-1}) as a function of time. Plain dark line: Gate voltage applied as a function of time, triangular signal centered at zero.