The Electroluminescence of Graphene/hBN transistors

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In this talk, I will present our recent discovery of graphene's electroluminescence in the mid-infrared spectral range. Electroluminescence is the phenomenon by which a material emits light in response to the passage of an electrical current. In solids, it is the prerogative of semiconductors and related organic materials, and it results from the radiative recombination of electrons and holes. The semi-metallic nature of graphene a priori forbids electroluminescence. Nonetheless, electroluminescence is possible, because (i) of the remarkable inefficiency of the non-radiative carrier relaxation in graphene, and (ii) thanks to an original carrier injection mechanism specific to 2D semimetals: the Zener-Klein (ZK) tunnel conductance [1].
We study high mobility graphene field-effect transistors at room temperature and ambient conditions. These transistors consist of a monolayer graphene flake encapsulated in a hexagonal Boron nitride (hBN) insulator. When subjected to a large bias, we observe the appearance of a sharp emission peak at a photon energy of 190 meV (1532 cm^{-1}) in the far-field radiation spectrum of the transistor (see Fig. 1 (a)). Using a series of test experiments, we show the electroluminescent nature of this emission [2]. Using mid-infrared micro-spectroscopy, we observe both the blackbody radiation from the SiO_2 substrate – from which we deduce the out-of-plane cooling power- and the electroluminescent signal originating from the scattering of confined hyperbolic phonon-polaritons [3,4] of hBN (Fig. 1, panels (a) and (b)).

References

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Figures

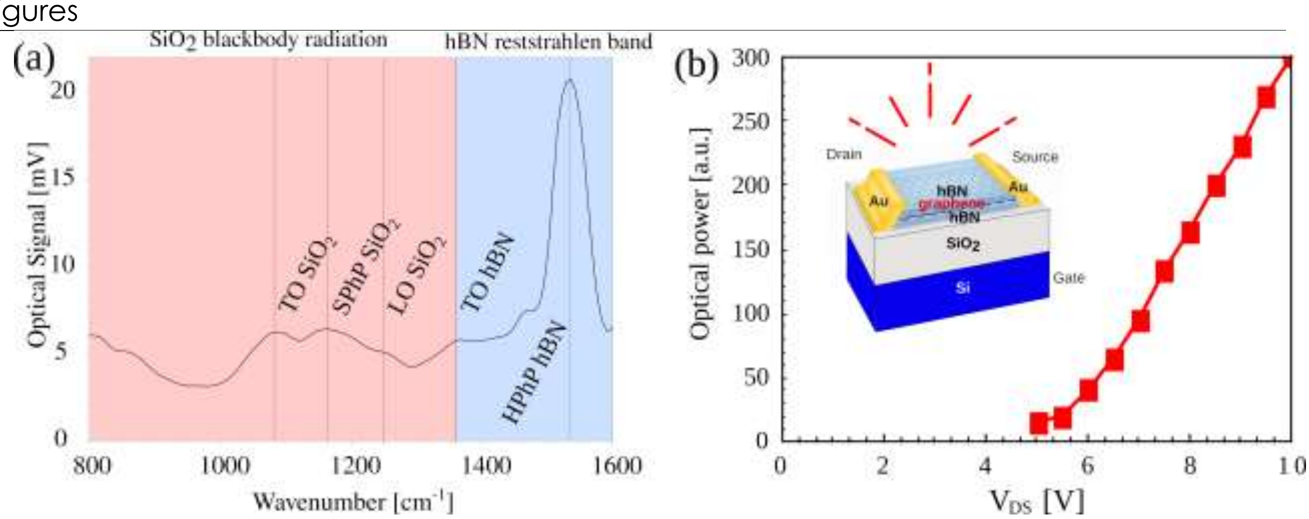

Figure 1: a) Mid-infrared emission spectrum of a graphene transistor, showing the blackbody radiation from the SiO_2 substrate and the electroluminescent signal from hBN. b) Integrated optical intensity as a function of bias voltage, revealing the electroluminescent threshold due to interband carrier injection.