Shape approaches for enhancing plasmon propagation in graphene

Roman Krahne

Mario Miscuglio, Davide Spirito, Remo Proietti Zaccaria

Graphene Labs, Istituto Italiano di Tecnologia, Via Morego 30, Genoa, Italy

Roman.krahne@iit.itl

Graphene plasmonics is a promising building block for high speed communication devices that that takes advantage of strong confinement of the electromagnetic energy at sub-wavelength scales, tunable via charge carrier density through a gate voltage.[1] The fabrication of integrated optoelectronic devices based on graphene plasmons however is extremely challenging, and launching and conveying graphene plasmons in efficient and reliable systems at practical length scales still represents an open challange.
One means for overcoming this limitation is represented by the combination of graphene plasmonic waveguides and noble metal antennas. [2] Here we discuss and analyze, using numerical simulations, different designs of metal antennas and their coupling to graphene plasmons, as well as graphene based nanopatterned waveguides that can lead to a more efficient GP propagation. On one side, the near field interactions among the elements of a Yagi-Uda antenna [3] leads to a stronger coupling to GPs and induces a more directive propagation compared to a single half wavelenght gold dipole antenna. Therefore the Yagi-Uda antenna represents an efficient and powerful tool for launching graphene plasmon in nanowires, where our simulation predicts propagation up to 3 μm while maintaining frequency and phase control. Further we demonstrate that in tapered graphene waveguides constructive interference of the plasmon reflections at the borders enables propagation of edge modes for more than 8 μm. In a different approach, nanostructured arrays of concatenated triangles sustain strongly directional graphene plasmon propagation that preserves phase information. Finally, this work presents a comparison in terms of graphene plasmon coupling and propagation length of several on-chip approaches and then confronts them with the efficiency of light scattering induced by scanning near field optical microscopy (SNOM) tips.[4]

References

[1] A. N. Grigorenko et al., Nature Photon., 6 (2012) 749–758
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Figures

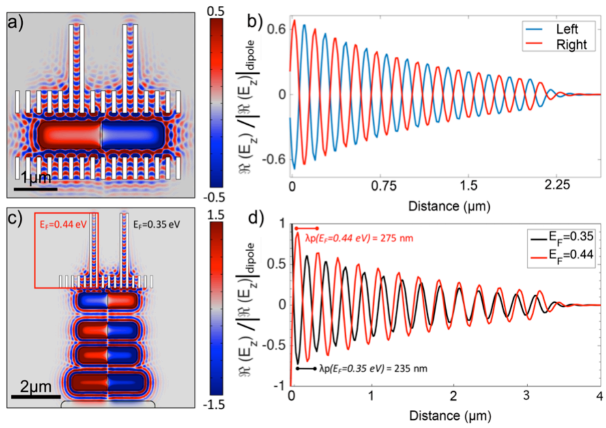

Figure 1: GP propagation in parallel nanowire waveguides: Electric near-field distribution at resonance for a dipole **(a)** and Yagi Uda **(c)** antenna under 10.9 μm laser excitation with an array of wire-shaped waveguides in the vicinity of their lateral sides. The regions without graphene are sketched in white. **(b,d)** Line plots of the electric near-field profile along the center of the two long nanowire waveguides.