Giant optical response of 2D materials embedded in photonic structures

Ipshita Datta[1], Sang Hoon Chae[2], Gaurang R. Bhatt[1], Bichang Li[2], Yiling Yu[3], Linyou Cao[3], James Hone[2] and **Michal Lipson[1]**

[1]Department of Electrical Engineering, Columbia University, New York, New York 10027, USA

[2]Department of Mechanical Engineering, Columbia University, New York, New York 10027, USA

[3]Department of Materials Science and Engineering and Department of Physics, North Carolina State University, Raleigh, North Carolina 27695, USA

ml3745@columbia.edu

2D materials such as monolayer transition-metal dichalcogenides (TMD) have been predicted to experience massive changes in optical response with carrier densities [1,2]. By integrating such monolayers on photonic structures, they can endow traditionally passive optical materials with electro-optic properties. These TMD materials enable strong light–matter coupling, with optical absorption around 10–20% in layers as thin as 0.6 nm [3] at visible wavelengths and have extremely efficient Coulomb interactions, as manifested in the exciton binding energies on the order of 0.5 eV [3].

Here we show that in a composite photonic structure, formed by embedded TMD monolayers in silicon-based photonic structures, strong light interaction with the excitonic lines occurs even under conditions of strong detuning from the excitonic resonance. In the NIR spectral range (1530 – 1560 nm), despite being well detuned from the TMD excitonic lines, centered around 2eV, the index of refraction is still expected to be dominated by this optical response while the absorption is expected to be minimal [4]. We demonstrate electric tunability of the index that is at least an order of magnitude stronger than traditional dieletric materials

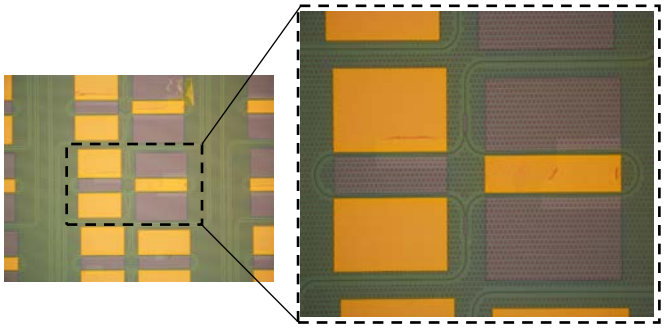

Figure 1: Optical micrograph of the fabricated composite device. Dashed inset shows the location of the patterned TMD monolayer embedded in the photonic structure.

References

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