Exploring Modulation Depth in Graphene Modulators: Insights from Straight, Bent, and Racetrack Ring Resonators

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Chip-scale electro-absorption modulators based on graphene are a great alternative to conventional millimetre-scale semiconductor modulators not only because of their significantly larger size but also because of their low speed and high energy consumption. Liu et. Al., for the first time, experimentally demonstrated a single- and double-layer graphene-based straight modulator by electrically tuning the fermi level of the graphene layer. However, due to the small interaction between the graphene layer and the guided optical mode in the waveguide, these devices were large and had a limited modulation speed of 1 GHz [1,2]. To elevate this interaction further, a novel method emerged where the graphene layer was integrated with the silicon and silicon nitride-based ring resonators [3]. In this study, with the help of FDTD simulation, we evaluate graphene-based electro-absorption modulators, which have been seamlessly integrated into SiN-based micro-ring resonators. These structures are the standard straight ring modulator, the bent bus ring modulator, and the racetrack ring modulator. Our simulation addresses the effect of gap width, as well as graphene length, on the modulator's performance. Our simulation indicated a significantly higher modulation depth of -45 dB and a high photon-limited bandwidth.

References

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[3] Phare, C., Daniel Lee, YH., Cardenas, J. et al.. Nature Photon, 9 (2015) 511–514

Figures

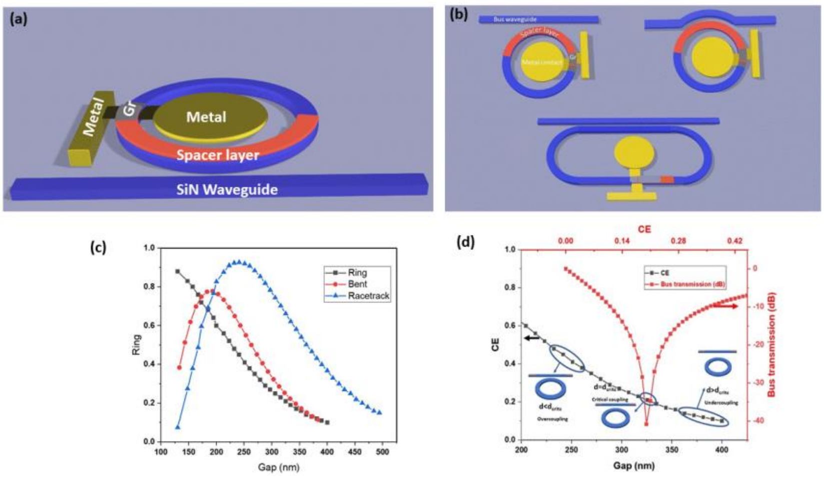

Figure 1: (a) Device schematics (b) Proposed structure (c) Coupling efficiency vs gaps (d) Transmission vs gap

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