Enhanced Raman scattering of graphene using double resonance in silicon photonic crystal nanocavities

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We demonstrate enhancement of the G' Raman band of graphene by coupling to the L3 silicon photonic nanocavity. The L3 nanocavities have been used to enhance the photoluminescence of carbon nanotubes [1], and monolayer graphene has an advantage of being compatible with cavities in a photonic crystal slab because of its two dimensionality. We utilize a unique mechanism for a double resonance in two-dimensional photonic crystals, which originates from simultaneous enhancements by a localized guided mode (LGM) and a cavity mode [2]. By adjusting the photonic cavity parameters, the double resonance can be tuned to the G' Raman scattering. Excitation wavelength dependence measurements show a large Raman peak enhancement when the excitation and emission wavelengths are simultaneously on-resonance with the LGM and the cavity mode, respectively. Furthermore, spatial imaging measurements are performed to confirm that the enhancement is localized, and we find that the enhanced Raman intensity is more than 50 times larger compared to the on-substrate Raman signal. The observed cavity enhancement of Raman scattering opens new possibilities for the development of graphene-based light sources for silicon photonics.

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