Spectral tuning of optical coupling between air-mode nanobeam cavities and individual carbon nanotubes

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Air-mode nanobeam cavities allow for high efficiency coupling to air-suspended carbon nanotubes due to their unique mode profile that has large electric fields in air [1]. We have fabricated air-mode nanobeam cavities from silicon-on-insulator wafers and grown carbon nanotubes on top of the cavities (Fig. 1). Here we utilize heating-induced energy shift of carbon nanotube emission [2] to investigate the cavity quantum electrodynamics effects. In particular, we use laser-induced heating which causes a large blue-shift of the nanotube photoluminescence as the excitation power is increased. Combined with a slight red-shift of the cavity mode at high powers, the spectral overlap between the nanotube emission and the cavity can be controlled. We estimate the spontaneous emission enhancement at different spectral overlaps and find linear increase of the enhancement factor as the spectral overlap improves, which is consistent with Purcell enhancement of nanotube emission.

This work is supported by KAKENHI (JP16H05962, JP16K13613), and MEXT (Photon Frontier Network Program, Nanotechnology Platform). H. M. is supported by RIKEN Junior Research Associate Program, and T. U. is supported by ALPS and JSPS Research Fellowship.

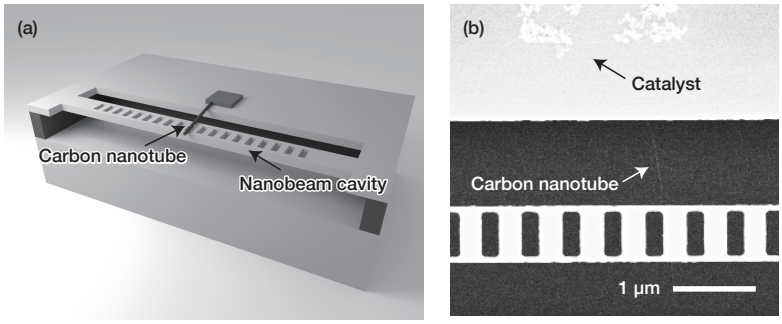

Figure 1 (a) A schematic of a nanobeam cavity with a single carbon nanotube. (b) Scanning electron microscope image of a fabricated device.

References

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