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Title: Tunable room-temperature single-photon emission at telecom wavelengths from sp³ defects in carbon nanotubes

Author(s): He, Xiaowei; Hartmann, Nicolai F; Ma, Xuedan; Kim, Younghee; Ihly, Rachelle; Blackburn, Jeffery L; Gao, Weilu; Kono, Junchiro; Tanaka, Takeshi; Yomogida, Yohei; Hirano, Atsushi; Kataura, Hiromichi; Htoon, Han; Doorn, Stephen K

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Xiaowei He¹, N. F. Hartmann¹, Xuedan Ma¹, Younghee Kim¹, Rachele Ihly², Jeffrey L Blackburn², Weilu Gao³, Junichiro Kono³, Yohei Yomogida⁴, Atsushi Hirano⁴, Takeshi Tanaka⁴, Hiromichi Kataura⁴, Han Htoon¹, Stephen K Doorn¹

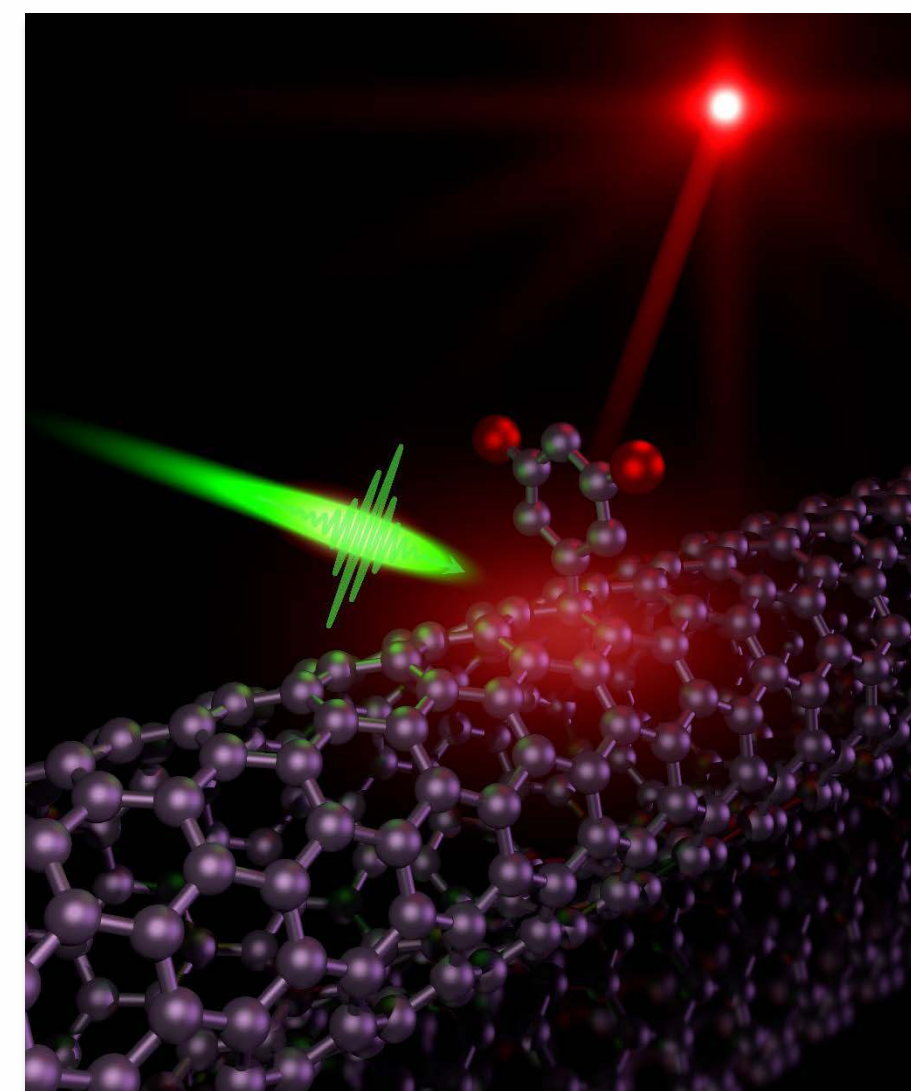
¹CINT, MPA, Los Alamos National Laboratory, USA; ²CMSC, National Renewable Energy Laboratory, USA; ³ECE, Rice University, USA; ⁴NRI, AIST, Japan

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Introduction

Single-photon sources (SPSs) are the enabling materials required for quantum photonics, quantum information processing and quantum computing. Developing room-temperature SPS at telecom band (1.3-1.55 μm) remains a significant material challenge.

Harnessing exciton localization at defect site in low-dimensional nanomaterials such as single wall carbon nanotube (SWCNT) is a promising route to achieve room-T single-photon emission (SPE).

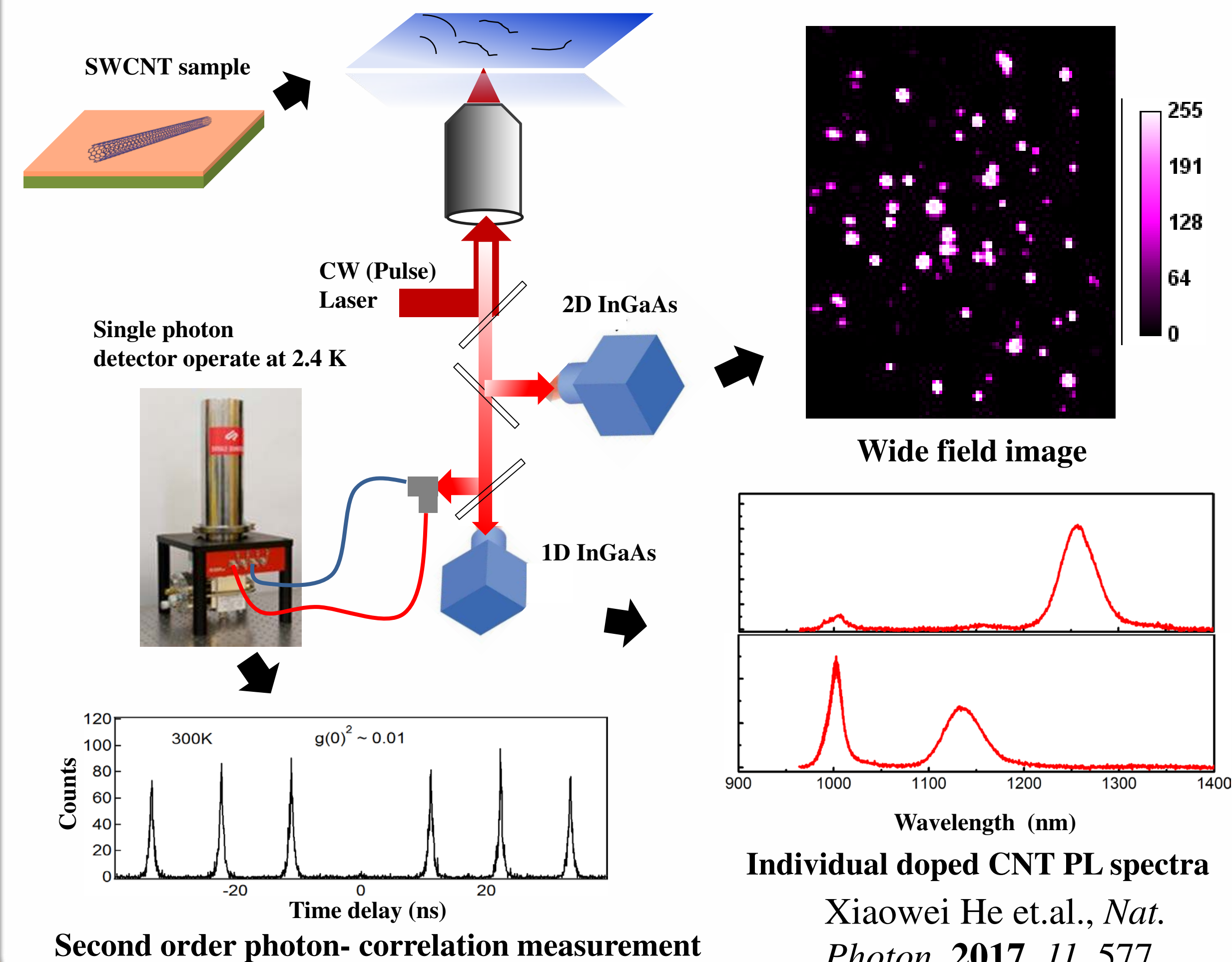


In this work, we demonstrate that solitary sp^3 defects on SWCNTs paired with nanotube structural diversity can generate room-T SPE spanning the entire telecom band.

[1] X. Ma et al. *Nat. Nanotechnol.*, **2015**, *10*, 671. [2] Nicholai F. Hartmann et al. *Nanoscale.*, **2015**, *7*, 20521. [3] Y. Piao et al., *Nature Chem.*, **2013**, *10*, 840.

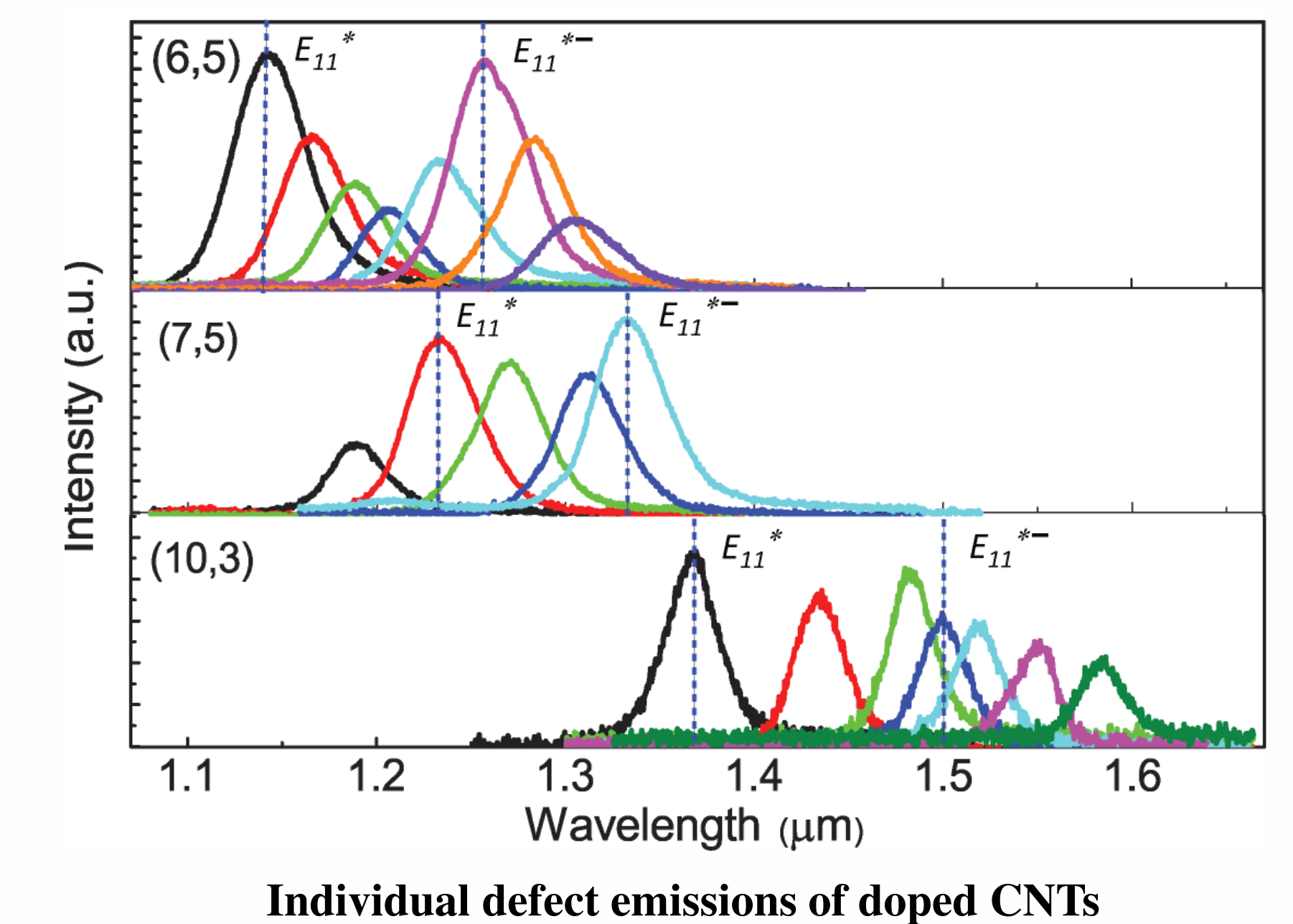
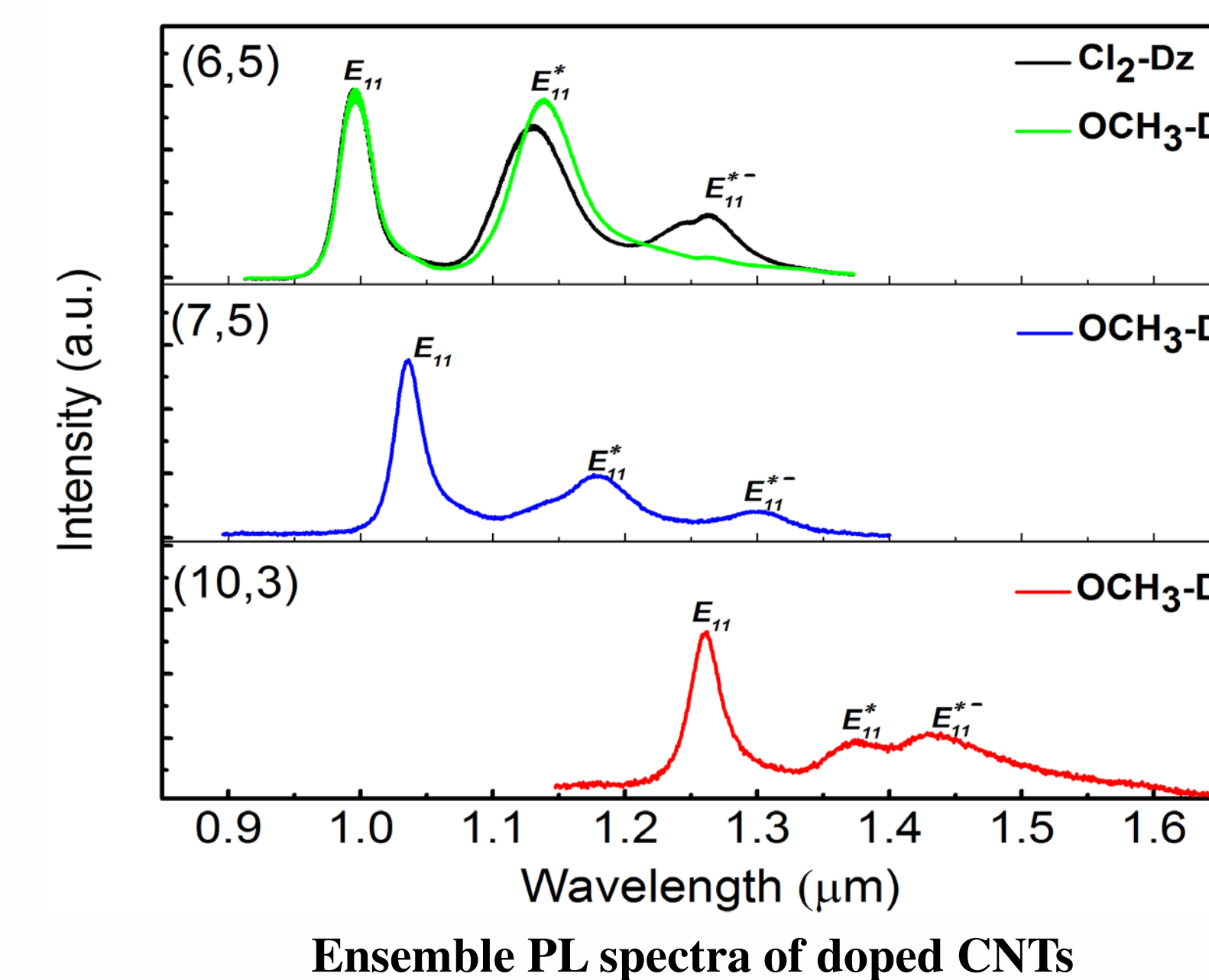
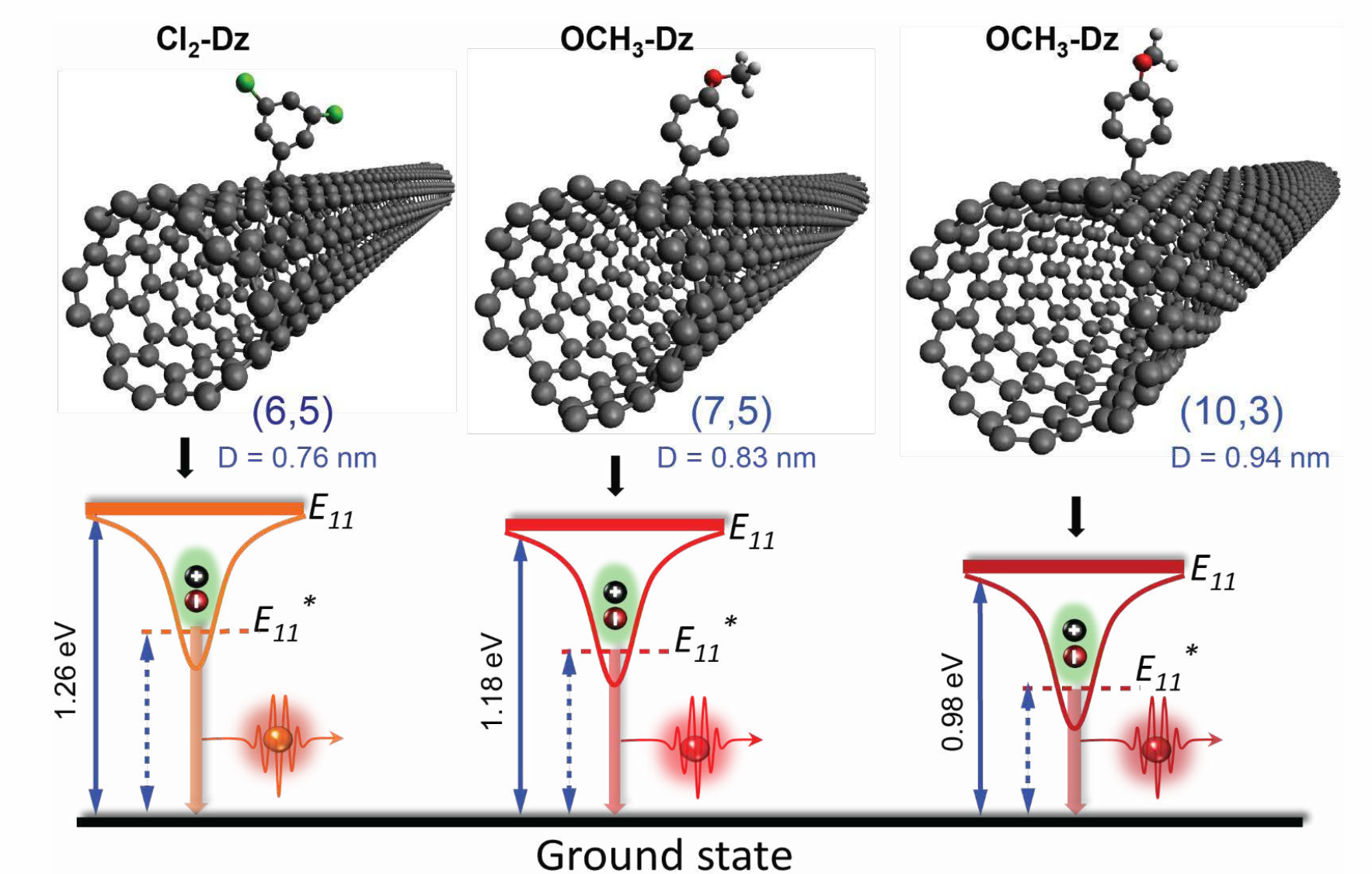
Experimental Setup

- Home-made confocal microscope system
- Single CNT optical imaging and spectroscopy
- Superconducting nanowire single photon detector
- Quantum optical measurements of individual CNTs

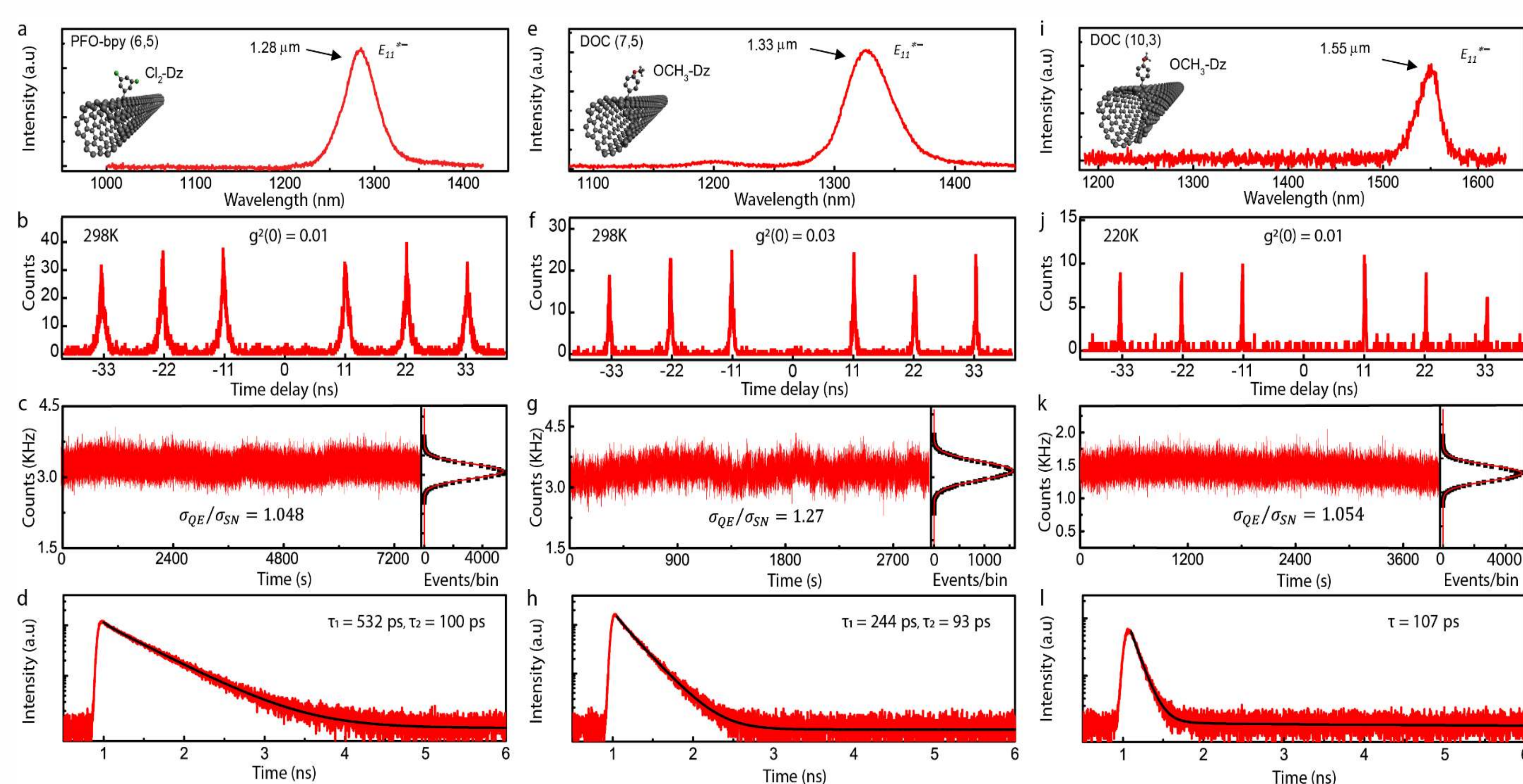


Tune Defect-emission Wavelength

- Generation of sp^3 defects on CNTs by solution based chemical doping — aryl diazonium functionalization
- Introduction of new red shifted emitting states E_{11}^* and E_{11}^{*-}
- Tuning the defect-emission wavelength to telecom band by selecting CNTs with different diameters



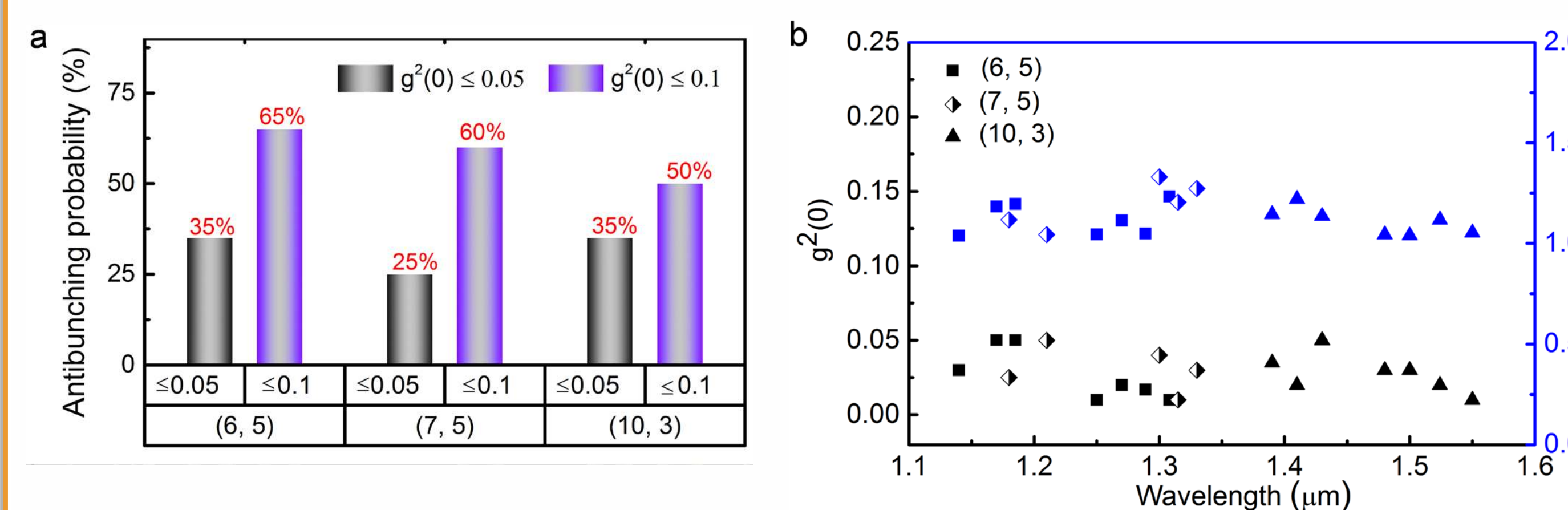
Room-T SPE at Telecom Band



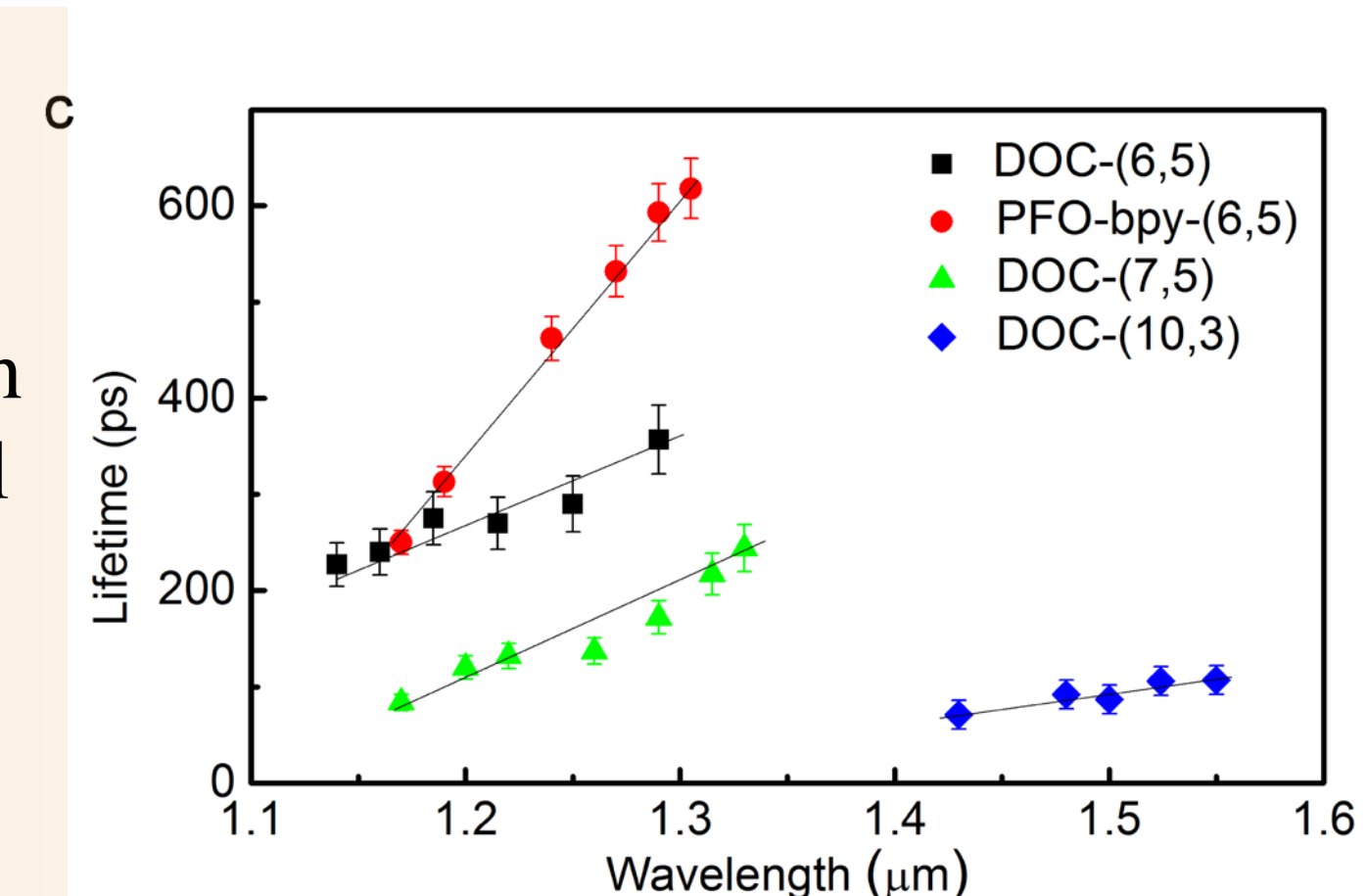
- Ultra high single photon purity with $g^2(0) \sim 0.01$.
- Exceptional emission stability approaching short noise limitation.
- Room-T operation at Telecom O and C band.

Xiaowei He et al., *Nat. Photon*, **2017**, *11*, 577.

Trends in Quantum Emission Behaviors



- Above 60% of the doped CNTs show the $g^2(0)$ lower than 0.1.
- High emission stability and high single photon purity exist for all three chiralities with emission range from 1.1 to 1.6 μm .
- The life time of defect emission shows dependence on tube diameters, the larger the diameter, the shorter the life time.



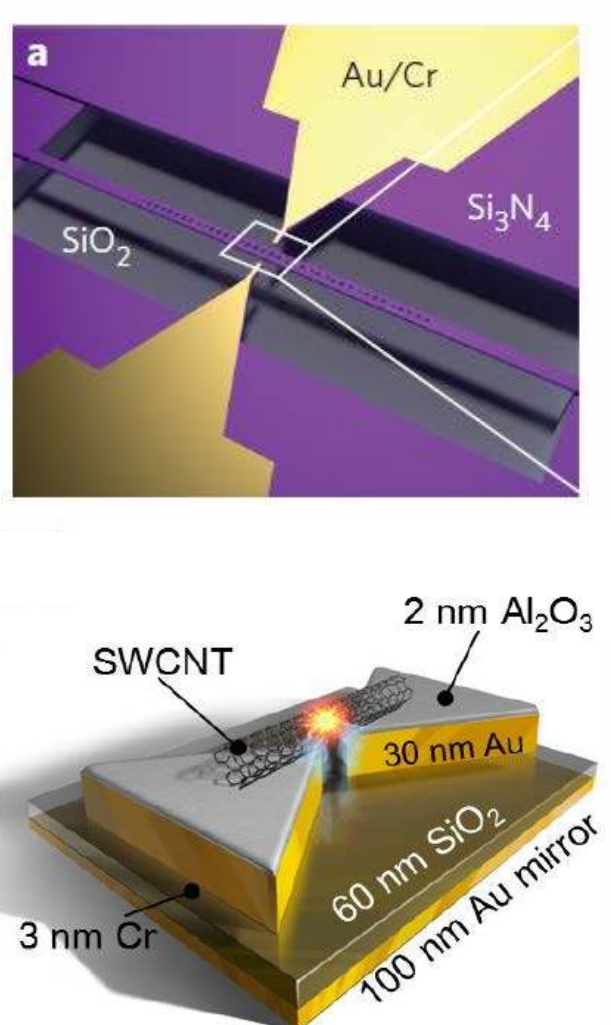
Xiaowei He et al., *Nat. Photon*, **2017**, *11*, 577.

Summary and Outlook

- Room-T operation at critical telecom wavelength (1.3 and 1.55 μm).
- High single photon purity ($\sim 99\%$)
- Short noise limited emission ability ($\sigma_{QE}/\sigma_{SN} \sim 1$)
- High emission rates (10^{-5} - 10^{-7} s^{-1})

What is next?

- Developing electrical-driven SPEs from doped CNTs [4]
- Investigating photon indistinguishability of the defect emission by coupling to plasmonic cavities [5]
- Realizing wavelength-controllable defect emission through diverse structures of CNTs



[4] Svetlana Khasminkaya et al., *Nat. Photon*, **2016**, *10*, 420.

[5] Yue Luo et al., *Nature commun*, under review.