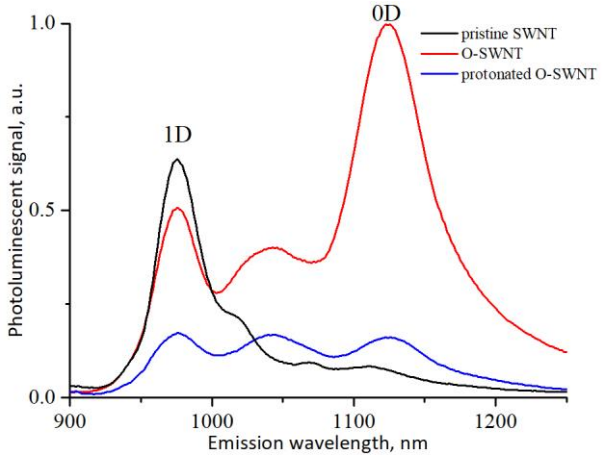
Protonation of oxygen doped single walled carbon nanotubes

Timofei Eremin [1,*], Elena Obraztsova[2]
[1]*University of Eastern Finland, Department of Physics and Mathematics, Yliopistokatu 2, Joemsuu, Finlamd*
[2]*General Physics Institute of RAS, Vavilova 38, Moscow, Russia*
timofei.eremin@uef.fi

Oxygen-doped single-walled carbon nanotubes (O-SWNT) attract huge interest because such nanotubes demonstrate brighter luminescence compared to pristine nanotubes [1] and possess such advances as photon antibunching [2], both due to inducing 0D-like excitonic states in addition to ordinary 1D excitons of pristine nanotubes. However, such aspect as the susceptibility of 0D states to the local environment, is not been sufficiently investigated so far, unlike the case of 1D states in pristine nanotubes.

To unveil this issue, we performed oxygen doping of single-walled carbon nanotubes by adding NaOCl to the SWNT aqueous suspension followed by lingering UV irradiation [3]. Efficient oxygen doping was confirmed by the appearance of a bright photoluminescence peak corresponding to recombination of 0D excitons which is redshifted from the ordinary photoluminescence peak corresponding to recombination of 1D excitons. Subsequently, a protonation of SWNT was performed by adding HCl to the suspension and the dependencies of 1D and OD-states photoluminescence intensity on the concentration of HCl were investigated. It was found that 0D states demonstrate sufficiently higher sensitivity to pH compared to 1D states of both oxygen-doped and pristine nanotubes. Differences in sensitivity of 1D and 0D states may reflect differences in the distribution of electronic and hole states, which 0D and 1D excitons consist of.



[1] Ghosh S. et al. Oxygen doping modifies near-infrared band gaps in fluorescent single-walled carbon nanotubes // Science. 2010. Vol. 330, № 6011. P. 1656–1659.
[2] Ma X. et al. Room-temperature single-photon generation from solitary dopants of carbon nanotubes // Nat. Nanotechnol. Nature Publishing Group, 2015. Vol. 10, № 8. P. 671–675.
[3]. Lin C.W. et al. Creating fluorescent quantum defects in carbon nanotubes using hypochlorite and light // Nat. Commun. Springer US, 2019. Vol. 10, № 1.