SP^3 DEFECTS IMPLANTED BRIGHT FLUORESCENT ULTRASHORT CARBON NANOTUBES AS NIR SINGLE MOLECULE PROBES

Somen Nandi, Laurent Cognet*
LP2N, Université de Bordeaux, Institut d'Optique & CNRS, Talence, France.
Email: nandi.somen@institutoptique.fr

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Near-infrared (NIR) fluorescence microscopy techniques have been emerged as an important tool for a variety of fundamental processes *viz* biomedical research, sensing and clinical applications owning to deep tissue penetration. Our main goal of this study is to create sp^3 defects implanted and immuno-labelled bright fluorescent ultrashort (~20 nm) carbon nanotubes (usCNTs) to use them for cancer diagnostic. Unfortunately, the intrinsic NIR PL is known to be quenched in usCNTs because of their small size compared to the exciton diffusion length (<100 nm). Sp^3 defects implantation of CNTs has opened the route toward enhancement of PL properties that occur in the NIR-II window, a biologically transparent region for *in vivo* bio-imaging. Although the demonstration of usCNTs has been performed recently, the process experienced limitations like long processing time including a very low yield (<10%) [1,2]. In order to augment the production yield required for bio-application, we now present another synthesis route, where the sp^3 functionalization is first done followed by chemical oxidation [3]. Herein, we first introduced aryl defects into the sidewall of CNTs using diazonium chemistry. The defect implantation has been confirmed by the appearance of strong red shifted peak at ~1150 nm, compared to the pristine one (~980 nm). After that these have been subjected to chemical oxidation at the defect sites using hydrogen peroxide to produce ultrashort CNTs with a relatively high yield (>50%) with its intact PL properties. We characterized them by various spectroscopy (UV-Vis-NIR, PL, IR, Raman etc.) and microscopy techniques (Fig. 1). The lengths of usCNTs have been estimated by AFM and single nanotube diffusion analysis. Subsequently, we introduce surface bio-functionalization to couple them with antibody (IgG) to be used as diagnostic biomarkers in cancer.

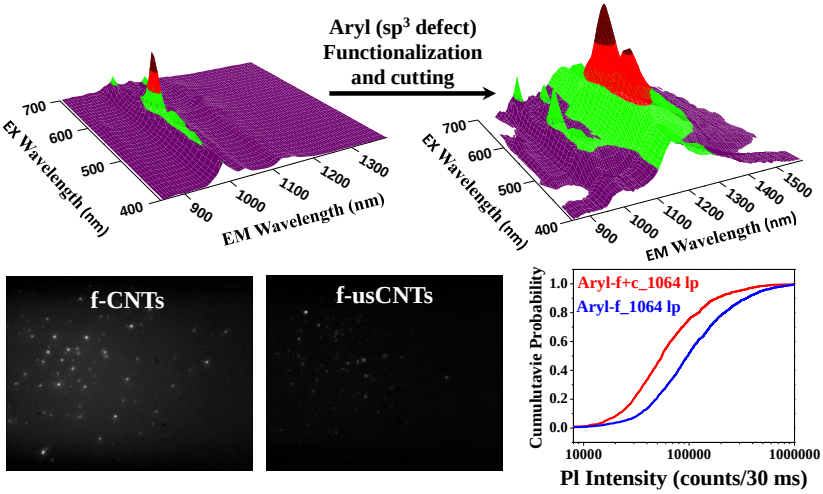

Fig. 1. 2D PL of CNTs showing the evolution of E11* peak after functionalization which remains intact even after oxidation. NIR PL Images of individual f-CNTs and f-usCNTs with their cumulative distribution.

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