Development and Applications of Carbon-Fluorine Spectroscopy, A (R)Evolutionizing Technology

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Introduction

Carbon-Fluorine Spectroscopy (CFS) *aka* Fluoro-Raman Spectroscopy (FRS), is a relatively new patented platform technology using a family of various methods and cost-effective devices called PLIRFA™ (Pulsed Laser Isochronic Raman and Fluorescence Apparatus) developed by Fluorotronics, Inc. The key feature of this progressive and non-destructive technology is based on the discovery of a characteristic optical signature of carbon-fluorine bond(s) in the fingerprint spectral area of 500–800 cm^{-1} allowing rapid, ultra-specific and sensitive detection, characterization, imaging, and measurement of any fluoroorganics. Interestingly, the C-F bond, unique in its character, can be used as a molecular label. Indeed, the C-F label is efficient, soluble, cheaper, smaller, more stable and less toxic than fluorescent dyes, nanoparticles or quantum dot materials. Thereby, C-F bonds are often incorporated into molecules, compounds in addition to nano-materials to achieve special properties (e.g. molecular stability, molecular tracing). In this study, we present some of our key data obtained from the promising CFS.

Results and Discussion

We have previously shown that most of the compounds containing aromatic rings give significant enhancement of the resonance Raman emission signal due to the high self-absorbance of the aromatic ring structures[1,2]. As a proof-of-principle experiment for detection of organofluorine compound, we have analyzed by CFS, molecules such as 3-Fluoroaniline (C_6H_6FN) *via* standard flow cell using methanol as solvent. 3-Fluoroaniline (3-FA) and derivatives are often used as intermediate for the preparation of various pharmaceuticals (e.g. Difloxacin or Dicural), pesticides (e.g. Fluquinconazole) and dyes (e.g. 2.4-dinitro-5-fluoroaniline). The excitation wavelength has been performed at 510.6 nm by pulsed copper vapor laser at the average power of 200 mW. The C-F bond was specifically detected at 752 cm^{-1} for 3-FA regardless to the concentration of the fluorinated compound but the characteristic C-F signal displayed, with a confidence of linearity equal to 95%, an intensity proportional to the concentration of 3-FA. Thereby, our technology was able to provide a fingerprint spectrum that is useful to ensure the safety/security product, quantify a fluoro-organic compound and can further determine the entire molecular structure and conformation in different environmental conditions[3]. Thus, we have extended our investigations to several other fluoroorganics such as fluoro-pharmaceuticals (e.g. anti-depressant Fluoxetine (Prozac®, $C_{17}H_{18}F_3NO$); anti-anticancer drug, 5-fluorouracil (5-FU, $C_4H_3FN_2O_2$)) as well as fluoro-biologics (e.g. blood substitute component Perfluorodecalin (PFD, $C_{10}F_{18}$), fluoro-aminoacids).

Conclusions

Eventually, our technology allows breakthroughs in unification of detection, measurement and characterization of fluoroorganics, becoming a ‘gold standard’ technology for numerous applications.

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