High time-resolved scintillation of biomolecules, induced by ultra-short electron bunches

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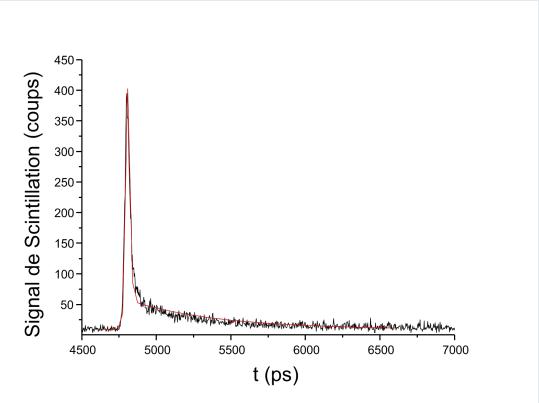
The DNA damages due to ionizing radiations result from two different processes: the direct and indirect effects. The indirect effect is well-known through pulse radiolysis studies in condensed phase. Direct effects are mostly studied in gas phase and have almost never been investigated by transient technics. We have undertaken the development of an ultra-fast tool which could allow direct effects studies in condensed phase. The tool is a high repetition rate (76 MHz) femtosecond laser-triggered electron gun, producing bunches of 1 to 200 electrons, with an energy range from 1 to 5 keV and a temporal width from 5 ps to 100 fs. The tool is coupled to luminescence decay measurements by Time Correlated Single Photon Counting (TCSPC).



Using this tool, we have studied the electron induced scintillation or cathodoluminescence from bio materials as DNA. The aim is to obtain additional informations to those obtained by photoluminescence. The sample consists in solid DNA deposited on a sapphire substrate by a spin-coating technique, covered by a 50 nm gold layer. A light collection system based on a microscope objective working in reflexion is used to guide the emitted photons by scintillation to a PM-MCP C10373 (Hamamatsu) photodetector. Time measurements take between 5 and 30 min. There is no scintillation issued from the golden substrate in absence of DNA.

We have performed the first temporal distribution measurements of high-time resolved cathodoluminescence from DNA (black curve). A fit (red curve) gives an apparatus function of 10 ps and shows two times decay regime, t1 < 10 ps and t2 = 600 ps. Scintillation efficiency of DNA under electron bunches is not known, we can assume it to be 10^6 photons.s^{-1}. It demonstrates that the tool developped allows the study of fast low scintillating materials by high time-resolved cathodoluminescence and paves the way to new applications.

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