Photoemission spectroscopy of carbon dots using synchrotron radiation

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Carbon dots (C-dots) are the newest class of carbon-based nano-materials, which have drawn attention mainly due to their stable multicolor light emission[1]. During the past decade significant progress has been achieved in their synthesis, while their properties and applications have been also reported[2-5]. However, even if the ability to tune their fluorescent emission by varying their size, chemical composition, and surface functionality is well manifested, the origin of this feature is not yet completely understood since C-dots comprise systems with complex chemical composition and subsequently complex electronic properties.

To gain insight in the structural and electronic properties of *N*-hydroxysuccinimide C-dots[6], X-ray photoelectron spectroscopy (XPS) has been performed on free nanoparticles, avoiding any effects from the substrates[7,8]. More precisely, an aerodynamic lens system was used to focus the C-dots into the interaction region with synchrotron radiation and electron spectra obtained with a VG-Scienta R4000 electron energy analyzer at the PLEIADES soft X-ray beamline at the SOLEIL synchrotron facility. C1s, O1s, N1s and valence band XPS spectra have been measured with high resolution. By varying the photon energy, and hence the kinetic energies of the emitted electrons, the surface sensitivity of the XPS was tuned to preferentially probe either the surface or the bulk of the nanoparticles. Complementary characterisation by DLS and HRTEM measurements has also been performed.

Taking into account the sp^2-to-sp^3 ratio determined from the C1s spectrum, complemented with the O1s and N1s spectra recorded with different probing depths, information on the extent of the functionalized groups to the nanoparticles' volume and the hybridization of the C-dots have been obtained. In addition, the valence band spectrum has been recorded for the first time, showing a well-defined structure which has been compared with that of pure diamond and graphite. The novelty of the present results is expected to promote a deep understanding in the electronic structure of C-dots, boosting their possible functionalisation in view of direct applications.

Références

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