Translational dynamics of 1D fullerenes chains encapsulated inside single-walled carbon nanotubes

Bousige C.[1,2,*], Rols S.[1], Kataura H.[3], Launois P.[2]

[1]*Institut Laue Langevin, F-38042 Grenoble, France*
[2]*Laboratoire de Physique du Solide, F-91405 Orsay, France*
[3]*National Institute of Advanced Industrial Science and Technology, Tsukuba, Ibaraki 305-8562, Japan*
**e-mail: bousige@ill.fr*

In addition to their numerous interesting physical properties, single-walled carbon nanotubes offer an inner cavity available to host molecules. It provides scientists with an exceptional molecular model system to study one-dimensional physics and confinement. This is particularly true when the inner molecules size is comparable to the tubes' diameters, as is the case with C_{60} fullerenes – such compound being called fullerene "peapods". In this communication, we propose to review some recent inelastic neutron scattering measurements that highlight the exotic behaviour of this system due to their low dimensionality: the rotational dynamics of the encapsulated fullerenes [1], and their translational one. The latter has recently been observed thanks to the synthesis of a large amount of peapods under the form of buckypapers – in which the tubes are mainly oriented along the buckypaper's plane. Using the time of flight spectrometer IN5 at the ILL, we showed that the translational motion of the confined fullerenes is characterized by an additional signal in the configuration where the scattering vector corresponding to the reciprocal parameter of the 1D chain is set parallel to the paper's plane. This signal has a quasielastic-like part due to the density of states of the longitudinal 1D phonons, whose analytical formula has been calculated, allowing extracting the sound velocity within the 1D fullerenes chains. Contrary to what is expected in the usual model of 1D liquid with infinite chains, this signal also features an elastic part due to the additional correlations induced by the confinement of the chains inside the nanotubes -- and of the finite size of the fullerenes chains. The good comprehension of this two-part signal and its evolution with temperature allow shedding light on the different forces at stake in this system, as well as probing fine structure parameters.

[1] S. Rols, J. Cambedouzou, M. Chorro, H. Schober, V. Agafonov, P. Launois, V. Davydov, A. Rakhmanina, H. Kataura, J.-L. Sauvajol, *Phys. Rev. Lett.* **101**, 065507 (2008).