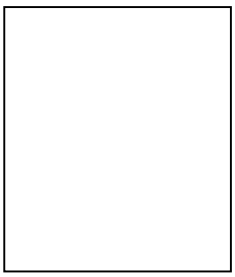
DNA wrapping around MWNTs and graphene: a SERS study



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In recent years, carbon nanostructure as nanotubes (CNTs) and graphene are at the centre of a significant research effort due to the strong scientific and technological interest because of their unique physical and chemical properties: large surface area, excellent thermal and electric conductivity, high electron transfer kinetics and strong mechanical strength. Recently, a great attention has been paid to the interaction of DNA with carbon-based nanostructures such as C_{60}, multiwalled-nanotubes (MWNTs), single-walled nanotubes (SWNTs) and graphene. The development of these studies is motivated by a wide spectrum of possible use of these materials e.g. as biosensors, drug delivery agents and diagnosis tools. In this work, we applied surface-enhanced Raman spectroscopy (SERS) to the study of DNA/MWNTs and DNA/graphene systems.
Since the discovery of the large Raman signal enhancement, occurring when a molecule is on or near a metallic nano-scale roughened substrate, SERS attracted a great interest in view of its possible applications [1-2]. It is widely recognized that the surface enhancement effect is based on the generation of an electromagnetic field at the surface of noble metals induced by the laser excitation. Although the electromagnetic mechanism is believed to be responsible of the main part of the enhancement, an additional enhancement is provided by the increase of polarisability of the adsorbed molecule, when a resonant charge transfer occurs between the metal and the adsorbate.
In our study, the carbon nanostructures were deposited as dilute dispersions on SERS active substrates with different morphologies.

Our investigation demonstrated that, since the SERS effect depends on the distance between the nanostructure and the adsorbed molecule, the Raman signal from the wrapped DNA or other molecules, deriving from functionalization/synthesis process and bound to the carbon surface, can be amplified.
We have previously investigated the wrapping of DNA double strands around the MWNTs, observing that the non-covalent interaction leads to the spectral shift of G line towards higher wavenumbers [3]. This finding indicates that the organic molecules are arranged among nanotubes leading to a debundling effect, which greatly enhances the MWNT solubility. Further, we studied the DNA-wrapping on graphene. Our findings indicate that the attachment of nucleotides to the graphene sheets occurs through hydrophobic interactions.

References

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