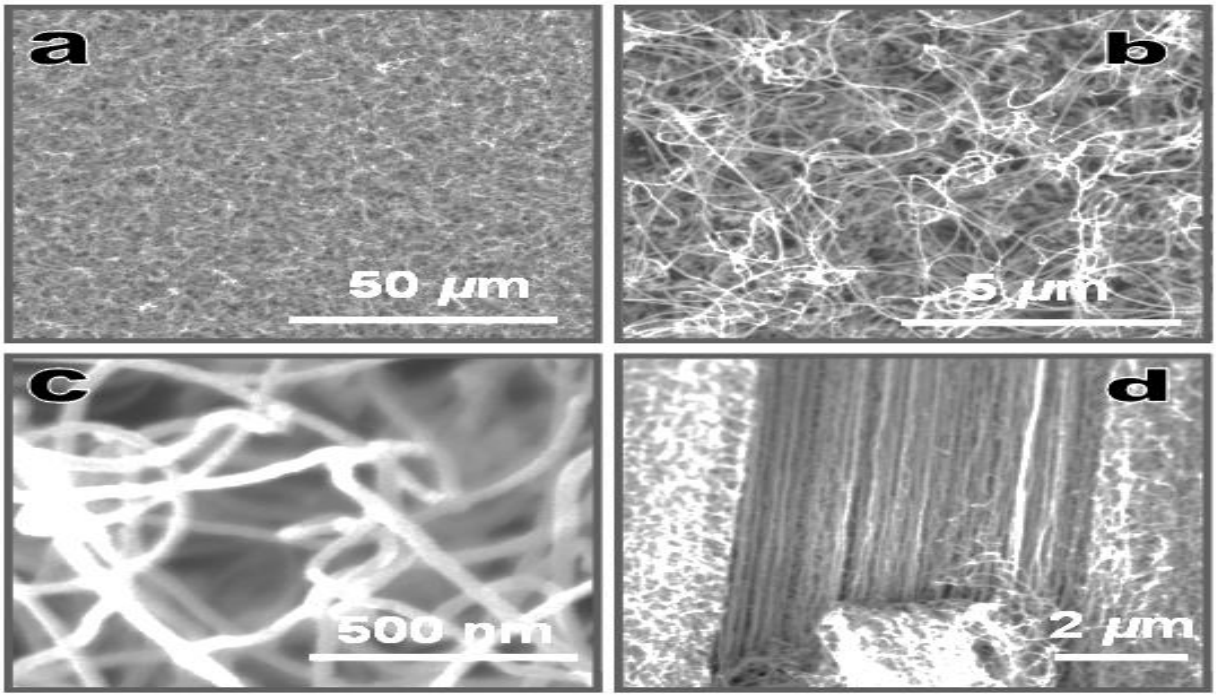
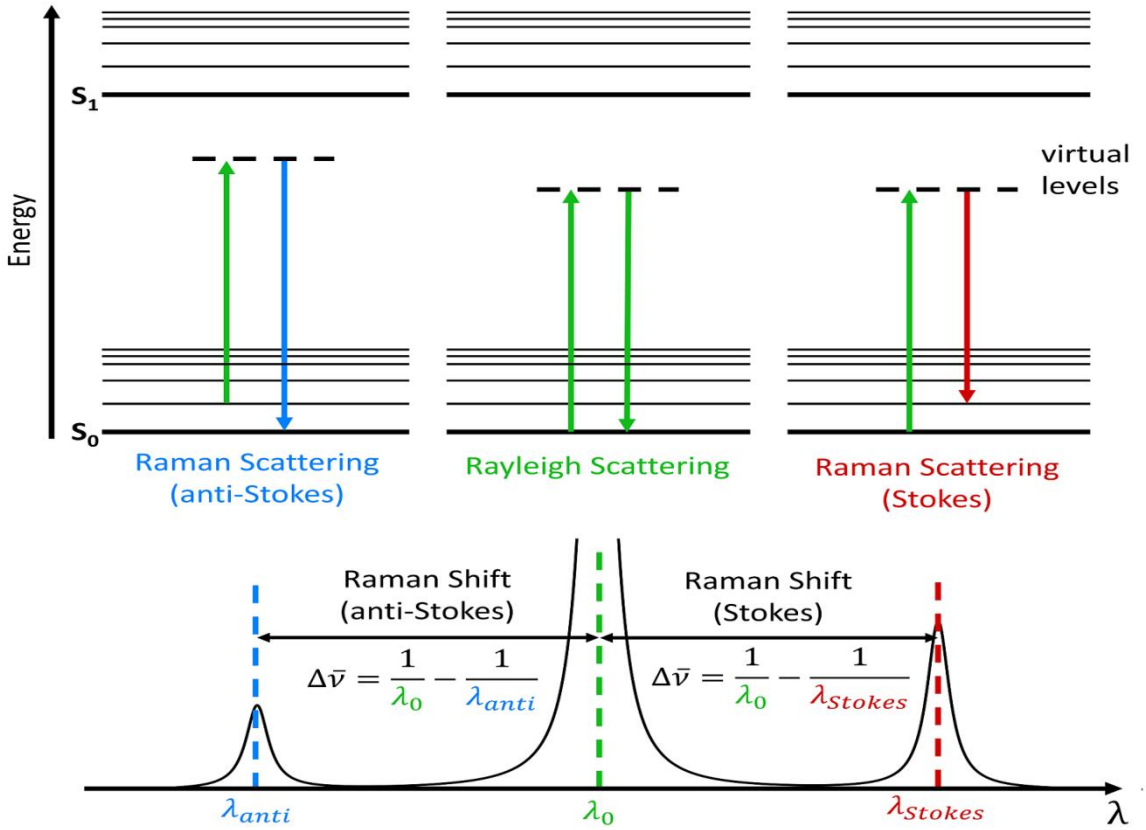


3 - Raman Spectroscopy :

Raman spectroscopy is a technique based on the inelastic scattering of single-wavelength light, often a laser. This technique can be used to study solids, liquids, and gases. The incident photon is absorbed by the material and then re-emitted, but at a frequency higher or lower than that of the incident photon. This is called the Raman effect. This frequency shift provides information about the vibrations and transitions occurring within the molecule.

The Raman effect depends on the distortion of the electric field due (α). When laser light interacts as to molecular polarization electromagnetic waves with an electric field (E) , it will generate an ($P = \alpha E$) which leads to the vibration of the electric dipole momentum molecules with an amplitude called nuclear displacement and a frequency (υ_m). In other words, the single-wavelength laser light with a frequency (υ_o)will excite the molecules and turn them into vibrating dipoles that will return to their stable state by emitting photons of three different frequencies,[Thomas Sand Jespersen, 2003].



1 - Molecules are excited by absorbing photons with frequencies υo - and then return to their stable vibrational state by emitting photons with the same frequency υo. This interaction is called elastic Rayleigh scattering .

2 - Molecules are excited by absorbing photons with frequencies vo and then emit photons with frequencies lower than the frequency of the incident photon. Therefore, the frequency of the emitted photons is (vex – vo), and this frequency is called the Stokes frequency.

3 - Molecules are excited by absorbing photons with frequencies vo and then emit photons with frequencies higher than the frequency of the incident photon. Therefore, the frequency of the emitted photons is (vex + vo), and this frequency is called the anti-Stokes frequency.

Now, Raman spectroscopy is one of the best and most accurate techniques used to detect the presence of nanostructure through the

patterns that appear in the Raman spectrum of samples. The Raman spectrum of single- and multi-walled carbon nanotubes is characterized by the presence of a group of patterns (peaks) at approximately specific wavelengths, which are [A Jorio et al, (2003)]

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