

# Raman spectra of Highly oriented pyrolytic graphite and Alcohols

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## 1 Objective

To study the Raman spectra of HOPG and Identify the unknown solutions using the spectra.

## 2 Introduction

Raman spectroscopy is a tool that detects vibrational and rotational properties of a molecule thereby deducing composition of the elements and their morphology. In order to be Raman active, a compound must undergo a change in polarisability of the molecule and not only depends on the symmetry as like that of rotational and vibrational active.

## 3 Theory: Raman Spectroscopy

In 1928, Raman observed a small change in frequency of the incident light when passed through the crossed filters (What we call us 'Raman active' samples today). The effect provided an experimental proof of the inelastic scattering of light. When a molecule is incident by a photon, the elastic scattering makes the molecule return to its same ground state from where it was excited (Rayleigh scattering). In inelastic scattering, the change in the frequency of the emitted photon is,

$$\nu_f = \nu_i \pm \Delta E$$

-ve corresponds to Stokes line and +ve corresponds to Anti stokes line. When a light is incident on the sample, the electric field of the light,

$$E = E_0 \sin 2\pi\nu t$$

Induced dipole moment is,

$$\mu = \alpha E_0 \sin 2\pi\nu t$$

and if the molecular polarisability oscillates with respect to equilibrium,

$$\alpha = \alpha_0 + \beta \sin 2\pi\nu_{vib}t$$

results in the superimposition of the modes.

$$\mu = \alpha_0 E_0 \sin 2\pi\nu t + \beta E_0 / 2 [\cos 2\pi(\nu - \nu_{vib})t - \cos 2\pi(\nu + \nu_{vib})t]$$

hence a molecule exhibiting change in molecular polarisability, it is seen that it has stokes and antistokes shift. The Polarisability changes in a molecule in different modes. Raman spectrum is a fingerprint of the compounds and it does not destruct the sample.

## 4 Instrument

Raman spectrometer consists of a laser source, which is highly monochromatic and coherent. The laser beam is sent through the sample and the resulting scattered light from the sample is collected by a lens and passed through the grating monochromator. The signal is measured by a photomultiplier and the measurements are collected in computer interfaced with the instrument.

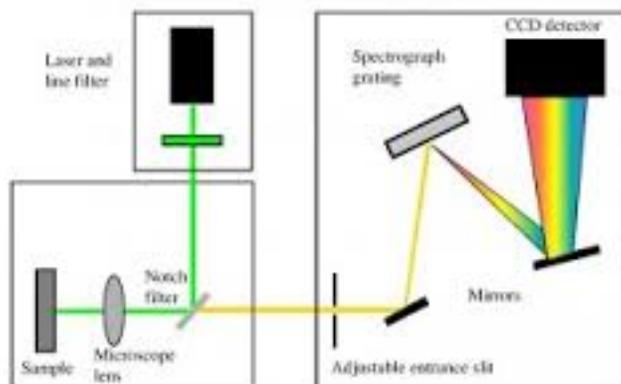


Figure 1: Raman spectrum of Ethanol

## 5 Results and analysis

- The unknown sample A is determined by the raman peaks and assigned as,
  - 1) (CC) alicyclic, aliphatic chain vibrations 600 - 1300 cm-1 medium
  - 3)(CH3) asym 1400 - 1470 cm-1 medium
  - 4) (C) 2800 - 3000 cm-1 strong
  - 5)(O-H) 3100 - 3650 cm-1 weak

A is  $\text{C}_2\text{H}_5\text{-OH}$  (ethanol)

- sample B is assigned as:
  - 1)(C) 2800 - 3000  $\text{cm}^{-1}$  strong
  - 2)(O-H) 3100 - 3650  $\text{cm}^{-1}$  weakB is  $\text{CH}_3\text{-OH}$  (Methanol)

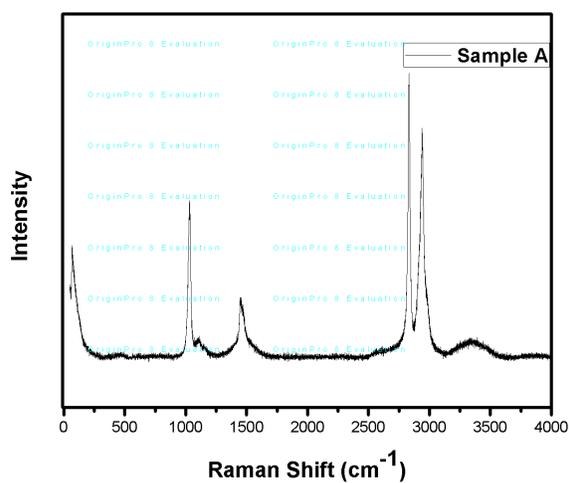


Figure 2: Raman spectrum of ethanol

## References

- [1] Colin N Banwell, Elaine M McCash, et al. *Fundamentals of molecular spectroscopy*. McGraw-Hill London, 1972.
- [2] J Michael Hollas. *Modern spectroscopy*. John Wiley & Sons, 2004.

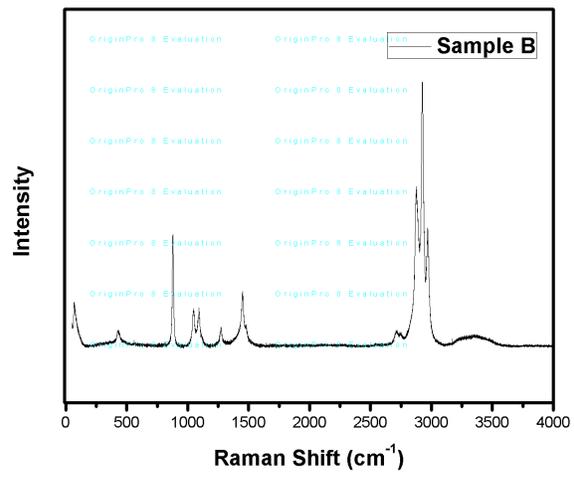


Figure 3: Raman spectrum of methanol

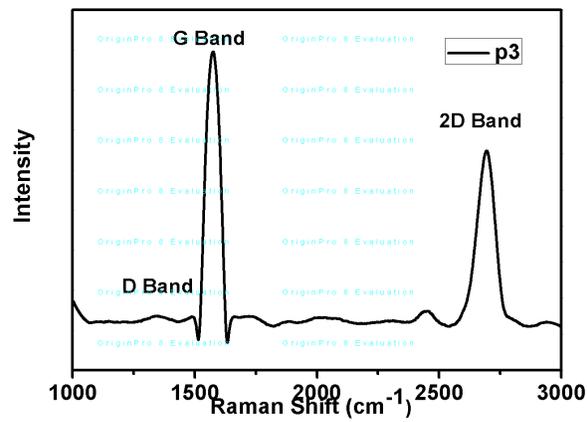
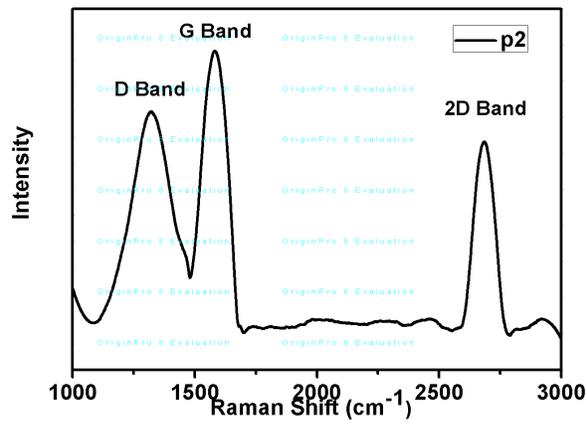
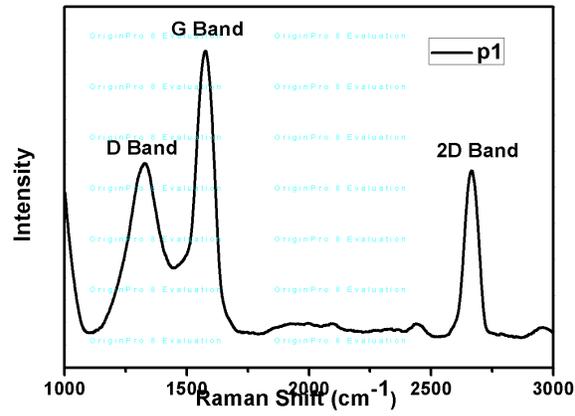


Figure 4: Raman spectrum of HOPG with different morphology