DESIGN AND CONSTRUCTION OF A LASER RAMAN SPECTROMETER TO STUDY HYDROCARBON EXTRACTS FROM PETROLEUM OF VIETNAM

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Abstract. We studied to design and construct a laser Raman spectrometer using an Argon laser and a double grating monochromator GDM-1000. The efficiency of the laser Raman scattering detection system was estimated by the obtained Raman spectra of some standard solution such as CCl_4, C_6H_6 and some hydrocarbon extracts from petroleum of Vietnam. This result is an important step to study Raman spectra of petroleum extracts in Vietnam as well as Raman spectra of photo-electronic materials.

1. Introduction

Laser Raman spectroscopy has become an effective method to study the composition and construction of materials, especially to analyse hidrocarcbon extracts from petroleum and opto-electronic materials.. Using an Argon laser and a double gratting monochromator GDM-1000 we have designed and constructed a Laser Raman spectrometer in our laboratory. By this system we obtained the Raman spectra of some standard solution such as C_6H_6, CCl_4... and some hydrocarbons extracted from petroleum of Vietnam.

2. Experimental setup

The band intensities in Raman spectrum may range from 10^{-2} to 10^{-6} % of the excitation laser beam intensity on the sample. Therefore, powerful excitation sources and sensitive detection systems are necessary to obtain a Raman spectrum. The schematic diagram of the basic component of the laser Raman spectrometer system was shown in the Fig.1. The excitation source is an Argon laser which can give power of 172mW at 488,1nm wavelength and 60 mW at 476,5nm wavelength. The laser beam is forcused on the liquid-sample cell by the lens O_1 (f_1=7,7 cm) and the scattering light is forcused on the monochromator entrance slit by the lens O_2.

Mounting two plane mirrors G_1 and G_2 on two sides of the sample cell increase the intensity of the scattered radiation. By this way, the laser beam is reflected back into the sample several times. The concave mirror G_3 (f_3 =16 cm, ϕ = 10,5 cm) brings back onto the monochromator slit the radiation scattered by the sample in the reverse direction. The main function of the optical system is to secure optimal conditions for sample illumination and to focus the scattered radiation on the monochromator entrance slit. The Raman spectra is recordered by a double gratting monochromator GDM-1000 and a photomultiplier tube MI2FC51. This spectrum recorder system operates in the range of 2850 A^0 ÷ 6650 A^0 (23810 cm^{-1} ÷ 22727 cm $^{-1}$) with the dispersion of 3 A^0/mm.

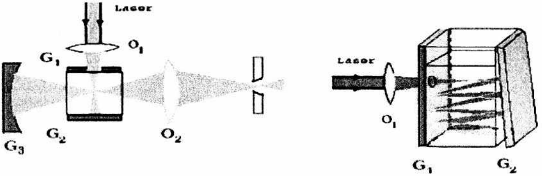
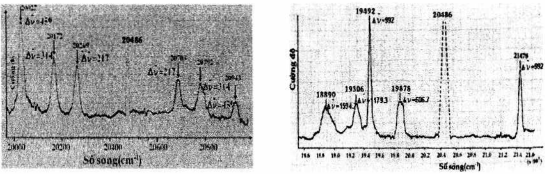


Fig 1: The optical system scheme for sample excitation

3. Experimental results and discussion

To examine the capacity and quality of the Raman spectrometer system we first recorded the Raman spectra of CCl_4, C_6H_6. Then, we recorded Raman spectra of some hydrocarbon extracts from petroleum of Vietnam. These samples have different boiling-temperatures: 110^0 C ÷ 115^0 C for the 5B110 sample and 115^0C ÷ 120^0 C for the 5B115 sample. In the case of CCl_4, C_6H_6 we recorded both Raman Stokes and Raman anti-Stokes spectra (as shown in Fig.2). This result indicated the high efficency of the laser Raman scattering detection system. Using this laser Raman scattering detection system we studied to obtain spectra of some hydrocarbon extracts from petroleum of Vietnam. The spectra of two samples of Vietnam petroleum extracts were shown in Fig.3



(a) (b)

Fig.2: Raman spectra of CCl_4 (a) and C_6H_6 (b) pumped by laser Argon (488,1nm)

We noted that in the spectra of both petroleum samples, there is a double line with strong intensity in the region of 2840 cm^{-1} ÷ 2930 cm^{-1} and a line of weaker intensity at 1444 cm^{-1} for the case of 5B110 sample and at 1454 cm^{-1} for the case of 5B115 sample and some lines of very weaker intensity in the region of wave number shorter than 1444 cm^{-1}.

Basing on the characteristic of boiling-temperature, intensity and frequency shift in Raman spectra of the two samples of Vietnam petroleum extracts [2,3] we could conclude that the two samples consisted of 2-Metyl pentane, Xyclo pentane, Octane, Etyxiclohexan, Nonan, p-Xylen and 2, 6 Dimetyl heptanes... All these compounds belong to paraffin, naphthalene and aromatic hydrocarbons family [5]. This result was in good agreement with several other documents reported on petroleum of Vietnam.

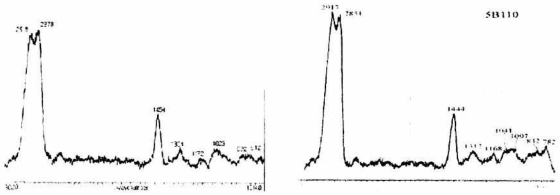


Fig.3: The Raman spectra of petroleum extract samples excited by 476,5nm wavelength of Argon laser : a - for sample 5B110 , b – for sample 5B115

4. Conclusions

A laser Raman spectrometry system with an Argon laser and a double grating monochromator GDM-1000 has been developed at our laboratory. Several studies were carried out to design optical system for optimal sample excitation. The obtained Raman spectra showed that this laser Raman spectrometry system could give high sensitivity and resolution. It is suitable not only to analyze hydrocarbon compounds of petroleum but also to study semiconductor material structure.

Acknowledgements: This work was supported by the Scientific Research Program of VNU

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