Characterization studies of Fullerenes with polyvinyl alcohol

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Abstract- Fullerene C60 nano particles in combination with polyvinyl alcohol is characterized and proposed as an effective drug delivery system without any side-effects. FT-Raman, XRD and FT-NMR characterization studies indicate drug-delivery medical applications.
Keywords – Fullerene C60, Polyvinyl alcohol, drug-delivery; FT-Raman; FTNMR, XRD, nano particles

I. INTRODUCTION

The first fullerene molecule C60 was discovered and manufactured in 1965 by Richard Smalley et al., at Rice University [1]. The properties of fullerene molecule as a drug delivery unit is a well studied area [2, 3]. Nano particles for drug delivery to the brain. Nano particles for drug delivery to the brain are a method for transporting drug molecules across the blood–brain barrier (BBB) using nano particles. These drugs cross the BBB and deliver pharmaceuticals to the brain for therapeutic treatment of neurological disorders. Polyvinyalcohol (PVOH) was first synthesized by Hermann and Haehnel in 1924 via saponification of poly (vinyl ester) in sodium hydroxide solution. Chemically and physically-modified PVOH structures have found applications in biomedical and pharmaceutical area [4, 5].PVOH is a synthetic non-toxic polymer. It is a stable and a biocompatible compound, and can be used for cross-linking with C60 (nano particles) and hence can be considered as an effective drug delivery system. [6-18].This polymer is considered as a nonhazardous material according to the American Standard for Precautionary Labeling of Hazardous Industrial Chemicals.

II. EXPERIMENTAL METHOD AND ANALYSIS

2.1 Instrumentation and Analysis

When performing the characterization studies, we had used a solvent that was research grade, 99.99% pure, deuterated DMSO. Initially, we did the FT-Raman characterization studies in the 3000cm-1 to 2500cm-1 as shown in [Fig.1] and between 4000 cm-1 to 400 cm-1 region in [Fig.2]. Both these two spectra show the presence of C60 molecule at 2909.36 cm-1 and at 2912.62 cm-1 respectively, within the limits of instrumentation error. In [Fig.3] , we have shown the spectrum of pure fullerene molecule only taken between the 4000 cm-1 to the 400 cm-1 region, in order to make a comparative study of additional lines between these figures above. Hence we can conclude that there is only one peak corresponding to same type of C60 carbon that is present between the, 3000cm-1 to 2500cm-1 ,whereas all other peaks between 1500cm-1 to 400 cm-1 region is the well known finger print region, correspond to polyvinyl alcohol, (PVOH) and C60 spectral lines. We then carried out XRD studies, The XRD analysis shown in figure 2 reveals a'd' spacing of 4.42051Å for Kα radiation and $2\theta = 20.025^{\circ}$, corresponding to a bond length of 3.02718Å using Bragg's law of diffraction. This corresponds to increased bond length due to the cross-linking of PVOH molecule with C60 molecule which otherwise , as a free molecule of C60 would have shown C1-C2 (5 member ring) plus the C1-C6 (six member ring) would be 1.458Å+1.401 Å = 2.859Å.[18].In the FT-Raman studies the sample containing C60 and PVOH matrix was irradiated with a 16mW NIR laser,10 Raman bands are seen which are expected from C60 molecule, and there are strong absorption peaks at 213nm, 257nm, and at 329nm corresponding again to the C60 molecule. A single peak corresponding to 2909.36 cm-1 (343.71nm) shows maximum Raman intensity signal strength of 0.020 a.u, shows a C60 strong absorption signal. Several peaks in the spectrum were obtained that correspond to presence of both the C60 and the PVOH in the sample. The analytical studies only give an idea of using C60 with PVOH for therapeutic purposes. However, this study is yet to confirm its application and usefulness of this complex molecule C60 and PVOH to be used safely as a drug delivery unit without any side-effects . . In the FT-NMR studies shown below in figures 3 and 4, the 13C studies were carried out using a standard frequency of 125.757 MHz and the $_1H^1$ proton studies were carried out using 500 MHz frequency in a heteronuclear-coupling mode. The peak corresponding to 45.702ppm and the 64.107ppm shown in figure 3 below [0-200ppm range], correspond to PVOH and only one peak at 51.719ppm corresponds to C60 molecule and this can be seen to correlate from the figure 4 below [0-75ppm range].

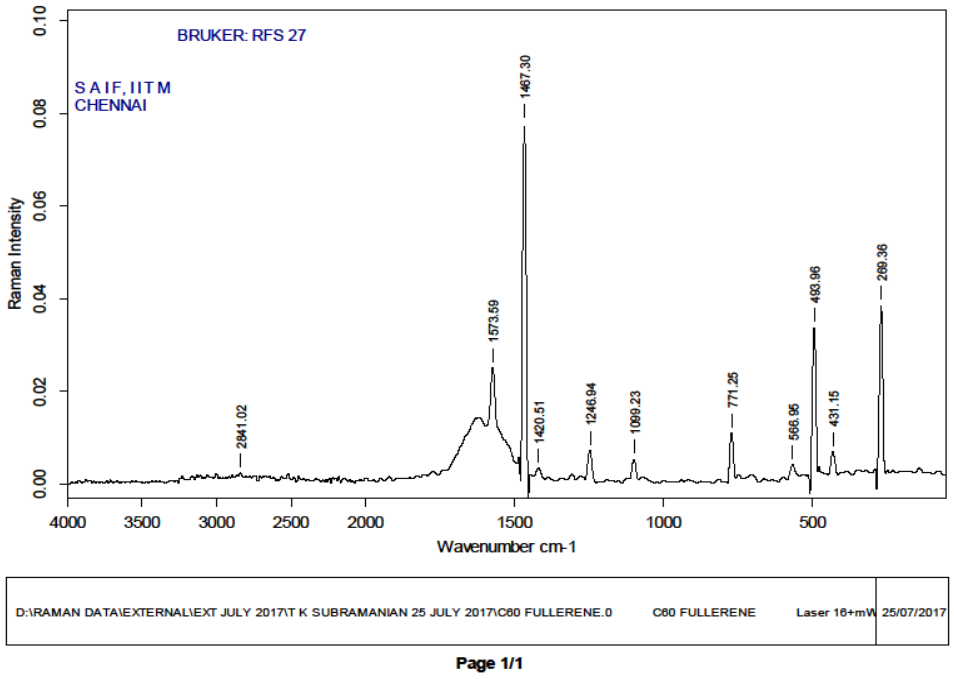

Figure 1. FT-Raman Spectrum of C60 Fullerene with PVOH molecule in the 4000cm^{-1} region to 400cm^{-1}region.

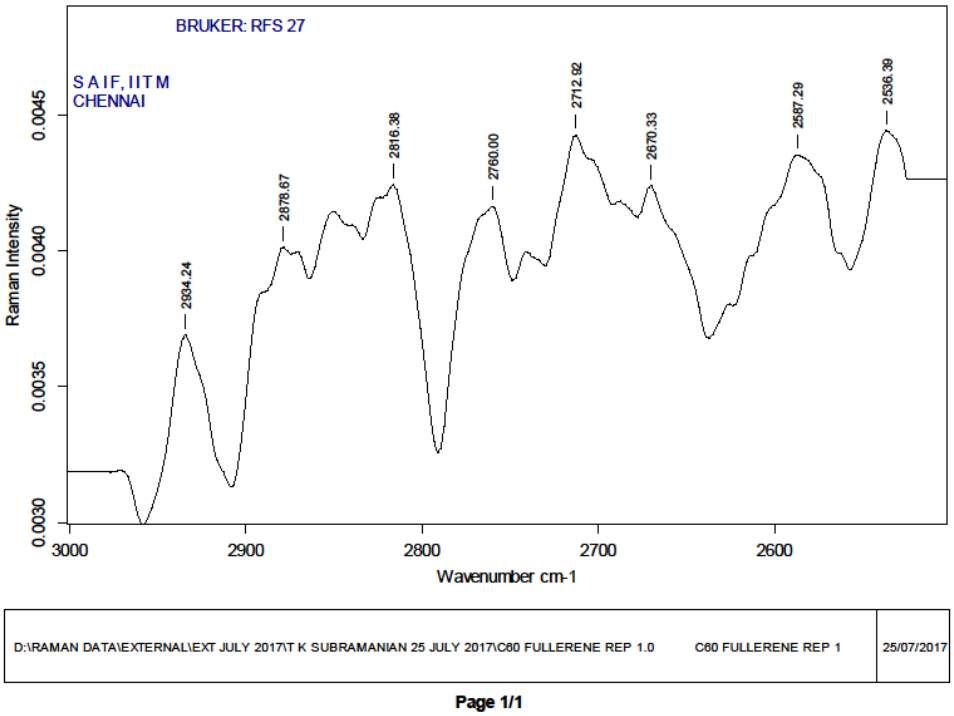

Figure 2.FT-Raman spectrum of Fullerene with PVOH in the region 3000cm^{-1} to 2500 cm^{-1}region.

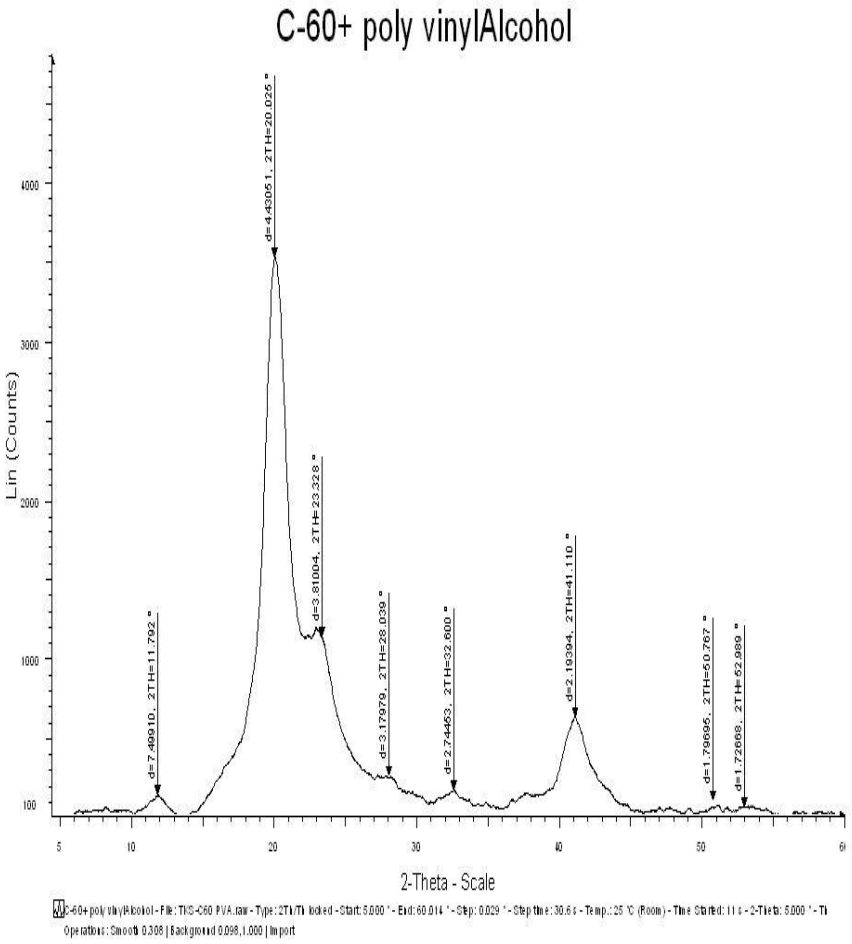

Figure 3. XRD spectrum of Fullerene with Polyvinyl alcohol.

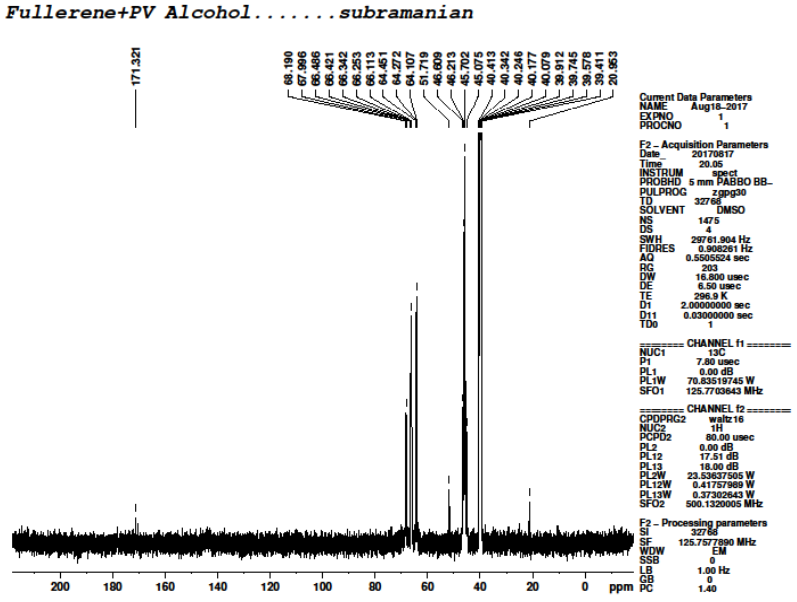

Figure 4. FT-NMR studies of Fullerene with PVOH in the 0-200ppm range.

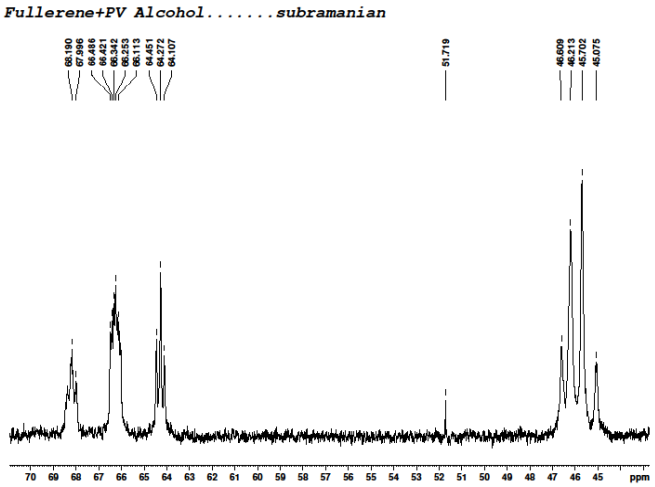

Figure 5. FT-NMR studies in the 0-75ppm range.

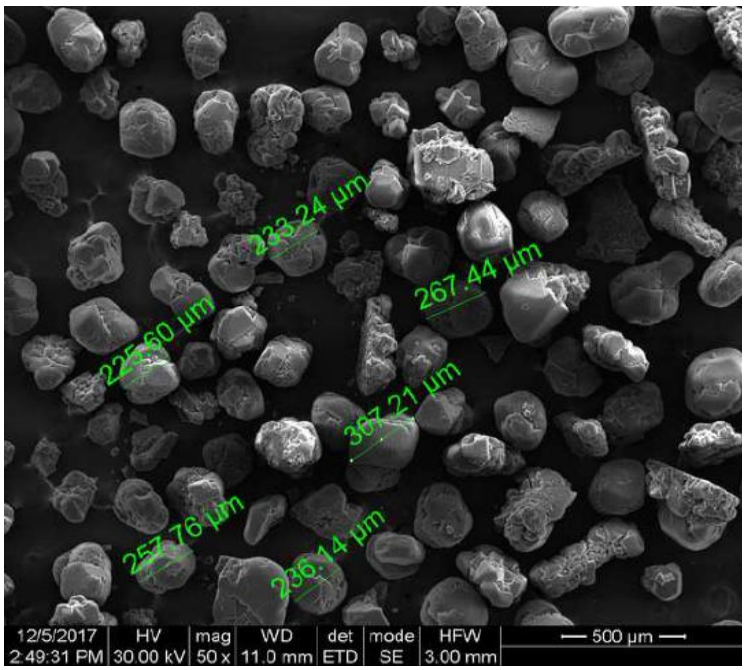

Figure 6. Scanning Electron Microscope Of The Fullerene With Pvoh Molecular Size.

III. RESULT AND DISCUSSION

Brabec et al, [3] have studied the semiconducting polymers and their incorporation into host matrices formed by conventional polymers such as polyethylene (PE) or polystyrene (PS) .They have characterized the linear optical properties of several guest–host systems by absorption and luminescence measurements and probed the excited states by photo induced absorption measurements (PIA) and light induced electron spin resonance (LESR). Fromageau.J.et al,[4] have suggested that the experimental results done by their group emphasize the interest of PVA cryogel as vascular phantoms for intravascular ultrasound elastography. Srinath Muppaleni [5] have found from their studies that the PVOH polymers and copolymers can offer unique water retention, film forming, strength and swelling properties, which can be vitally beneficial in general health applications, and in particular pharmaceutical use. These have also found major application in biomedical field due to non-toxicity and desirable swelling and mechanical property that they offer in their water-swollen states. Due to their biocompatibility, drug compatibility, water solubility, film forming, good mechanical and swelling properties, the PVOH hydrogels have

been studied as drug delivery systems in oral, transdermal, buccal, intramuscular, rectal routes of administration. Degree of crystallinity plays a major role in controlling diffusion of the drug from Hydrogels. In general, PVOH hydrogels can be designed either as matrix or reservoir drug delivery platforms. Altering gelling properties, solubility, adding copolymers have also been utilized to control the drug release from PVOH Hydrogels.Matsumura .S [6] has studied the biodegradation of polyvinyl alcohol and its copolymers thoroughly.F.L.Marten has studied the commercial applications of polyvinyl alcohol [8].

Gebben B, van den Berg HWA, Bargeman D,Smolders CA,[9] have studied Poly(vinyl alcohol) which is cross linked in dilute solution (c=0.1 wt%) with glutaraldehyde. DeMerlis CC, Schoneker DR [10] have found that orally administered PVA is relatively harmless. They had done experiments on rats before describing its properties. They have mentioned that the safety of PVA is based on the following: (1) the acute oral toxicity of PVA is very low, with LD(50)s in the range of 15-20 g/kg; (2) orally administered PVA is very poorly absorbed from the gastrointestinal tract; (3) PVA does not accumulate in the body when administered orally; (4) PVA is not mutagenic or clastogenic; and (5) NOAELs of orally administered PVA in male and female rats were 5000 mg/kg body weight/day in the 90-day dietary study and 5000 mg/kg body weight/day in the two-generation reproduction study, which was the highest dose tested. A critical evaluation of the existing information on PVA supports its safety for use as a coating agent for pharmaceutical and dietary supplement products. Omidian H, and Park K [11], has studied various hydrogels that were prepared for various applications in pharmaceutical and biomedical fields. Hydrogel based on polysaccharides, hydrocolloids, and synthetic polymers are discussed here in this paper accordingly. Finally, the chapter concludes with known hydrogel applications in the pharmaceutical area. These include superdisintegrants, ion exchanging resins, super porous hydrogels, hydrogel implants, hydrogel inserts, osmotic products (devices, implants, and tablets), as well as tissue expanding hydrogels and contact lenses. Fullerene molecule C60 with Polyvinyl alcohol (PVOH) has been studied and analyzed using the following techniques, namely, FT-Raman, XRD and FT-NMR studies.

Table -1 Experiment Result
https://data.mendeley.com/datasets
Published: 7 Dec 2019 | Version 1 | DOI: 10.17632/kp9yhwf6pw.1
Data Published in www.mendeley.com

IV. CONCLUSION

FT-Raman, XRD and FT-NMR characterization studies indicate drug-delivery and confirm medical applications of fullerene with polyvinylalcohol.

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