

Inclusion behaviour of Organic Probe inside Micellar Nano Cavity in Polymer Phase

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Abstract—Organic salt Pyrrole-2 carboxaldehyde (PCL) was entrapped using polymer micellar system like Sodium dodecyl sulphate, (anionic), Polysorbate-80 (non-ionic) along with polymers like Polyethylene oxide (PEO). Synthesized and characterized using UV-Vis, FTIR, and fluorescence. The influencing factor in the determination of all the characterization was to check whether polymer is able to hold the micelle formation occurring between the salt and surfactants used without interacting with them.

1. INTRODUCTION

Due to the wide-range of applications of organic materials on the nanometre size scale the desire to control their composition, function, and structure is receiving increasing interest from microelectronics to medicines. Using both of the covalent and non-covalent interactions, control has been achieved on the macromolecular size and shape. The assembly of numerous small molecules are required for the application of these interactions to form structures with large nanoscale dimensions [1]

In order to make the synthesis possible of these nanostructures as definite entities, development of methodologies has been done to exploit covalent interactions in order of the formation of robust building blocks, such as block copolymers [2-4]. By means of non covalent interactions these can be designed, with a moderately small number of components, in order to form nanostructures, such as polymer micelles. This universal process is well known as the dimensional evolution of synthetic organic chemistry[5, 6].

There is an important advancement in the field of polymer science represented by the applications of these particular techniques towards the simplistic synthesis of distinct functionalised hydrophilic and hydrophobic copolymers, which enables the construction of polymers which are having a great power of control over the molecular weight, sequence and end functionalisation, for operation in the self assembly of well-defined nanostructures. Most accessible assemblies among all are Spherical polymer micelles and nanoparticles which are leading towards the significant potential in varying applications which are ranging from delivery vehicles for

therapeutics, as precursors to nano-sized microelectronic devices and molecular imaging agents [7].

One very important feature of using organic salts or different organic compounds is that carbon-carbon bonds are strong enough, so it is possible to form long chains or rings of carbon atoms which are bonded to one another. Organic chemistry is having a wide application range now a day in biotechnology, petroleum, pharmaceuticals and many other industries [8, 9].

In our study we have used an organic salt called Pyrrole-2-carboxaldehyde (PCL) because of its wide application in the area of bio-medical field as it serves as a medicine for the cure of cancer and several electronic applications such as in making LED, SENSORS, OLEDs etc [10]. The main problem which arises with PCL is that it can't be directly inserted in the human body because it is cytotoxic in nature and causes harm to the human body. Therefore, we take the help of micellar system to overcome this problem because it helps to entrap the PCL drug in the micelle formed by the interaction of PCL with the surfactants used above a certain CMC (critical micellar concentration) value and then it can be inserted in the human body and help to overcome the problem.

2. EXPERIMENTAL

2.1 Apparatus

The UV-Visible absorption spectra were recorded at 300 Kelvin by a Perkin Elmer spectrophotometer (model Lambda-35) with a varying slit width. All luminescence measurements were made with a Perkin Elmer spectrophotometer (Model Fluorescence-55) with a varying slit width (Excitation slit=10.0 nm and Emission slit=5nm) ranging from 190-900 nm. The Model LS 55 Series uses a pulsed Xenon lamp as a source of excitation. Deionized water (mili-pore) was used for measuring absorption and emission spectra. All optical measurements were performed at room temperature under ambient condition. IR spectra at ATR mode are recorded with a perkin elmer FTIR spectrometer (model spectrum BX-11 source: nichrome glower wire with DTGS detector) at 400-4000 cm⁻¹ range with spectral resolution of 2cm⁻¹.

2.2 Materials

All reagents were of analytical grade and were used without further purification. Deionized water (milipore) was used for solution preparation. Pyrrole-2 carboxaldehyde (PCL), Sodium Dodecyl Sulphate (SDS), Polyvinyl Alcohol (PVA) and other chemicals were purchased from Sigma-Aldrich.

3. RESULTS AND DISCUSSION

3.1 Synthesis of Polymer thin film doped with PCL and SDS

In the synthesis of polymer film we weighed 1 gm of PVA polymer, 0.02g of PCL and 0.02g of SDS and mixed them with 30 ml of deionized water. Keep the solution at 80°C to heat for 2 hrs and after that allow the stirring to take place for 1 hr at room temperature. When the solution become completely transparent i.e PCL and SDS get completely dissolved, remove the solution from the magnetic stirrer and pour it in the petadish and allow the solvent to evaporate. After the complete evaporation Of the solvent the thin film of polymer is formed and cab be removed from the petadish easily.

3.2 Characterizations of Thin film polymer

3.2.1 UV-Vis absorption Spectroscopy

The absorption spectra of different doped and undoped polymer film are shown in Fig. .1. In PVA polymer film absorption peak arises at 292nm while, in presence of PCL, film of PVA+PCL shows an appearance of new peak at 249 nm with the existing peak at 292 nm. When we doped SDS in the mixture of PVA+PCL the newly appeared peak at 249 nm get suppressed with keeping the 292 nm peak intact. The disappearance of 249 nm peak verifies the entrapment of PCL inside SDS cavity which is only possible when complex formation takes place between PCL and SDS.

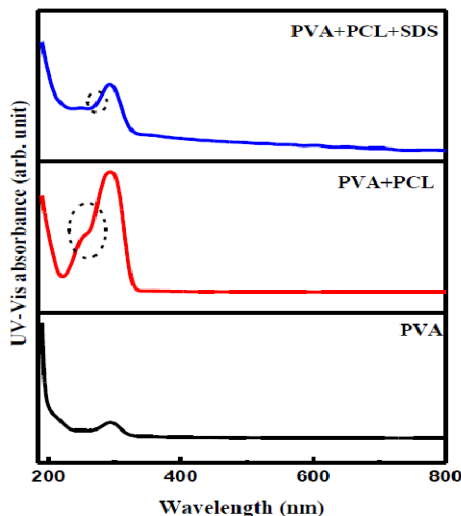


Fig. 1: UV-Vis Absorption spectra of PVA, PVA+PCL and PVA+PCL+SDS.

3.1.2 FTIR Spectroscopy: The FTIR absorption spectra of PVA, PVA+PCL, PVA+PCL+SDS polymer films are shown in Fig. 2&3. We have divided the whole IR spectra in two regions. First one from 600 cm^{-1} to 2000 cm^{-1} and second one from 2000 cm^{-1} to 4000 cm^{-1} . The FTIR spectra of PVA polymer film shows wide band at 1000-1500 cm^{-1} and 3000-3500 cm^{-1} . Film of PVA+PCL shows no specific change in the absorption spectra. Due to doping of SDS in the mixture of PVA+PCL, a new IR peak arises at 1432 cm^{-1} . This new band is due to the C=O stretching mode of PCL. Similarly, the band at 2356 cm^{-1} confirms stretching of N-H band. The appearance of new peaks confirm the complex formation between PCL and SDS whereas, no interaction occurs between PVA and PCL since, no new changes were found in the absorption spectra.

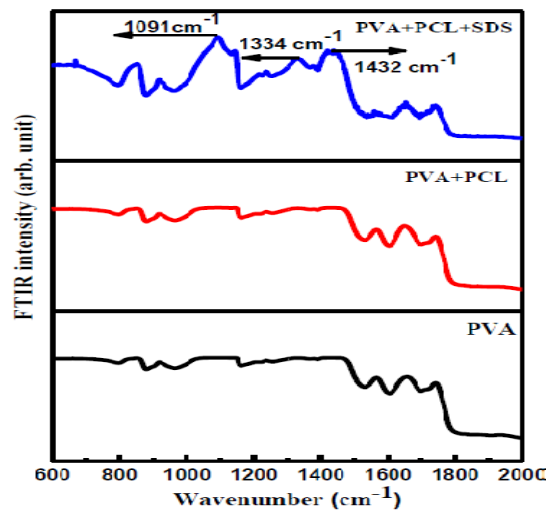


Fig. 2: FTIR Absorption spectra of PVA, PVA+PCL and PVA+PCL+SDS.

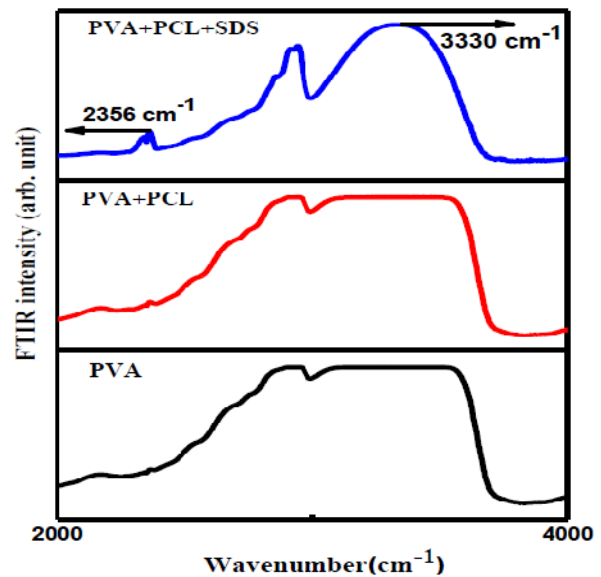


Fig. 3: FTIR Absorption spectra of PVA, PVA+PCL and PVA+PCL+SDS.

3.1.3 Fluorescence Spectroscopy: In the fluorescence spectra of PVA an emission peak arises at 421nm while, in presence of PCL, film of PVA+PCL shows decrease in the intensity of the same peak as shown in Fig. 4. When we doped SDS in the mixture of PVA+PCL there was a further decrease in the intensity of the same peak. The results of luminescence show that there is interaction of PCL molecule with the micellar cavity of SDS. Depending on the nature of micelle that means depending on the polarity of micelle the nature of the interaction is different.

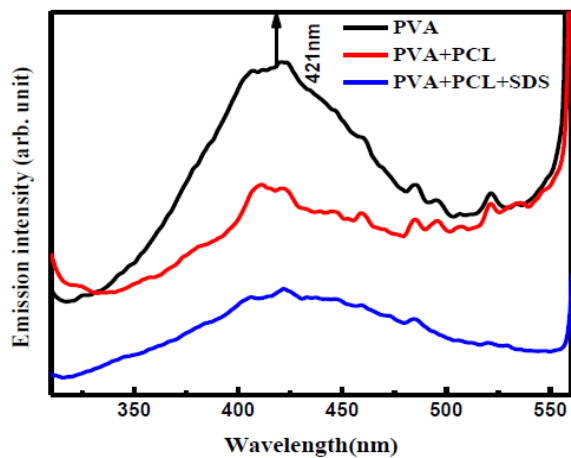


Fig. 4: Emission spectra of PVA, PVA+PCL, PVA+PCL+SDS.

4. CONCLUSION

Polymer films of PVA, PCL and SDS were synthesized using acetonitrile as a solvent at room temperature through a simple and straightforward process. The Polymer films were characterized using UV-Vis spectroscopy, FTIR spectroscopy

and Fluorescence spectroscopy. It is clearly visible that the micellar cavity trapped PCL in its nanosize cavity in the polymer environment above certain critical micellar concentration (CMC) value of SDS and polymer is used to hold the micelle:PCL complex.

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