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Effect of PEO of PS-P2VP photonic gel films

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Abstract

We prepared polystyrene-b-poly(2-vinyl pyridine) (PS-b-P2VP) lamellar films which is hydrophobic block-hydrophilic polyelectrolyte block polymer have 57 kg /mol-b-57 kg/mol. The result of UV-visible absorption spectra supported that effect of poly(ethylene oxide) on the band gap tuning of PS-P2VP photonic gel like salt effect.

1. Introduction

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Photonic crystals are periodic optical structures that are formed to affect the motion of photons like that periodicity of semiconductor crystals affect the motion of electrons.[1] Photonic crystals, which are also known as photonic band gap materials, contain regularly repeating internal region of high and low dielectric constant on the wavelength of light. Photonic band gap materials have drawn increasing attention due to their unique potential use in various applications such as controlling and processing light, active component of display, sensory or telecommunication devices.[2-4]

They demonstrated various methods of tuning of photonic band gap by changing the refractive index and/or the periodicity of the photonic crystal structure[5-9] Effective way of fabricating 1D photonic crystals from lamella structure has been demonstrated using self-assembly of block copolymers.[10-12] The well-ordered photonic crystal lamellar films are also called photonic gels. The band gaps of photonic gel films reversibly changed with swelling and deswelling.[13] Especially in the salt solution, swollen polyelectrolyte gels can be made to collapse by osmotic deswelling, resulted band gap shift.[14-15]

In this study, we fabricated and studied the photonic gel with poly(ethylene oxide) (PEO) changing the concentration. To investigate effect of PEO on the change of band gap, UV-visible absorption spectra were carried out with different concentration of PEO solution.

2. Experimental

We prepared polystyrene-b-poly(2-vinyl pyridine) (PS-b-P2VP) lamellar films which is hydrophobic block-hydrophilic polyelectrolyte block polymer have 57 kg /mol-b-57 kg/mol. To fabricate the photonic gel, well-oriented lamellar film were prepared by spin-coating (MIDAS Model spin1200D) from a 5 % PS-b-P2VP solution in propylene glycol monomethyl ether acetate. The spin-coating films were annealed in chloroform vapor at 50℃ for 24 hours. Quarternization was performed with 5 wt% of iodomethane. Iodomethane were reacted with pyridine groups in PS-b-P2VP at 50 ℃ for 72 hours as shown Figure 1.

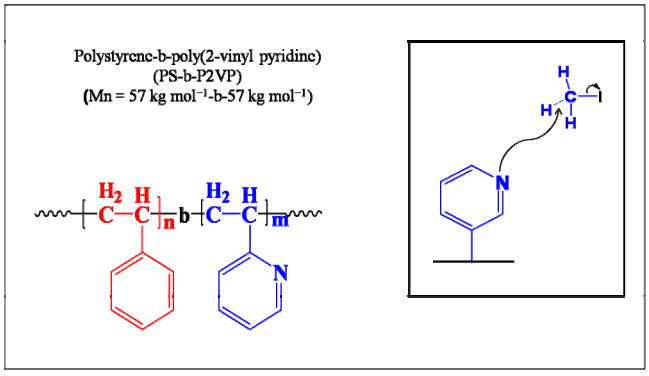

Fig. 1. Structures of PS-P2VP Block copolymer.

Figure 2 shows processes of fabrication for photonic gel films. The quarternized photonic gel films were dried and saved for measurements. And we also prepared the 0.5 %, 1 %, 2% and 3% PEO solution in distilled water. PS-b-P2VP was purchased from Polymer Source (Doval), 1-iodomethane and PEO were purchased from Aldrich. These chemicals

were used as it was without further purifications.

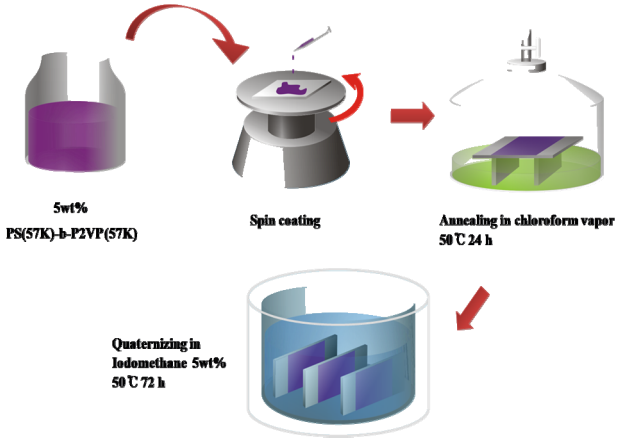

Fig. 2. Preparation of photonic gel films.

The photonic band gaps were measured with the diode array type spectrophotometer (Agilent Model 8435) and all of spectra were normalized.

3. Results and discussion

The PS-P2VP film itself does not show any significant visible absorption and transparent. As shown in Figure 3, in the NH_4Cl solutions, photonic band gap position of the PS-P2VP films shifted to the shorter wavelength as increasing salt concentration.

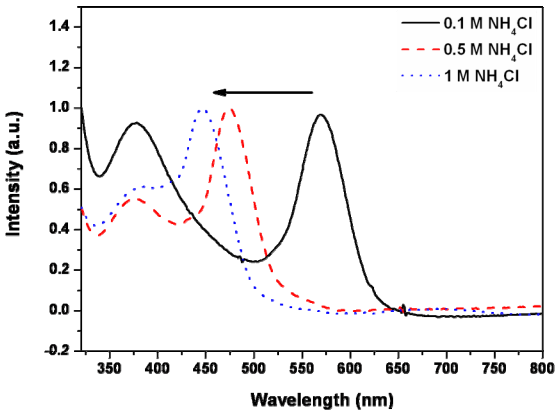

Fig. 3. UV-vis. Absorption spectra of PS-P2VP block copolymer swollen at different NH4Cl *(aq)* concentration.

As like the salt effect of band gap tuning, PEO also acted as a electrolyte. According to this PEO effect also capable of band gap tuning. However as shown in Figure 4, in the PEO solutions, those photonic band gap position of films shifted to the longer wavelength as increasing PEO concentration.

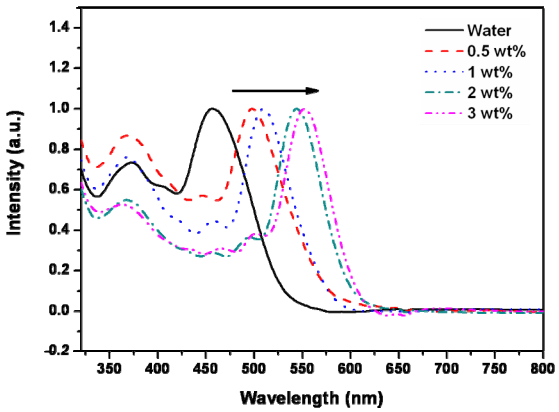

Fig. 4. UV-vis. Absorption spectra of PS-P2VP block copolymer swollen at different poly(ethylene oxide) *(aq)* concentration.

It is different from the band gap tuning of using salt concentrations. Table 1. shows difference of the absorption maximum positions shift between in the NH_4Cl solution and PEO solution, significantly.

Table 1. Shift of the absorption maximum positions in different solutions.

Solutions	*Absorption maximum positions*
NH_4Cl solution	570 nm (0.1 M)
	474 nm (0.5 M)
	446 nm (1 M)
PEO solution	498 nm (0.5 %)
	509 nm (1 %)
	544 nm (2 %)
	552 nm (3 %)

The results indicates that the PEO also can be using in color tuning of PS-P2VP photonic gel films and with salt effect it can be capable of broad wavelength range band gap tuning.

4. Summary

We have investigated the effect of PEO on the optical properties of photonic gel films. The photonic band gap were shifted to the longer wavelength as increasing PEO concentration.

Our results represent the PEO also work as a electrolyte on the photonic gel films, and it makes tuning of PS-P2VP photonic gel band gap. We considered PEO has possibility for color tuning of photonic gel films.

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5. References

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