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Conductive Polymer

# Polycarbazole Showing Fingerprint Structure

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**ABSTRACT**

Electrochemical polymerization of carbazole was carried out in cholesteric liquid crystal. Polarizing optical microscopy observation of the polymer film thus obtained shows fingerprint texture resembling with cholesteric liquid crystal electrolyte solution. The POM observations revealed that transcription of helical structure of cholesteric liquid crystal to the polymer was occurred. Furthermore, circular dichroism optical absorption spectrum shows that the polycarbazole prepared in cholesteric liquid crystal has optical activity.

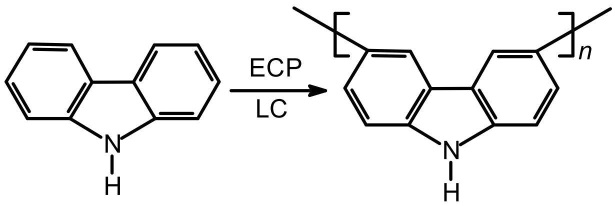
**Keywords:** Polycarbazole, liquid crystal, electrochemical polymerization

## Introduction

Conductive polymer is attracted materials because of flexibility, lightness, printable process, and so on. Polycarbazole is one of the most studied conductive polymers for various applications [1]. For example, polycarbazole is used as a photoreceptor of laser printer because polycarbazole has photoconductivity. In this research, electrochemical polymerization of carbazole was carried out in cholesteric liquid crystal (LC).

## Experimental

Cholesteryl oleyl carbonate (COC) or cholesteryl pelargonate (chiral inducer) (Figure 1), tetrabutylammonium perchlorate (TBAP, supporting salt) and carbazole (monomer) was dissolved in 4'-cyano-4-hexyloxybiphenyl (6CB, nematic LC solution) (Figure 1). This electrolyte solution shows cholesteric phase at room temperature due to chiral induction of COC to 6CB (from nematic LC to cholesteric LC with helical aggregation structure). Thus prepared cholesteric liquid crystal electrolyte solution was injected to the sandwich ITO glass electrode (ITO = indium tin oxide) developed by our group previously. Direct current (dc) of 4.0 voltages was applied to the cell for 30 min (Scheme 1). After polymerization, polycarbazole film was deposited on an anode side electrode. Thus obtained polymer film was washed with acetone and distilled water in this order to remove a residual 6CB, TBAP and unreacted monomer.




**Scheme 1**. Electrochemical polymerizaiton of carbazole in cholesteric liquid crystal. ECP: electrochemical polymerization, LC: liquid crystal.

## Results and discussions

UV-vis absorption spectroscopy and Fourier Transform Infrared (FT-IR) spectroscopy confirm that synthesis of polycarbazole is acheieved in cholesteric liquid crystal electrolyte solution. Polarizing optical microscopy (POM) observation shows that surface optical texture of polycarbazole

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film is similar to electrolyte solution. Figure 2 shows a POM image of the cholesteric electrolyte solution. Fingerprint texture derived from formation of choresteric liquid crystal is confrimed. Figure 3 shows an example of POM image of the polycarbaozle film prepraeed in cholesteric liquid crystal. The POM image indicates that transcription of molecular order (helical structure) was occurred.

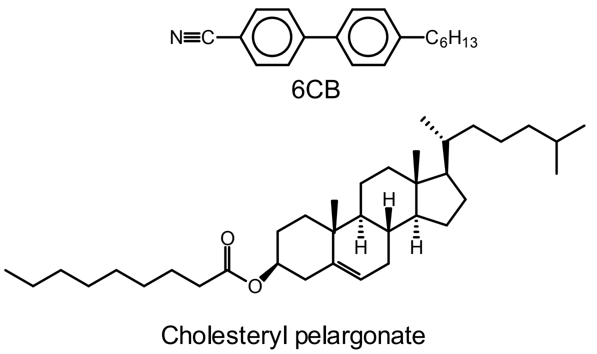


**Figure 1.** Chemical structure of 4'-cyano-4-hexyloxybiphenyl (6CB) and cholesteryl pelargonate (chiral inducer or chiral dopant).

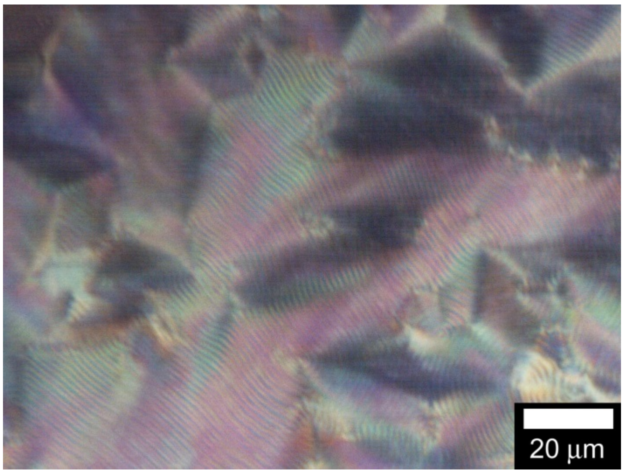


**Figure 2.** Polarizing optical microscopy (POM) image of cholesteric liquid crystal electrolyte solution containing monomer.

The fingerprint structure is derived from imprinting process from matrix liquid crystal. However, the sample thus obtain as shown in Figure 3 is fragil. Inmrprovement of composition of the liquid crystal electorlyte solutuion containing monomer allows production of steady film [2].

Circular dichrosim (CD) spectroscopy show that this polycarbazole film has optical activity. Moreover, after reduction of this polycarbazole film by hydrazine vapor, sign of CD spectra changes opposite site.

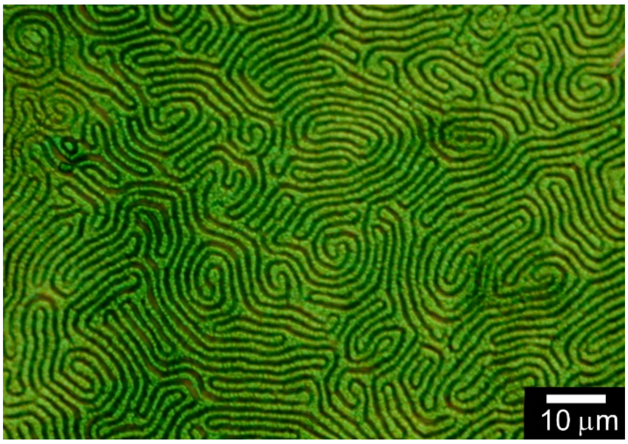


**Figure 3**. Polarizing optical microscopy (POM) images of polycarbazole film prepared in cholesteric liquid crytal. Constituent of liquid crystal electrolyte solution: cholesteryl pelargonate (chiral inducer, 0.02 g), tetrabutylammonium perchlorate (TBAP, supporting salt, 0.5 mg) and carbazole (monomer, 0.02 g), 4'-cyano-4-hexyloxybiphenyl (nematic liquid crystal solution, 6CB, 0.25 g). Polymerization was carried out for 30 min at 21 °C. Application voltage = 4 V.

## Conclusions

Electrochemical polymerization of carbazole was achieved in cholesteric liquid crystal. The POM observations revealed that transcription of helical structure was occurred. The CD spectra indicate that the polymer thus obtained has optical activity and redox process can drive change in the sign of the Cotton effect.

## Acknowledgments

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## References


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