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Chiral organic glass and its infrared spectrum property*

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Chiral molecules griseofulvin were disseminated homogeneously in poly methyl metahcrylate (PMMA) host, which agglomerate from methyl metahcrylate and N, N-dimethyl formamide dimethyl acetal, using benzoyl peroxide as a catalyst. So the chiral organic glass has been manufactured successfully. Its optical rotatory were investigated from a solution state to a solid state. The results of measurement show that the chiral parameter of the chiral organic glass is 2.65×10^{-7} and its specific rotation has increased compared with its solution condition. Its infrared spectra property has been measured by Fourier transformation infrared spectrometer. The results show that the chiral molecules fill in the pore of the network structure in the organic glass, which hardly link with the host.

Keywords: chiral molecules, PMMA, chiral parameter, infrared spectrum
PACC: 7000, 7855

1. Introduction

The propagation characteristics of waveguides or fibres filled with homogeneous chiral media have been studied theoretically.[1−4] In respect of experiments on chiral media, the optical nonlinear phenomenon of chiral media has been investigated.[5] Manufacture of chiral optical fibre with liquid core was also reported.[6] But the chiral molecule studied in Refs.[5,6] was in liquid state. So further basic and application research has been restricted, and seeking suitable solid chiral materials becomes the key problem in miniaturization of devices and practical development. One way of manufacture solid chiral materials is the sol-gel method.[7,8] In this paper, the chiral molecules griseofulvin are disseminated homogeneously into the organic glass, and their optical rotatory is studied. We will show that the optical polarization property of the chiral organic glass is different from that of the crystal.[9] The infrared spectra are also measured.

2. Manufacture of the chiral organic glass and its measured result

2.1. Manufacture of the chiral organic glass

Firstly, 15 ml methyl metahcrylate and 15 ml N, N-dimethyl formamide dimethyl acetal are mixed. They are sealed up and stirred up about 30 min with magnetic power stirrer. Secondly, 1g griseofulvin and 0.1 g benzoyl peroxide are added in gradually. After stirred for 30 min, the transparent chiral solution can be obtained. The solution is poured into a 5 cm×1 cm×3 cm glass groove, the transparent length of which is 5 cm. They are sealed up and put in the oven at 60 °C for 7 d; then, the chiral organic glass is manufactured. The procedure is shown schematically in Fig.1.

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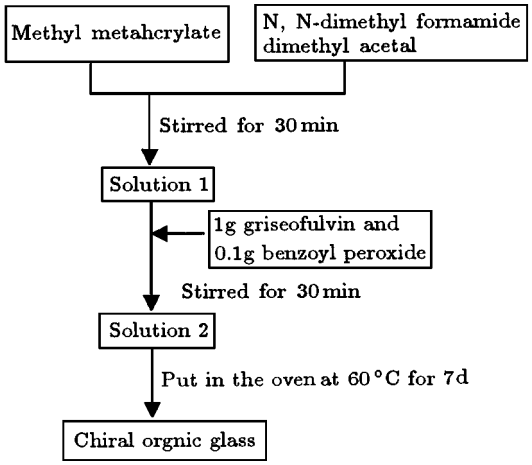


Fig.1. The manufacture procedure of chiral organic glass.

2.2. Measurement of the chiral organic glass property

The apparatus of Fig.2 in Ref.[7] is used to measure the optical polarization property of the He-Ne laser, chiral solution and chiral organic glass. All values are recorded and normalized, and the measured results of optical polarization property are plotted in Fig.2.

The infrared spectrum of the chiral molecule, organic glass matrix and chiral organic glass are measured by Nicolet NEXUS-670 Fourier transformation infrared spectrometer, with a resolution of $4\,\mathrm{cm}^{-1}$.

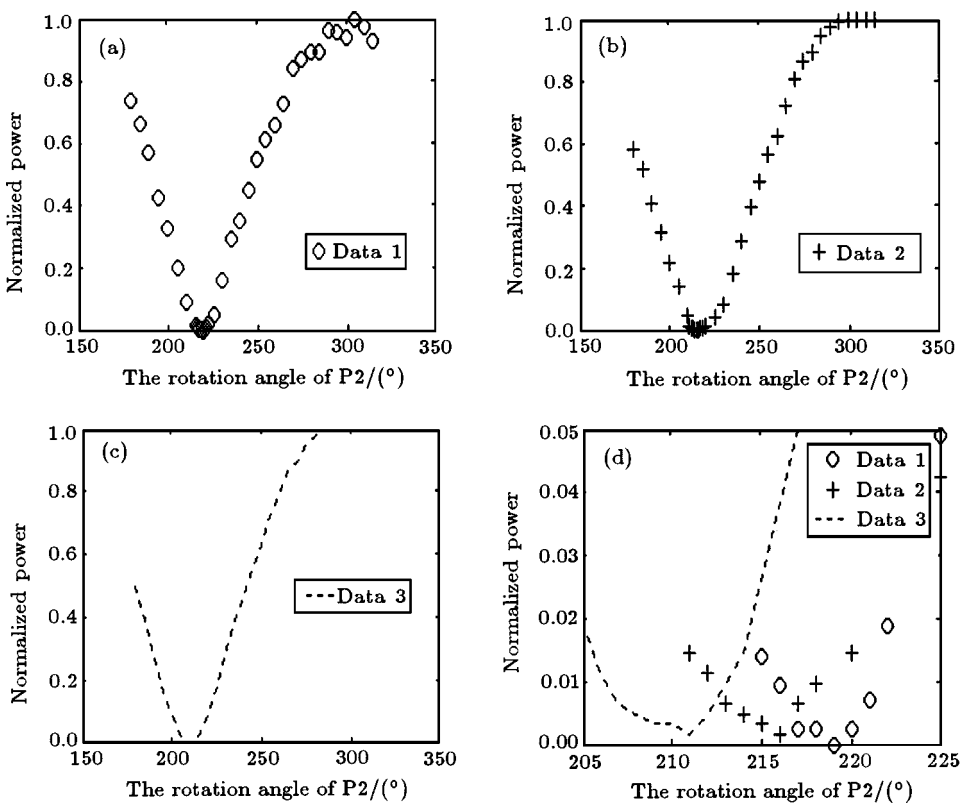


Fig.2. Measured results of the optical polarization property. (a) He-Ne laser, (b) chiral solution, (c) chiral organic glass, (d) optical polarization properties of (a), (b) and (c) nearby the extinction location.

3. Discussions

3.1. Chiral parameter

Figure 2 shows that the angle of a polarized light is –5°, when it passes through the chiral sol; and the angle becomes –8° when it passes through the chiral gel. Evidently, the rotated angle of the chiral organic glass is bigger than the chiral solution. This phenomenon may be caused by the aggregation of molecules of methyl metahcrylate. The angle of optical rotatory δ is relevant with the specific rotation α and the length of chiral organic glass L, that is

$$\delta = \alpha L. \tag{1}$$

From Eq.(1), the specific rotation α=–1.6°/cm. From Eq.(10) of Ref.[7], the chiral parameter of the chiral organic glass is 2.65×10^{-7}.

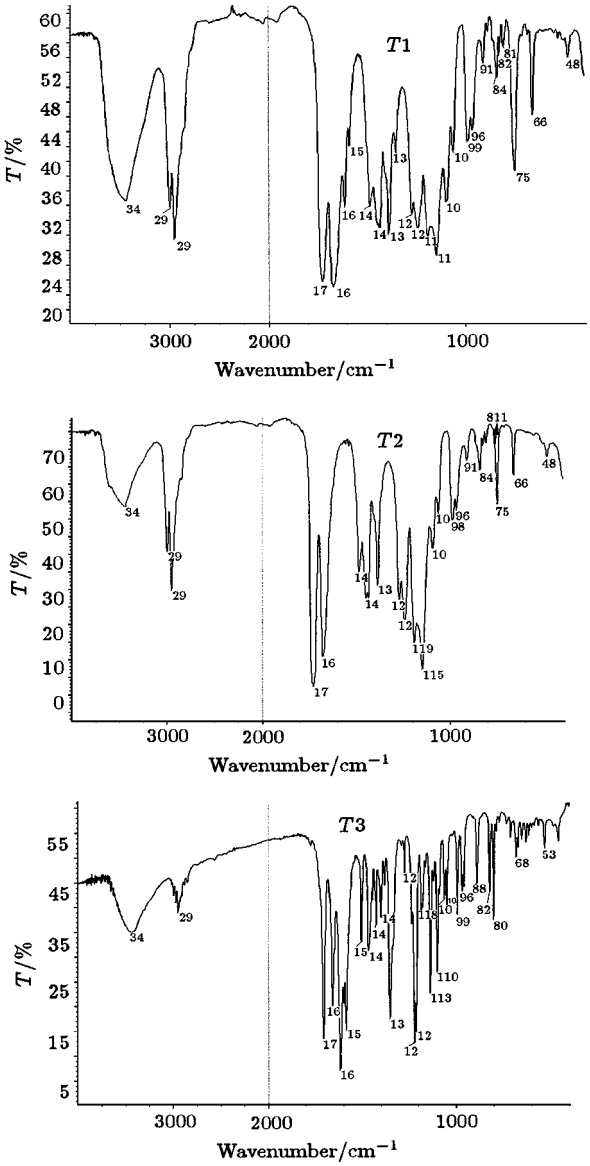


Fig.3. Infrared absorption spectrum. $T1$ represents the chiral organic glass, $T2$ represents the organic glass matrix, $T3$ represents the chiral molecule griseofulvin.

3.2. Analysis of infrared absorption spectra

The purpose of measuring infrared absorption spectra is to find out which state the chiral molecule may be in the organic glass. Does it fill in the pore of the network structure or link with the host? In Fig.3, $T1$ represents the infrared absorption spectrum of the chiral organic glass, $T2$ represents that of the organic glass matrix, and $T3$ represents that of the chiral molecule griseofulvin. Firstly, in the fingerprint region (1333–667 cm^{-1}), the intensity, shape and location of $T1$ are similar with that of $T2$. Although there are many subtle absorption peaks in $T3$, they are not incarnated in $T1$, which is covered by $T2$. Secondly, in the feature region (4000–1333 cm^{-1}), there are four obvious differences between $T1$ and $T2$. In $T1$, four absorption peaks can be found at 1616, 1591, 1354 and 1437 cm^{-1}. The former three absorption peaks do not appear in $T2$. Though $T2$ has an absorption peak at 1449 cm^{-1}, it is 12 cm^{-1} less than 1437 cm^{-1}. However, if compared with $T3$, four absorption peaks can be found at 1619, 1587, 1353 and 1428 cm^{-1}. These absorption peaks are close to those of $T1$, and there are not any obvious redshifts or blueshifts. So, it can be reasoned that the chiral molecules fill in the pore of the network structure in the organic glass, which hardly link with the host.

4. Conclusion

The chiral organic glass has been manufactured successfully, and its optical rotatory has also been observed. The results of measurement show that its chiral parameter is 2.65×10^{-7}. So it is possible to make solid chiral waveguide and solid chiral nonlinear device.

References

[1] Mazur J *et al* 1992 *J. Electromagn. Wave Appl.* **6** 641
[2] Cory H 1995 *J. Electromagn. Wave Appl.* **9** 805
[3] Dong J F 1997 *Acta Opt. Sin.* **17** 476 (in Chinese)
[4] Robert C *et al* 1994 *J. Opt. Soc. Am.* A **11** 3212
[5] Li J Q *et al* 2000 *Chin. J. Lasers* A **27** 608 (in Chinese)
[6] Tao W D, Dong J F, Bai G R and Nie Q H 2001 *Acta Opt. Sin.* **21** 1174 (in Chinese)
[7] Tao W D, Xia H P, Bai G R, Dong J F and Nie Q H 2002 *Acta Phys. Sin.* **51** 685 (in Chinese)
[8] Xie D T *et al* 1999 *Acta Phys. Sin.* **48** 1773 (in Chinese)
[9] Niu J S *et al* 2001 *Chin. Phys.* **10** 836