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SOLVENT EFFECT ON THE ORIENTATION OF BENZOPHENONE GROUPS IN THE SIDE CHAIN OF POLY-γ-p-BENZOYLBENZYL-L-GLUTAMATE

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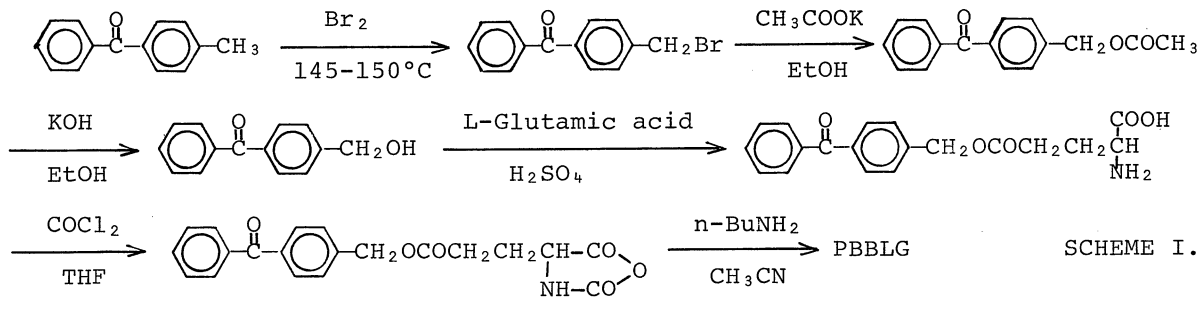
The orientation of benzophenone groups in the side chain of poly-γ-p-benzoylbenzyl-L-glutamate (PBBLG) has been studied together with its conformation by infrared, circular dichroism and ultraviolet spectra. The results suggest that the benzophenone groups in the side chain of α-helical PBBLG are more rigidly orientated in hexafluoroisopropanol (HFIP) than in dichloroethane (DCE).

There have been a number of reports of solvent effects on the secondary structures of polypeptides. However in no cases have solvent effects been observed on the orientation of side chain chromophores with the secondary structures being unchanged. We wish to report in this communication a solvent effect on the orientation of the benzophenone groups in the side chain of α-helical PBBLG.

The synthesis of PBBLG is outlined in Scheme I. Its number-average molecular weight was determined to be 11000 by the titration of the amino endogroup with perchloric acid crystal violet being used as an indicator.



SCHEME I.

We also prepared a copolypeptide of γ-p-benzoylbenzyl-L-glutamate with γ-benzyl-L-glutamate (molar ratio, 1:1) in the same manner. Polymerization was carried out in acetonitrile[1] with n-buthylamine as an initiator at N-carboxy α-amino acid anhydride/initiator ratio of 50/1.

The CD spectra of PBBLG and the copolypeptide dissolved in DCE are shown in Figure 1. Both polypeptides show a negative circular dichroism band at 220-221 nm. The magnitude of their ellipticity is comparable to that of poly-γ-benzyl -L-glutamate in the α-helical conformation.[2] The n-π* and the parallel π-π* bands are not well resolved in these CD spectra. These polypeptides show no ellipticity in the absorption region of the benzophenone groups. This finding indicates that the benzophenone groups in these polypeptides are not in a regular orientation in DCE. The CD spectra of these polypeptides dissolved in HFIP are shown in Figure 2. Both polypeptides show a negative dichroism band near 220 nm. The n-π* and the parallel π-π* band (210 nm) are well resolved in the copolypeptide spectrum but not in the PBBLG spectrum. The most striking characteristic of the CD spectra in HFIP is a positive band at 250 -295 nm. This finding indicates that the benzophenone groups in these polypeptides are in a regular orientation in HFIP.

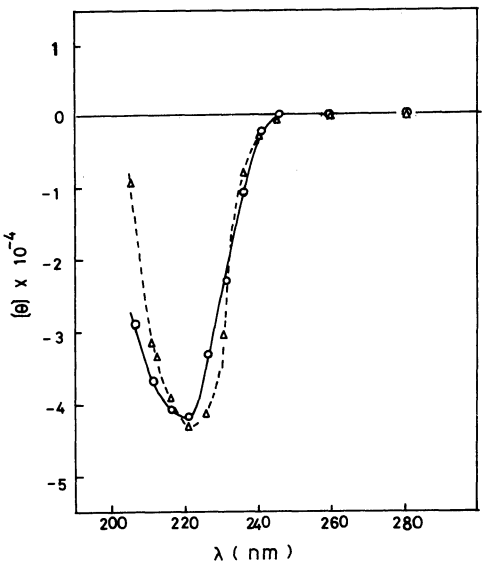


Fig. 1. The CD spectra of PBBLG and the copolypeptide in DCE.
—o—: PBBLG, --Δ--: Copolypeptide

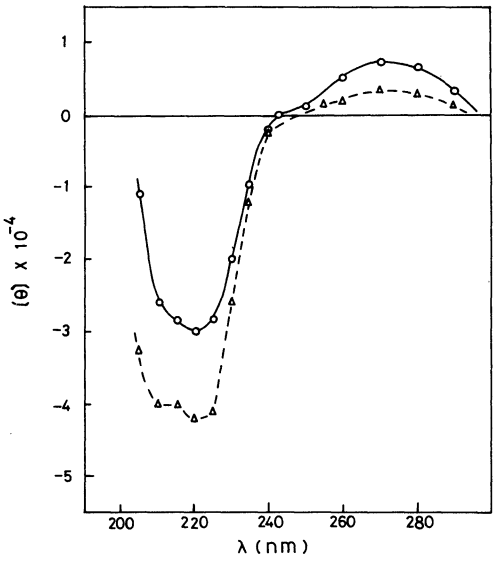


Fig. 2. The CD spectra of PBBLG and the copolypeptide in HFIP.
—o—: PBBLG, --Δ--: Copolypeptide

The infrared absorption spectra of PBBLG in DCE and HFIP are shown in Figure 3. The spectrum in DCE shows the absorption of the amide I band at 1656 cm^{-1}, the amide II at 1546 cm^{-1} and the ester carbonyl at 1739 cm^{-1} which are characteristic of α-helical conformation. The spectrum of PBBLG in HFIP shows the absorptions of amide I band at 1650 cm^{-1}, the amide II at 1546 cm^{-1} and the ester carbonyl at 1720 cm^{-1}. The ester carbonyl peak is shifted by about twenty wave numbers to lower frequencies relative to that in DCE possibly due to hydrogen bonding of the group with HFIP. The position of the amide II band in HFIP is similar with that in DCE. The amide I peak in HFIP is shifted by about five wave numbers to lower frequencies relative to that in DCE. Recently it was reported that poly-L-alanine (PLA) assumes a distorted α-helix in HFIP.[3] The infrared spectrum of PLA showed the amide I band at 1643±1 cm^{-1} which is clearly different from that at 1654±2 cm^{-1} of an α-helical film of PLA. However the position of the amide I band for PBBLG in HFIP is still in the region of that of usual α-helical polypeptides (1652±4 cm^{-1}). In both solvents the absorption of the benzophenone carbonyl is overlapped by the amide I band.

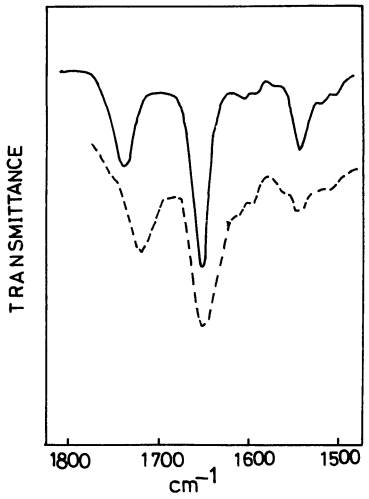


Fig. 3. The infrared spectra of PBBLG in DCE (——) and in HFIP (---).

The ultraviolet spectrum of PBBLG in DCE shows two absorption peaks at 256 nm (π-π* transition) and 340 nm (n-π* transition). The former is red-shifted to 261 nm in HFIP. On the other hand, the latter is blue-shifted in HFIP till the absorption peak is extinguished on account of overlapping with the absorption trail of the π-π* transition. These results suggest formation of hydrogen bonding of the benzophenone carbonyl with HFIP.[4]

In HFIP, the steric interaction between the benzophenone groups and HFIP molecules attached to the ester and ketone carbonyls would become significant. Therefore one can expect the benzophenone groups to be in more rigid orientation.

References

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