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CHIROPTICAL PROPERTIES OF AMINO ACID ESTERS

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The chiroptical properties of α-substituted acids and esters have been widely studied[1-10]. In a number of cases two CD bands with opposite sign are found in the region between 250 and 200 nm. Generally, these bands are ascribed to the $n\rightarrow\pi^*$ transitions of two different conformers. The absorption maxima of these conformers occur at slightly different wavelenghts, while the opposite sign of the CD bands gives rise to the familiar separation of about 30 nm.[11]

The assignment of the 210 and 240 nm bands in α-substituted acids and esters to two different conformers has been criticised by Polonski[12] on the argumentation that the band at 230–240 nm depends on the nucleophilicity of the hetero atom attached to the asymmetry center and vanishes in acidic media. Therefore, the band was ascribed to a charge-transfer transition of an electron from a non-bonding orbital of the hetero atom to the π^* anti-bonding orbital of the carboxyl group.

Measuring the temperature dependency of CD spectra has often helped in elucidating the conformational aspects. [13,14]Because Polonski's argument is mainly based on measurements of α-amino acids and derivatives, it is of interest to examine the temperature dependency of the chiroptical properties of α-amino acid esters (esters have been chosen for solubility reasons).

RESULTS

Comparison of our CD data of eight amino acid esters in methanol at 25° and in EPA (diethyl ether/isopentane/ethanol, 5/5/2) at 25 and − 185°C (Table 1), with Polonski's data shows discrepancies. The differences can be explained by the easy dimerisation of amino acid esters to dioxopiperazines.[15] Dioxopiperazines have a strong negative CD band at 210–220 nm ($\Delta\epsilon \sim 5$–10),[16] which already at 240 nm has an appreciable intensity. Addition of the dioxopiperazine spectrum to the amino acid ester spectrum results at 240 nm in an increase of the intensity of the band and a shift to shorter wavelenght and at 210 nm in a decrease in the intensity of the band. The influences are noticeable already at contaminations up to 5%. Our samples were checked by IR spectrometry on the presence of dioxopiperazines (strong band at 1670 cm^{-1}) before the CD measurements.

DISCUSSION

The 210 nm and 240 nm CD band in α-substituted acids and esters have generally been assigned to various possible conformers of different stabilities. Korver and Van Gorkom,[13] for instance, have considered conformers I, II and III (Scheme 1) with conformations II and III being the most stable ones. CD contributions of these conformers are deduced from Listowsky's empirical rule. Recent INDO and CNDO calculations indicate a satisfactory agreement between calculation and experiment for lactic acid assuming the occurence of conformers similar to I, II and III.[17]

The CD data of the amino acid esters can be rationalized in the following way:

At room temperature conformations II and III occur, giving rise to a positive band at ~210 nm (III) and a negative band at ~240 nm (II). In aromatic compounds transitions from the aromatic chromophore are involved, making the situation less clear.

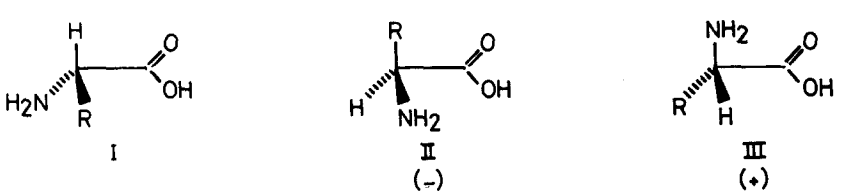
At low temperature the conformational equilibrium shifts to III, i. e. completely for compounds **1**, **2**, **3** and **6** and partly for compounds **5** and **7**. Apparently, conformation II is more stable when R is alkyl i. e. there seems to be a relation with the size of R.

Proline and methionine are special cases. In proline, the ring imposes extra constraints on the conformational freedom. In methionine, one of the transitions involves the sulphide chromophore absorbing at ~240 nm.[18,19] The residual CD intensity at − 185° at 240 nm arises from this band.

Our experimental data are explained using the conventional picture of conformational equilibria and there is no need to invoke new concepts, such as a charge-transfer transition. There are even strong arguments against such an approach:

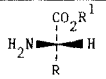
A charge-transfer band would not disappear at low temperature;

Also in α-Me substituted acids the two bands at 210



Scheme 1.

Table 1. CD data of some α-amino acid esters



S(+)

Compound	R	R^1	Methanol 25°C		EPA 25°C		EPA -185°C*	
			λ(nm)	Δε	λ(nm)	Δε	λ(nm)	λε
1	$-CH_2C_6H_5$	$-C_2H_5$	264		266		267	+0.098
			257		259		259	+0.098
			252		253		254	+0.052
			247	-0.035	246	-0.056		
							221 sh	+4.150
			217	+3.503	219	+2.90	216	+5.270
2	$-CH_2C_6H_5OH$	$-C_2H_5$					286	+0.854
					276	+0.136	278	+1.105
					245	-0.173		
					229	+2.812	230	+3.373
					210	+1.209	209	+2.556
3	$-(CH_2)_2CO_2C_2H_5$	$-C_2H_5$			243	-0.087		
					210	+1.926	213	+2.896
4	Proline	$-C_2H_5$			236	-0.241	No clear	
					203	+0.888	maximum	
5	$-CH_3$	$-C_2H_5$	236	-0.131	236	-0.202	244	-0.023
			206	+0.757	207	+0.877	213	+1.284
6	$-CH(CH_3)_2$	$-C_2H_5$	248	-0.009	249	-0.020		
			213	+1.913	213	+2.341	215	+2.810
7	$-CH_2CH(CH_3)_2$	$-C_2H_5$	243	-0.037	242	-0.087	248	-0.004
			211	+1.461	212	+1.658	215	+2.477
			205	+1.332				
8	$-(CH_2)_2SCH_3$	$-CH_3$	236	-0.231	237	-0.205	235	-0.102
			206	+1.983	208	+2.210	211	+2.258

*A shrinkage factor of 0.71 (20) has been taken into account.

and 240 nm are found,[14] with a similar temperature dependency.

The dependency of the 240 nm band on the nucleophilicity of the hetero atom, as argued by Polonski, may well be rationalized in terms of conformational equilibria. Also in acidic media conformer III may well be more stable, thus explaining the disappearance of II.

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