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Odd-Even Effect in the Optical Resolution by Optically Active Polyamides Having (-)-Anti Head-to-head Coumarin Dimer Component

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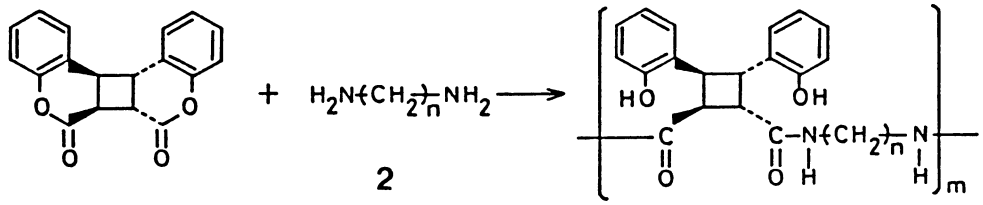
Optically active polyamides were synthesized by ring-opening polyaddition reaction of (-)-anti head-to-head coumarin dimer with H_2N-$(CH_2)_n$-NH_2 (n=2-10). The polyamides show high optical resolution ability to racemates containing an aromatic group(s) when n is even number of 6 and over, while no resolution could be achieved when n is odd number.

Optically active polyamides,[1] derived from (-)-anti head-to-head coumarin dimer[2] and diamines, have been found to be efficient chiral stationary phases for high-performance liquid chromatographic resolution depending on the structure of the diamine component.[3] Among these polyamides, the polyamide, derived from 1,6-hexanediamine, showed excellent chiral recognition ability to racemates containing an aromatic group on the basis of simultaneous interactions.[3] In order to elucidate the role of the 1,6-hexanediamine residue for the resolution, a series of homologous polyamides were synthesized from (-)-anti head-to-head coumarin dimer and α,β-alkanediamine (H_2N-$(CH_2)_n$-NH_2; n=2-10), and their chiral recognition ability was evaluated. Here we wish to report an unprecedented odd-even effect of the diamine residue of the polyamides in the optical resolution.

Polyamides (**3**) were synthesized by the ring-opening polyaddition reaction of (-)-anti head-to-head coumarin dimer [(-)-**1**] with α,β-alkanediamine (n=2-10) (**2**) as reported in the previous paper.[1] The obtained polyamides were all identified by ^1H NMR and IR spectra. As expected from the high reactivity of

the lactone rings in (-)-**1**, optically active linear polyamides (**3**) with inherent viscosity between 0.28 to 0.88 (3.0 g dm^{-3} in N,N-dimethylacetamide (DMAc) or N-methylpyrrolidone (NMP)) were easily obtained by the ring-opening polyaddition reaction. All the polyamides have little solubility in nonpolar and protic polar solvents, but can be dissolved in aprotic polar solvents and aqueous alkaline solutions [except for the polyamide derived from $H_2N-(CH_2)_{10}-NH_2$].

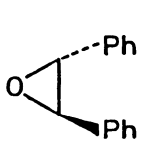


(–)-**1** **2** n=2–10 **3**

Macroporous silica gel,[4] pretreated with diphenylsilane coupler, was coated with about 25 wt% of the polyamide in DMAc or NMP. Thus obtained silica gel was then packed in a stainless steel column [25 cm x 0.46 (id) cm] by the slurry method. The resolution was accomplished with a Shimadzu LC-5A liquid chromatograph apparatus equipped with a Shimadzu SPD-2A UV detector at room temperature using 2-propanol/hexane (10/90 v/v) as an eluent at the flow rate of 0.50 ml min^{-1}. The chromatographic parameters for the resolution of racemates (**4-8**) using the silica gel columns coated with the polyamides **3** (n=5-10) are summarized in Table 1.

The polyamides **3** (n=2-4) showed no resolution ability to all of the racemates. The decrease of the number of the methylenes in the diamine residue would increase the repulsion between the functional groups nearby the cyclobutane ring, i.e. would result in more restricted conformation to afford disadvantage for simultaneous interactions.[3,5] For the appearance of the chiral recognition ability by these polyamides, sufficient conformational flexibility seems to be essential in the formation of diastereomeric intermediates with the solutes.

The chiral recognition ability of the polyamides **3** (n=5-10) was highly dependent on the number of the methylenes in the diamine component. Namely, distinct odd-even effect was observed in the chiral recognition by these polyamides. The polyamides with the methylenes of even number in the diamine residue showed high resolution ability (separation factor α is larger than 1.10)



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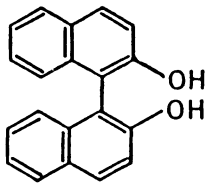

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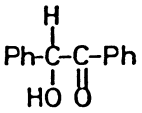

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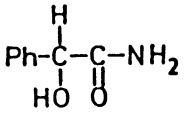

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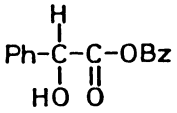

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Table 1. Resolution of Racemates (**4-8**) on Polyamide-coated Silica Gel Columns[a)]

n =	5[b)]	6			7[b)]	8			9[b)]	10		
	k'_1[c)]	k'_1	α[d)]	Rs[e)]	k'_1	k'_1	α	Rs	k'_1	k'_1	α	Rs
4	0.71	0.40	1.42	0.92	0.70	0.65	1.19	0.85	0.67	0.53	1	NR[f)]
5	8.12	5.59	1.29	0.88	8.84	4.86	1.19	0.60	4.64	6.19	1.36	3.51
6	2.96	1.91	1.43	1.45	3.90	2.26	1.27	0.96	2.39	2.38	2.14	14.70
7	2.12	1.60	1.10	0.60	2.70	1.88	1.12	0.60	1.75	2.46	1.09	0.60
8	5.00	4.36	1.17	0.60	3.55	7.72	1	PR[g)]	5.40	7.79	1.30	0.92

a) Column: 25 cm x 0.46 (id) cm. Eluent: 2-propanol/hexane (10/90 v/v). Flow rate: 0.50 ml min^{-1} at room temperature. b) Showed no resolution ability to all of the racemates (α = 1 and Rs = no resolution). c) k'_1 (capacity factor of less retained enantiomer) = (retention time of less retained enantiomer - dead time)/dead time (6.0 min). d) α (separation factor) = (capacity factor of more retained enantiomer)/k'_1. e) Resolution factor = 2 x (difference of retention times of more and less retained enantiomers)/(sum of the band width of the two enantiomer peaks). f) No resolution. g) Partial resolution.

for the racemates, while those of odd number showed no ability to all of the racemates.

The chiral discrimination of these polyamides would involve the simultaneous interactions of aromatic stacking and hydrogen-bonding with the solutes as considered for the polyamide **3** (n=6).[3,5] Moreover, the discrimination should be attributable to the difference in the conformations of the polyamides **3**. But, no distinct difference was obsereved in IR, UV, CD, and PA (photoacoustic) spectra of the polyamide films and of the polyamide-coated silica gels, and the reason for the odd-even effect is not clear yet.

Further investigation on the elucidation of odd-even discrimination is in progress.

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3) K. Saigo, Y. Chen, N. Yonezawa, K. Tachibana, T. Kanoe, and M. Hasegawa, Chem. Lett., 1985, 1891; Y. Chen, K. Saigo, N. Yonezawa, K. Tachibana, T. Kanoe, and M. Hasegawa, Bull. Chem. Soc. Jpn., 60, 3341 (1987).

4) Macroporous spherical silica gel has 10 mm of mean particle size with 100 nm of mean pore diameter and 20000 $m^2\ kg^{-1}$ of specific surface area.

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