Formation of a Specific Co-ordination Cavity for a Chiral Amino Acid by Template Synthesis of a Polymer Schiff Base Cobalt(III) Complex

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A template polymer complex, which incorporates *N*-benzyl-D-valine with almost 100% stereospecificity, was synthesised by copolymerization of Δ-β_2-[Co{(*R,R*)-*N,N'*-bis[4-(*p*-vinylbenzyloxy)salicylidene]-1,2-diaminocyclohexane}(*N*-benzyl-D-valine)] (**3**), styrene, and divinylbenzene, followed by dissociation of the co-ordinated amino acid.

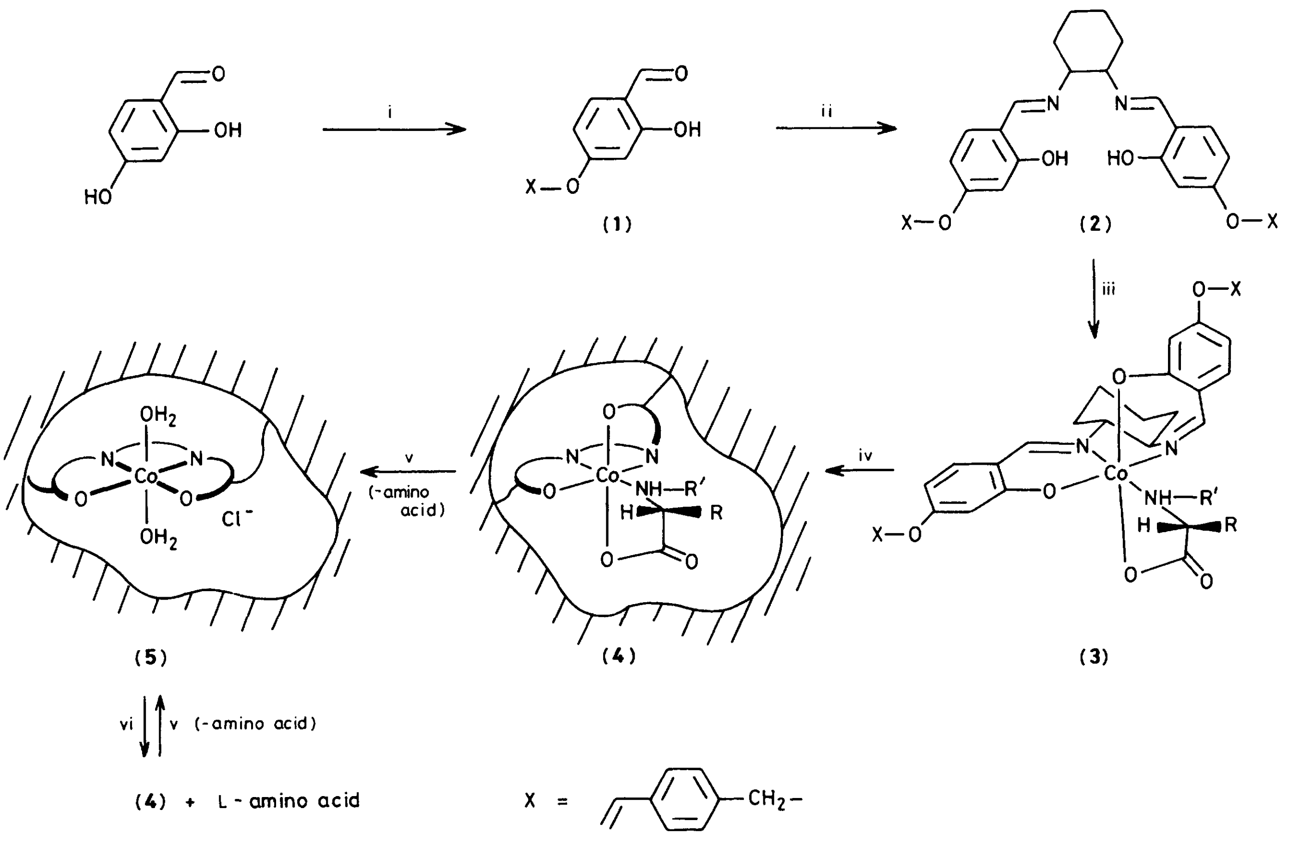
Template synthesis of macromolecules is an attractive method for preparing active sites and/or specific cavities in the field of biomimetic and separation chemistry.[1] We have applied the template synthesis method to a Co^{III}–Schiff base complex with *N*-benzyl-D-valine and succeeded in forming a polymer complex which discriminates between the stereoisomers of this *N*-benzyl-amino acid with high stereospecificity.

The preparative method is shown in Scheme 1. 4-(*p*-Vinylbenzyloxy)salicylaldehyde (**1**) was prepared from 4-hydroxysalicylaldehyde and *p*-chloromethylstyrene in about 40% yield,[2] and treatment with (1*R*,2*R*)-1,2-diamino cyclohexane[3] gave the Schiff base ligand (**2**) (90%). The mixed

Table 1. Optical yield of the recovered amino acid (a.a.) *N*-benzylvaline.

Complex	Optical purity/% Reacted (D-a.a.)	Optical purity/% Unreacted (L-a.a.)	Mol ratio reacted: unreacted a.a.	K^a	$\Delta G°$ kJ mol^{-1}
Template polymer complex (**5**)	99.5	26.2	3.80	682	16.2
Non-template polymer complex^b	86.5	14.5	5.97	18.5	7.2
trans-$[Co(\mathbf{2})(H_2O)_2]Cl$	88.2	21.8	4.05	24.8	8.0

[a] K = {[Co(D-a.a.)][L-a.a.H]}/{[Co(L-a.a.)] [D-a.a.H]}. [b] Prepared by copolymerization to Schiff base (**2**) with styrene and divinylbenzene (mol fraction 1 : 20 : 4) in THF followed by reaction with $CoCl_2$ under air oxidation conditions.



R = Pr^i, R′ = CH_2Ph

Scheme 1. *Reagents:* i, *p*-chloromethylstyrene, NaOH; ii (1*R*,2*R*)-1,2-diaminocyclohexane; iii, $Co(OAc)_2$, *N*-benzyl-D-valine, O_2; iv, styrene, divinylbenzene; v, 3 M HCl; vi, *N*-benzyl-D,L-valine.

ligand Co^{III} complex (**3**) was synthesized from $Co(OAc)_2$, ligand (**2**), and *N*-benzyl-D-valine under air oxidation conditions[4,5] (90%). The Δ-β_2-structure of the complex was confirmed by its electronic and c.d. spectra.[5,6] Complex (**3**) was then copolymerized with styrene and divinylbenzene (mol fraction 1 : 20 : 4) in tetrahydrofuran (THF) at about 60 °C for one day using azoisobutyronitrile as initiator. The green polymer complex (**4**) thus formed (70% yield) is insoluble in tetrahydrofuran (THF), $CHCl_3$, MeOH, *etc.*, whereas (**3**) (green) is soluble in organic solvents. Complex (**4**) was treated with 3 M HCl in MeOH to produce (**5**) quantitatively. Complex (**5**) is brown and insoluble in organic solvents. Its reflectance spectrum (300—1000 nm) closely resembled that of the corresponding *N*,*N*′-bis(salicylidene)ethylenediaminediaqua complex.[7] When (**5**) (about 200 mesh) was treated with an excess of racemic *N*-benzylvaline in MeOH–$CHCl_3$ (1 : 1 v/v), it became green within a few hours affording (**4**), with incorporation of ~1.2 × 10^{-4} mol of amino acid per g of (**5**). On treatment with 3 M HCl complex (**5**) and free *N*-benzylvaline were recovered, with the optical purity given in Table 1.

In order to evaluate the template effect, the chiral recognition of the *trans*-$[Co(\mathbf{2})(H_2O)_2]Cl$[5,7] complex itself and also the non-template polymer Schiff base complex, prepared without *N*-benzyl-D-valine co-ordination was tested by the method used for (**5**), as the Co–(**2**) complex itself can discriminate between the chirality of amino acids to some extent.[4,5] The results are given in Table 1. The chiral discrimination of the template polymer complex (**5**) reaches almost 100% and is higher than that of *trans*-$[Co(\mathbf{2})(H_2O)_2]Cl$

and the non-template polymer complex by at least 8.0 kJ mol^{-1} in ΔG° value. These results then, clearly indicate that the template effect operates quite effectively in this system.

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References

1 K. J. Shea, E. A. Thompson, S. D. Pandy, and P. S. Beauchamp, *J. Am. Chem. Soc.*, 1980, **102**, 3149; G. Wulff, A. Sarhan, and K. Zabrochi, *Tetrahedron Lett.*, 1973, **44**, 4329; G. Wulff and W. Verper, *J. Chromatogr.*, 1978, **167**, 171; G. Wulff, R. Kemmerer, J. Vietmeier, and H. G. Poll, *Nouv. J. Chim.*, 1982, **6**, 681; S. N. Gupta and D. C. Neckers, *J. Polym. Sci., Polym. Chem. Ed.*, 1982, **20**, 1609.

2 J. Daly, L. Horner, and B. Witkop, *J. Am. Chem. Soc.*, 1961, **83**, 4787.

3 R. G. Asperger and C. F. Liu, *Inorg. Chem.*, 1965, **4**, 1492.

4 Y. Fujii, M. Sano, and Y. Nakano, *Bull. Chem. Soc. Jpn.*, 1977, **50**, 2609.

5 Y. Fujii, M. Matsufuru, A. Saito, and S. Tsuchiya, *Bull. Chem. Soc. Jpn.*, 1981, **54**, 2029.

6 Y. Kushi, T. Tada, Y. Fujii, and H. Yoneda, *Bull. Chem. Soc. Jpn.*, 1982, **55**, 1834.

7 A. Bigotto, G. Costa, G. Mestroni, G. Pellizer, A. Puxeddu, E. Reisenhofer, L. Stefani, and G. Tauzher, *Inorg. Chim. Acta*, 1970, **4**, 41.