Effect of Cathodic Potential on the Electrochemical Synthesis of Optically Active Amino-acids

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Summary In acetate buffer solution, in the presence of strychnine, the electroreduction of phenylglyoxylic acid oxime leads to optically active phenylglycine, the absolute configuration of which depends on the cathodic potential used.

WE report that the absolute configuration of amino-acids, synthesised by cathodic reduction of oximes in the presence of alkaloids,† is dependent on the cathodic potential used; the stereochemical course of the reduction is reversed when the potential is changed.

The two isomers of phenylglyoxylic acid oxime[1] were reduced potentiostatically at a mercury cathode in aqueous acetate buffer solution containing a small amount of strychnine as supporting electrolyte. The four-electron reduction of the oxime (*syn* or *anti* isomer) leads quantitatively to an optically active mixture of the enantiomers of phenylglycine [equation (1)] the absolute configuration

$$\mathrm{PhC({=}NOH)CO_2H} \xrightarrow[\text{strychnine}]{4e,\ 4H^+} \mathrm{Ph\overset{*}{C}H(NH_2)CO_2H} \qquad (1)$$

of which depends on the electrode potential (Table).

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† Alkaloids have been used as inductors in some electrochemical reductions: J. Hermolin, J. Kopilov, and E. Gileadi, *J. Electroanalyt. Chem.*, 1976, **71**, 245, and references cited therein.

TABLE. Cathodic reduction of the *anti*-isomer[a] of PhC(=NOH)-CO_2H ($2 \cdot 42 \times 10^{-2}$ M) in acetate buffer (pH 4·7) in the presence of strychnine ($1 \cdot 6 \times 10^{-4}$ M) and the effect of cathodic potential on the optical yield of (−)-(*R*)- or (+)-(*S*)-phenylglycine.

Potential/V (*vs.* S.C.E.)	Absolute configuration of phenylglycine	Optical yield/%
−0·950	*R*	17·1
−1·050	*R*	11·7
−1·100	*R*	6·9
−1·140	—	0·0
−1·200	*S*	4·1
−1·300	*S*	10·1
−1·350	*S*	11·1

[a] The *syn*-isomer behaves similarly.

Many parameters[2,3] can influence optical yield and eventually reverse the preferential configuration of the product. Some of these may be affected by the electrode potential. It is therefore difficult to interpret our results satisfactorily. Nevertheless, protonation of the intermediate chiral carbanion (A) or (B)[4] is a determining factor in the stereochemical course of the reduction. Thus we were able to interpret our results on the basis of our recently

$$\underset{(A)}{Ph\bar{C}(NHOH)CO_2H} \qquad \underset{(B)}{Ph\bar{C}(NH_2)CO_2H}$$

postulated hypothesis[3] concerning competition at the electrode surface between the inversion of the carbanion and its protonation in the initial configuration.

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[1] J. Armand and J. P. Guette, *Bull. Soc. chim. France*, 1969, 2894.

[2] M. Jubault, E. Raoult, and D. Peltier, *Electrochim. Acta*, 1974, **19**, 865.

[3] M. Jubault, E. Raoult, and D. Peltier, *Electrochim. Acta*, 1977, **22**, 67.

[4] H. Lund (*Acta Chem. Scand.*, 1959, **13**, 249) has postulated that oximes are reduced to amines *via* the imines intermediates. In this hypothesis, only the carbanion (B) has to be considered.