Anodic Oxidation of *N*-Alkyl-lactams

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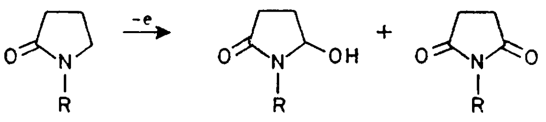
Summary The anodic oxidation of *N*-alkyl-lactams occurred regioselectively at the endocyclic carbon atom α to nitrogen in five- and six-membered rings, and at the exocyclic α-carbon atom in seven-membered rings to provide hydroxy-lactams, imides, and dealkylation products.

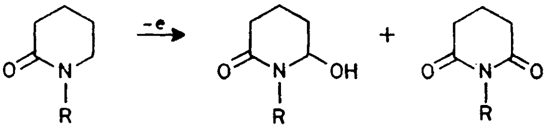
Recent publications on the anodic oxidation of *N*-acylazacycloalkanes[1] and other related compounds[2–5] mostly concerned with alkoxylation at the carbon atom α to nitrogen, prompts us to report our results on the electrochemical oxidation of *N*-alkyl-lactams, which provided the α-hydroxylated compound as the major product along with the corresponding imide by further oxidation at the same position.

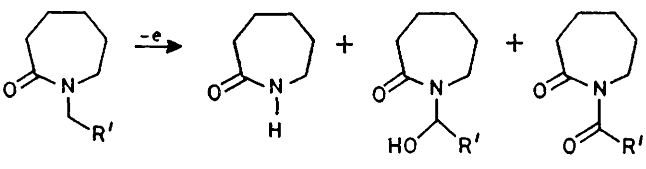
It is particularly noteworthy that the regioselectivity of oxidation in our case is dependent upon the size of the rings of the substrate. With five- and six-membered rings, on controlled potential electrolysis, oxidation occurred at the endocyclic carbon atom α to nitrogen, whereas with seven-membered rings, oxidation proceeded at the exocyclic α-carbon atom (Table). Thus, with 1-methyl-pyrrolidinone (**1a**) and -piperidinone (**4a**), the main products were the hydroxylactams (**2a**) and (**5a**), respectively; the corresponding imides (**3a**) and (**6a**) were also obtained. In marked contrast, 1-methyl-ε-caprolactam (**7a**) was electrochemically oxidized at the α-carbon atom of the alkyl group attached to nitrogen, affording 1-hydroxymethylcaprolactam (**9a**), 1-formylcaprolactam (**10a**), and ε-caprolactam (**8**); the latter might be produced from (**9a**) by loss of HCHO.† The general procedure for these anodic oxidations is as follows.

Table. Anodic oxidation by controlled potential electrolysis.

Compound	Potential/V	F/mol	Product	(% yield)
(**1a**)	2·2	2·3	(**2a**) (**3a**)	(54·6) (11·7)
(**1b**)	2·0	2·1	(**2b**) (**3b**)	(56·7) (2·1)
(**4a**)	2·2	2·6	(**5a**) (**6a**)	(64·3) (10·1)
(**4b**)	2·0	2·1	(**5b**) (**6b**)	(47·3) (9·1)
(**7a**)	2·4	3·1	(**8**) (**9a**) (**10a**)	(17·3) (35·0) (21·2)
(**7b**)	2·3	2·7	(**8**) (**10b**)	(55·8) (3·1)


(**1**) (**2**) (**3**)


(**4**) (**5**) (**6**)


(**7**) (**8**) (**9**) (**10**)

a; R = Me, R′ = H
b; R = Et, R′ = Me

A mixture of the lactam (7 mmol), Et_4NBF_4 (14 mmol) as supporting electrolyte, acetonitrile (40 ml), and water (1·2 ml) was electrolysed in an undivided 50 ml cell, with a saturated calomel electrode (SCE) as reference, a platinum plate (10 × 25 mm) as anode and with a platinum cathode. Current was passed at room temperature with a potential of 2·0—2·4 V *vs.* SCE. After about 2—3 F/mol had been passed, solvent was removed under reduced pressure to leave a residue which was chromatographed on alumina to afford the products.

Tetraethylammonium fluoroborate (Et_4NBF_4)[6] was preferable to $Et_4NOSO_2C_6H_4Me$-*p* as supporting electrolyte under these conditions. Also, constant current electrolysis seems to be preferable to the controlled potential method.

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† For other examples, see Table. 1-Ethyl-ε-caprolactam (**7b**) gave ε-caprolactam (**8**) as the major product in high yield on anodic oxidation; this must have been generated from (**9b**) by loss of MeCHO.

[1] M. Mitzlaff, K. Warning, and H. Jensen, *Annalen*, 1978, 1713; *cf.* M. Mitzlaff, D.O.S. 2557,765(1977) (*Chem. Abs.*, 1977, **87**, 134,997k).
[2] M. Finkelstein and S. D. Ross, *Tetrahedron*, 1972, **28**, 4497; E. J. Rudd, M. Finkelstein, and S. D. Ross, *J. Org. Chem.*, 1972, **37**, 1763; S. D. Ross, M. Finkelstein, and R. C. Petersen, *J. Amer. Chem. Soc.*, 1966, **88**, 4657.
[3] T. Shono, H. Hamaguchi, and Y. Matsumura, *J. Amer. Chem. Soc.*, 1975, **97**, 4264.
[4] K. Nyberg and R. Servin, *Acta Chem. Scand.* (*B*), 1976, **30**, 640.
[5] L. Cedheim, L. Eberson, B. Helgee, R. Servin, and H. Sternerup, *Acta Chem. Scand.* (*B*), 1975, **29**, 617.
[6] N. S. Moe, *Acta Chem. Scand.*, 1965, **19**, 1023.