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REDUCTION OF α-HALOGENATED IMINES
SYNTHESIS OF PYRROLES AND AZIRIDINES

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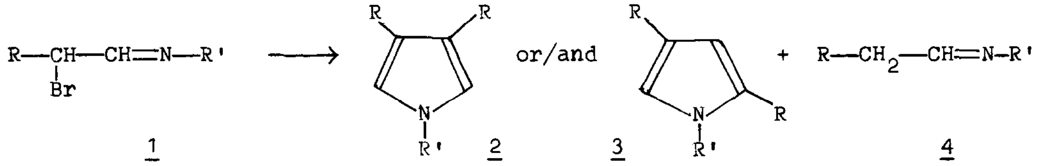
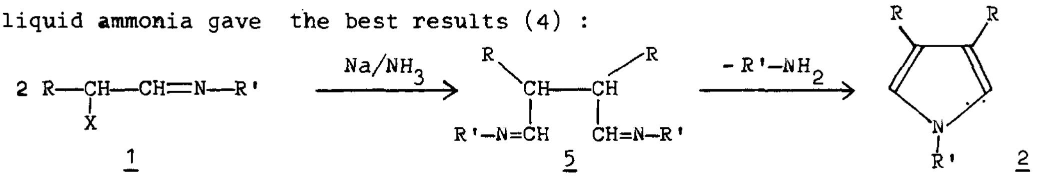
We have recently demonstrated that the reactions of metals such as lithium or magnesium with α-halogenated imines 1 yield the isomeric pyrroles 2 and 3 . By varying the nature of the metal and the solvent, the reaction can be directed toward either isomer (1,2,3). In all cases, the isomeric pyrroles 2 and 3 are accompanied by varying quantities of imine 4 . The imines 4, which are easily separated by distillation, are formed by reduction.



The formation of the pyrroles 2 by a radical mechanism has been suggested by us (2). This hypothesis has led us to study the effects of the dissolving metals. This new procedure has the advantage of selectivity : producing only pyrroles 2 to the exclusion of pyrroles 3 . The use of sodium in liquid ammonia gave the best results (4) :



In general, this reaction yields pyrroles 2 directly (table I).

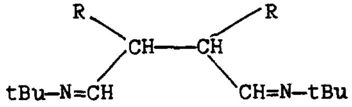
However, with certain examples, we were able to isolate the intermediate succinic di-imines (5g),or identify them in the reaction mixtures (5h) (table II). Their cyclisation into pyrroles 2 is induced by heat. Study of other chemically properties of these di-imines, is in progress.

TABLE I SYNTHESIS OF PYRROLES 2 (5)

	α-HALOGENATED IMINES 1			PYRROLES 2				
						NMR CDCl$_3$, TMS		
	R'	R	X	bp, °C/mmHg	Yield %	R	R'	=C–H
1a	tC_4H_9	CH_3	Cl	70-71/15	31	2,05 (s)	1,5 (s)	6,6
1b	-	C_2H_5	Cl	65-68/0,7	38	1,15 (t) 2,3 (q)	1,35 (s)	6,4
1c		-	Br	-	44	-	-	-
1d	iC_3H_7	iC_3H_7	Br	65-68/0,4	48	1,2 (d) 2,85 (q)	4,1 (q) 1,4 (d)	6,5
1e	tC_4H_9	-	Br	77-80/0,7	32	1,2 (d) 2,85 (sex)	1,45 (s)	6,55
1f	-	nC_4H_9	Cl	110-115/0,8	31		1,45 (s)	6,55
1g	-	tC_4H_9	Br	79-80/0,5	75	1,4 (s)	1,48 (s)	6,65
1h	-	nC_5H_{11}	-	108-109/0,35	53		1,48 (s)	6,5
1i	-	néo C_5H_{11}	-	92-95/0,8	34	0,9 (s)	1,45 (s) 2,3 (s)	6,5

TABLE II

DI-IMINES 5

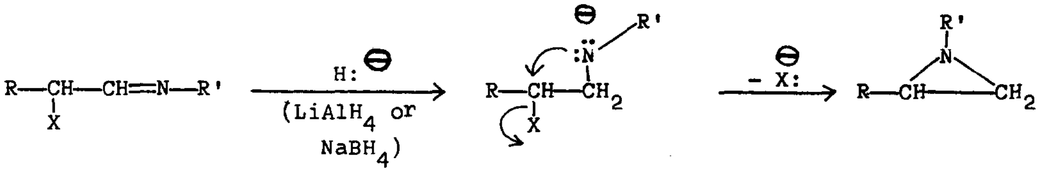


R	mp, °C	Yield, %	N M R CDCl$_3$, TMS	
			–CH=N–	–CH
tC_4H_9 *	114	35	7,62(d);7,66(d) J= 5 Hz	2,53(d);2,57(d) J= 5 Hz
		*** 38	7,7 (d) J=8,5 Hz	2,3 (d) J=8,5 Hz
nC_5H_{11} **		*** 53	7,4 (d);7,35(d) J= 5 Hz	2,4 (m)

* the two isomers are separated.
** the two isomers are not separated.
*** yields are given as distilled pyrroles.

We obtained analogous results with sodium-naphtalene prepared according to reference (6), but this procedure is less convenient because of the presence of the resulting naphtalene. With solutions of lithium, or potassium in hexamethylphosphoramide, prepared according to reference (7), a significant quantity of by-products result.

In addition to the dissolving metals, we have used some mixed metal hydrides as reducing agents. The products formed are different : instead of pyrroles, aziridines 6 are obtained (table III) :



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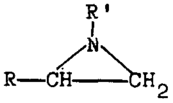
The isolation of aziridine 6 lend support to the proposal of Picot and Lusinchi (8), and is analogous to the formation of aziridines by the reduction of α-halogenated nitriles with LiAlH$_4$ (9).

TABLE III SYNTHESIS OF AZIRIDINES 6 (10)

HALOGENATED IMINES 1			AZIRIDINES 6 		
R	R'	X	Yield, %	bp, °C/mmHg	IR cm^{-1}
C_2H_5	$-CH_2-CH=CH_2$	Cl	55	116-118/760	3050-3080 1650
-	c C_6H_{11}	Br	44	98/42	3040
- *	tC_4H_9	Br	60	118-119/760	3050
iC_3H_7	tC_4H_9	Br	47	41-42/16	3050
tC_4H_9	CH_3	Br	48	80-82/760	3060

* the reduction by NaBH$_4$/EtOH gives the same result.

NOTES

(1) J.Y. VALNOT, Thesis of 3th cycle, Rouen, May 1971.

(2) P. DUHAMEL, L. DUHAMEL and J.Y. VALNOT, Tetrahedron Letters, 1973, 1339.

(3) L. DUHAMEL, P. DUHAMEL and J.Y. VALNOT, C.R.Acad.Sci., 1974, 278C, 141.

(4) The proportions of imine by reduction 4 accompanying di-imine 5 or pyrrole 2 vary between 10 and 30 %.

(5) 0,1 mole of α-halo-imine 1 diluted in his volume of ether was added to 125 ml of anhydrous liquid ammonia. The solution was vigorously stirred and 0,11 g-atom of sodium was added slowly, in little pieces. The reaction mixture was neutralized by adding 5 g of NH_4Cl. The ammonia was evaporated and pentane was added. After filtration the pentane was evaporated (the formation of the di-imine appeared by working at a low temperature during the final steps).

(6) H. NORMANT and B. ANGELO, Bull.Soc.Chim., 1960, 354.

(7) T. CUVIGNY, J. NORMANT and H. NORMANT, C.R.Acad.Sci., 1964, 258, 3503.

(8) A. PICOT and X. LUSINCHI, Tetrahedron Letters, 1974, 679.

(9) K. ICHIMURA and M. OHTA, Angew.Chem. Int.Ed., 1968, 7, 149.

(10) To a vigorously stirred suspension of 0,4 g of $LiAlH_4$ in 15 ml of anhydrous ether, was added at 0°C, 0,01 mole of α-halo-imine 1 in 20 ml of anhydrous ether. After one night at room temperature, the reaction mixture was hydrolysed by a saturated sodium hydroxide solution, extracted with two 50 ml portions of ether. The ethereal layer was washed with 50 ml of water, dried and distilled.