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CONDENSATION OF CF_2Br_2, CF_2BrCl AND $BrCF_2CF_2Br$ WITH ENAMINES AND YNAMINES

I. RICO, D. CANTACUZENE and C. WAKSELMAN*

C.N.R.S.-C.E.R.C.O.A. 2 à 8, rue H. Dunant 94320 THIAIS, France

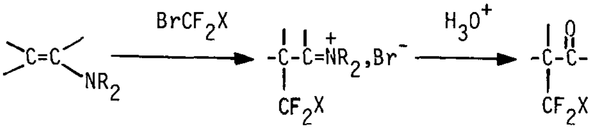
SUMMARY : *$BrCF_2X$ (X : Cl, Br, $BrCF_2$) react with enamines and ynamines. A radical chain mechanism is proposed. Halogen (Br or Cl) - fluorine exchange of α halodifluoromethylketones to α trifluoromethylketones using $Bu_4\overset{+}{N},F^-$, $3H_2O$ is examined.*

Recently (1) we showed that the condensation of CF_2Br_2 or CF_2BrCl with different phenoxides and thiophenoxides gives O or S alkylated products ($ArOCF_2X$ or $ArSCF_2X$, X=H,Br). An ionic chain mechanism was postulated involving the difluorocarbene.

Other reactions of CF_2Br_2 are known to involve a radical mechanism like its addition to enol ethers under UV irradiation (2). On the other hand, we showed that perfluoroalkyliodides (R_FI) react spontaneously with enamines ; the reaction proceeds through a radical chain mechanism (3).

In this paper, we study the reactivity of the perhaloalkanes CF_2Br_2, CF_2BrCl and $BrCF_2CF_2Br$ with unsaturated nitrogen compounds and we compare it with the reactivity of perfluoroalkyliodides with the same substrates.

Enamines like 1-pyrrolidinocyclohexene condense rapidly with the perhaloalkanes $BrCF_2X$ (X : Br, Cl, CF_2Br), in pentane solution, without irradiation or initiation, affording, after hydrolysis, the corresponding α perhaloalkylcyclohexanones (Table I). The reactivity of $BrCF_2X$ is very similar to the one observed in the condensation of R_FI with enamines.



1 2 3

(X=Br, Cl, CF_2Br)

Ynamines do not react spontaneously with $BrCF_2X$. As with perfluoroalkyliodides, UV irradiation is necessary to perform the condensation of CF_2Br_2 and $BrCF_2CF_2Br$ with 1-diethylaminopropyne in pentane solution. Amides 6 and 8 are obtained after hydrolysis (Table I).

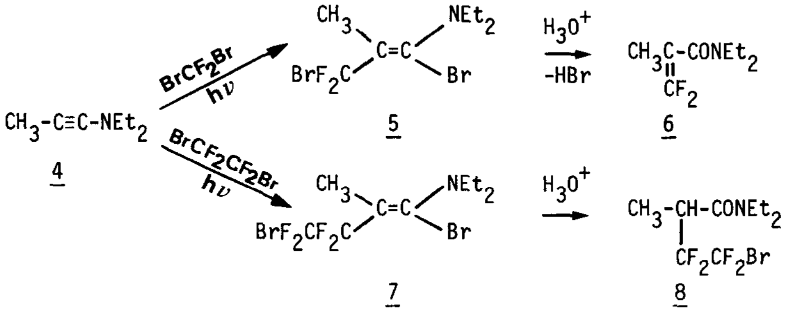
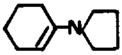
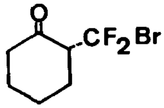
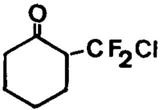
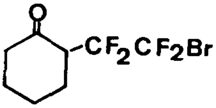
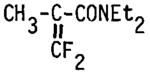
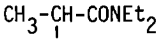


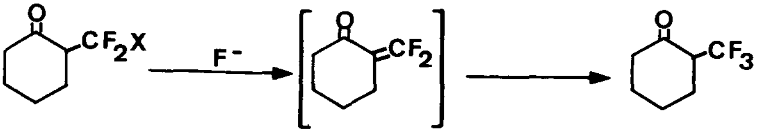
Table I : Condensation of $BrCF_2X$ with enamines and ynamines

Substrate	X	Product[(a)]	Yield %	bp/mmHg	^{F}NMR[(b)]
	Br	**3a** 	40	90°C/15	$\delta CF_2Br=45.8$ JHF=8.3
"	Cl	**3b** 	65	80°C/15	$\delta CF_2Cl=50$ JHF=8.3
"	CF_2Br	**3c** 	40	95°C/15	$\delta CF_2Br=59.5$ $\delta CF_2=104$ JHF=14 JFF=255
$CH_3C\equiv CNEt_2$	Br	6  $CH_3-\underset{\underset{CF_2}{\Vert}}{C}-CONEt_2$	35	45-50°C/0.3	$\delta CF=82.5-89.2$ JFF=30
"	CF_2Br	8  $CH_3-\underset{\underset{CF_2CF_2Br}{\vert}}{CH}-CONEt_2$	60	75-80°C/0.3	$\delta CF_2Br=58.3$ $\delta CF_2=102.5$ JHF=19 JFF=260

(a) : same procedure as in the condensation of R_FI with enamines and ynamines (3).

(b) : F_{NMR} spectra were recorded with a Jeol 60HL instrument with $CDCl_3$ as solvent and $CFCl_3$ as internal standard (chemical shift δ in ppm, coupling constant J in Hz).

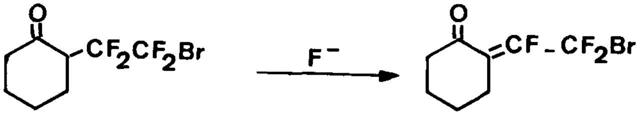
Ketones 3a and 3b are not very stable (4). They decompose partly to α trifluoromethylcyclohexanone 9. This reaction is quantitative if tetrabutylammonium fluoride ($Bu_4\overset{+}{N}F^-$, $3H_2O$) is added to a solution of 3a (or 3b) in THF.



3a,b (85%) **9**

This procedure is a good method for preparing α trifluoromethylketones, much cheaper than the one using CF_3I (3). Bromochlorodifluoromethane (CF_2BrCl) is used industrially as a fire suppressant (5) and is unexpensive.

Ketone 3c is stable when pure. It decomposes partly in the reaction mixture by loosing HF. The decomposition is quantitative if $Bu_4\overset{+}{N}F^-$, $3H_2O$ is used : the unsaturated cyclohexanone 10 is obtained (yield : 40 % - b.p. = 105°C/15) (6).

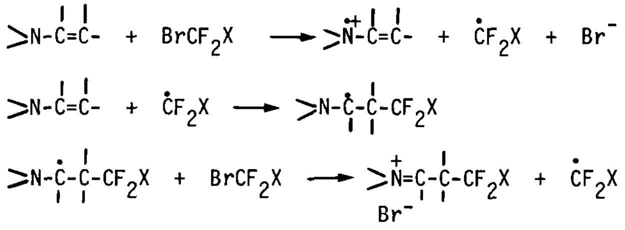


3c **10** **(cis+trans)**

Mechanism

In the case of phenoxides and thiophenoxides, we postulated an ionic mechanism involving the difluorocarbene $:CF_2$. The formation of hydrogenated by-products ($ArOCF_2H$ and $ArSCF_2H$) and the fact that only bromoderivatives ($ArOCF_2Br$ and $ArSCF_2Br$) were obtained from CF_2BrCl were in favor of this mechanism (1).

In the case of enamines, no hydrogenated by-product is observed. Furthermore, CF_2BrCl gives only α chlorodifluoromethyl (CF_2Cl) ketones. As with perfluoroalkyliodides a radical chain mechanism can be postulated, similar to the one proposed by BUNNETT (7) in aromatic substitutions. The fact that the reactions are inhibited by nitrobenzene is in favor of this mechanism.



$$>N-\overset{|}{C}=\overset{|}{C}- \;+\; BrCF_2X \longrightarrow >\overset{\bullet+}{N}-\overset{|}{C}=\overset{|}{C}- \;+\; \dot{C}F_2X \;+\; Br^-$$

$$>N-\overset{|}{C}=\overset{|}{C}- \;+\; \dot{C}F_2X \longrightarrow >N-\underset{|}{\overset{\bullet}{C}}-\underset{|}{\overset{|}{C}}-CF_2X$$

$$>N-\underset{|}{\overset{\bullet}{C}}-\underset{|}{\overset{|}{C}}-CF_2X \;+\; BrCF_2X \longrightarrow \underset{Br^-}{>\overset{+}{N}=\underset{|}{C}}-\underset{|}{\overset{|}{C}}-CF_2X \;+\; \dot{C}F_2X$$

This mechanism is also probably involved with ynamines.

Conclusion

- α Trifluoromethylketones can be prepared easily from bromochlorodifluoromethane which is advantageous compared to the costly iodotrifluoromethane.

- Perhaloalkanes of the type $BrCF_2X$ react with unsaturated nitrogen compounds by a radical chain mechanism, as opposed to the ionic chain mechanism involved with phenoxides and thiophenoxides.

We plan to extend the study of the reactivity of $BrCF_2X$ with other nucleophiles to better understand the orientation towards one or the other mechanism.

References and notes

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