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PRELIMINARY NOTE

Electrophilic Fluorination with N-Fluoroquinuclidinium  
Fluoride

R.E. BANKS,\* R.A. Du BOISSON and E. TSILIOPOULOS

Chemistry Department, The University of Manchester  
Institute of Science and Technology, Manchester M60 1QD  
(U.K.)

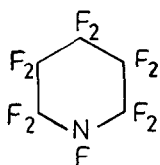
SUMMARY

N-Fluoroquinuclidinium fluoride (NFQNF), obtainable in ca. 90% yield by direct low-temperature liquid-phase fluorination of quinuclidine, has been used to deliver 'positive' fluorine to carbanionic sites in a number of organic substrates.

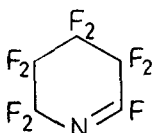
Reagents capable of delivering positive fluorine continue to be sought as interest in the mild, selective fluorination of organic molecules with biological associations mounts [1]. Efforts elsewhere [2] have been

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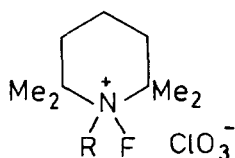
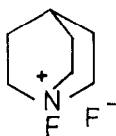
\* To whom enquiries should be addressed.



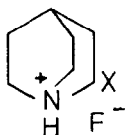
(1)



(2)

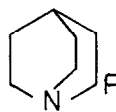
(3) R=C<sub>2</sub>H<sub>5</sub>(4) R=C<sub>4</sub>H<sub>9</sub>

(5)



(6) X=H

(8) X=F



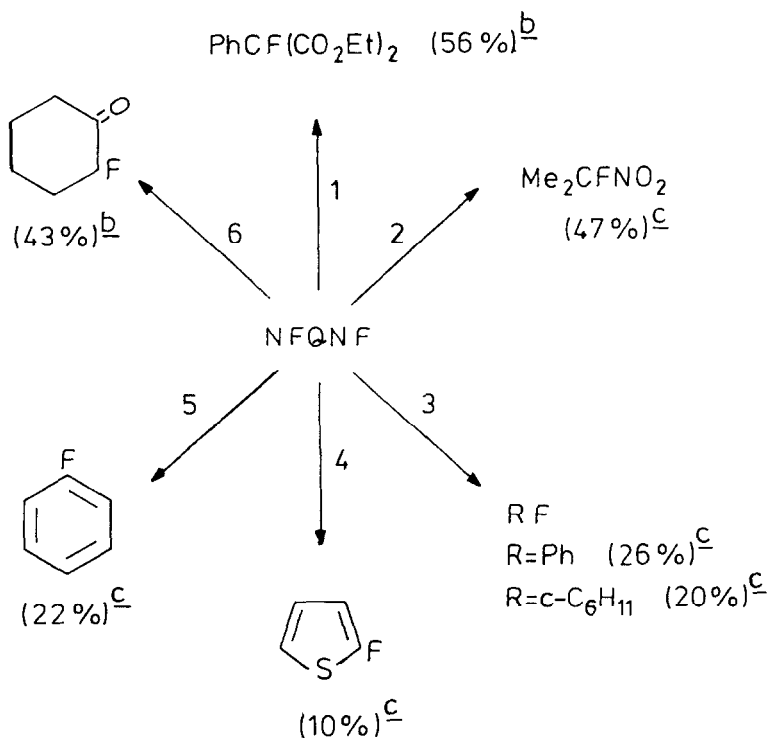
(7)

directed towards the development of electrophilic fluorinating agents of the N-F class analogous to the prototypical Banks reagent, perfluoro-N-fluoropiperidine (1) [3], yet more easily and efficiently prepared [4]. A further drawback to use of 1 is that in action it liberates a powerful competitor (2) for carbanionic substrates [5]. Thus, we have chosen to search for readily isolable, efficiently-made organic N-fluoroammonium compounds capable of effecting site-selective fluorination of carbanionic entities with release of a fairly innocuous tertiary amine. Three possible candidates were identified at the outset: the N-fluoropiperidinium chlorates 3 and 4 [6], and N-fluoroquinuclidinium fluoride (NFQNF) (5) [7], none of which had been reported (or shown [7]) to act as fluorinating agents towards organic substrates. Wishing

to avoid using perchloryl fluoride [8], the reagent needed to make 3 or 4 from the corresponding penta-alkylpiperidines, a study has been made of only NFQNF (5), a salt easily prepared from quinuclidine and fluorine [7].

Developmental work on the reaction of fluorine with quinuclidine has shown that passage of the undiluted halogen into a cold ( $-78^{\circ}\text{C}$ ) solution of the amine in trichlorofluoromethane (1% w/v) provides NFQNF in 89% yield, together with quinuclidinium fluoride(6)(8%) and 2-fluoroquinuclidine (7)(2%) and its hydrofluoride (8)(traces). Raising the fluorination temperature to  $-35^{\circ}\text{C}$  scarcely affects the yield of NFQNF (83%); the yield of quinuclidinium fluoride rises to 13%. The NFQNF precipitates during the reaction and after treatment with hot, dry acetone to remove quinuclidinium fluoride, is obtained as an extremely hygroscopic white solid, m.p.  $126-128^{\circ}\text{C}$  (decomp.), which can be assayed iodometrically (reaction with aqueous acetic KI occurs instantaneously at room temperature). Examples of reactions used to demonstrate that NFQNF acts as an electrophilic fluorinating agent towards appropriate organic substrates are shown in the scheme.

Acceptable values for the C.H and N content of NFQNF have not yet been obtained by combustion analysis owing to the compound's marked hygroscopicity - a property which detracts from its use as a fluorinating agent but



Scheme 2

<sup>a</sup> Yields not optimised. <sup>b</sup> Isolated material. <sup>c</sup> Yield estimated by GLC and NMR.

**REAGENTS :**

1.  $\text{PhC}^-(\text{CO}_2\text{Et})_2 \text{Na}^+$  in THF, -10 to 20 °C;
2.  $\text{Me}_2\text{CNO}_2 \text{Li}^+$  in MeOH, 0 °C; 3.  $\text{RMgX}$  in  $\text{Et}_2\text{O}$  (R= Ph, X = Br; R = c-C<sub>6</sub>H<sub>11</sub>, X = Cl);
4. 2-thienyl-lithium in  $\text{Et}_2\text{O}$ , 0 to 20 °C ;
5.  $\text{PhSiCl}_3$  in THF, -50 to 20 °C;
6.  $\overline{\text{CH}_2\text{CH}_2\text{OCH}_2\text{CH}_2}\text{N}-\overline{\text{CH}=\text{CH}(\text{CH}_2)_3}\text{CH}_2$  in  $\text{CH}_2\text{Cl}_2$  -196 to 20 °C.

hopefully may be absent, or less troublesome, in analogues derived by exchanging the fluoride counter-ion for another anionic species (work in progress). Previously-determined [7]  $^{13}\text{C}$ ,  $^1\text{H}$  and  $^{19}\text{F}$  NMR parameters for NFQNF [20% w/v soln. in  $\text{D}_2\text{O}$ ;  $\delta_{\text{F}}$  ( $\text{CF}_3\text{CO}_2\text{H}$ ) 135.1 (NF), -51.2 ( $\text{F}^-$ ) ppm] have been confirmed, and mass spectrometric data have been obtained (top mass peak has  $m/z$  129.0952 [(M-HF) $^+$ , 64%]; calc. for  $\text{C}_7\text{H}_{12}\text{FN}$ , 129.1334). The mechanism whereby N-fluoroquinuclidinium fluoride acts as a fluorinating agent towards nucleophilic species will be discussed in a full paper.

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