

REPORT DOCUMENTATION PAGE

Form Approved OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.

1. AGENCY USE ONLY (Leave blank)		2. REPORT DATE 20 September 1994	3. REPORT TYPE AND DATES COVERED Final Report	
4. TITLE AND SUBTITLE Report on the Synthesis of a Lubricant Sample and an Extra Sample			5. FUNDING NUMBERS F6170894W0447	
6. AUTHOR(S) Prof Richard D. Chambers				
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) University of Durham South Road Durham DH1 3LE United Kingdom			8. PERFORMING ORGANIZATION REPORT NUMBER N/A	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) EOARD PSC 802 BOX 14 FPO 09499-0200			10. SPONSORING/MONITORING AGENCY REPORT NUMBER SPC 94-4036	
11. SUPPLEMENTARY NOTES				
12a. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution is unlimited.			12b. DISTRIBUTION CODE A	
13. ABSTRACT (Maximum 200 words) This report results from a contract tasking University of Durham as follows: Supply at least one 10-20 g sample of the novel perfluorinated polyether where n-x will have an average value of ca. 18 or greater.				
14. SUBJECT TERMS Nil			15. NUMBER OF PAGES 7	
			16. PRICE CODE N/A	
17. SECURITY CLASSIFICATION OF REPORT UNCLASSIFIED	18. SECURITY CLASSIFICATION OF THIS PAGE UNCLASSIFIED	19. SECURITY CLASSIFICATION OF ABSTRACT UNCLASSIFIED	20. LIMITATION OF ABSTRACT UL	

DTIC QUALITY INSPECTED

19980312 068

Report on the synthesis of a lubricant sample (REF SPC 94-4036)
and an extra sample

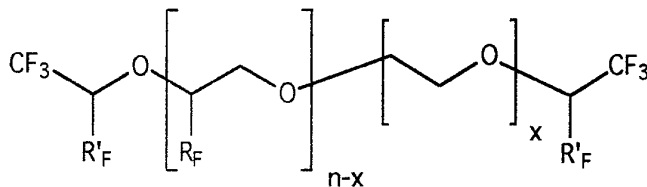
Prof. R.D. Chambers & Dr. M.P. Greenhall, University of Durham, UK.

(This report completes the agreement)

September 20, 1994

Introduction

The objective of this project was to further develop the techniques associated with the preparation of samples of substituted perfluoropolyethers, including the preparation of a 10 to 20 gram sample of perfluoropolyether (1) for lubricant testing by the USAF.



(1)

($n = \text{ca } 45$, $n-x = \text{ca } 26$)
($\text{R}_{\text{F}} = \text{CF}_3\text{CF}_2\text{CF}_2$, $\text{R}'_{\text{F}} = \text{R}_{\text{F}}$ (predom) or F, all unmarked bonds to F)

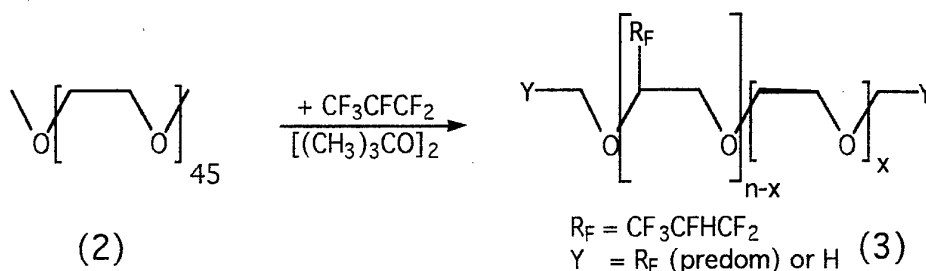
(Note: Chambers, US Patent 4,877,905)

Experimental

a) Starting materials

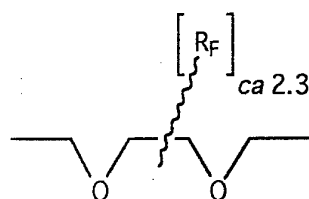
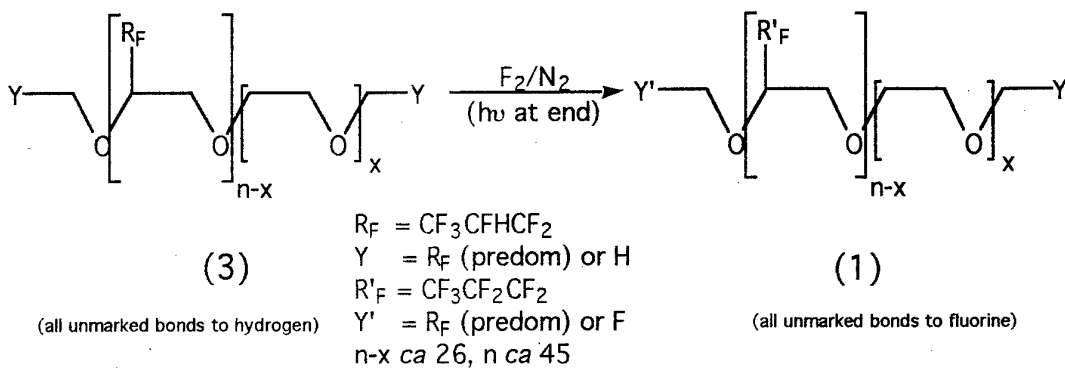
Dimethylpolyethylene glycol(2000) ($n = 45$) was supplied by Merck-Schuchardt, ditertiarybutylperoxide was supplied by Aldrich Chemical Company Limited. Hexafluoropropene was supplied by Fluorochem Limited. 50% Fluorine/Nitrogen mixture was supplied by Air Products.

b) Reaction of Dimethylpolyethylene glycol (2) with hexafluoropropene



Dimethylpolyethyleneglycol(2000) was dried at 140°C under vacuum for a period of 6 hours and was then introduced (457g, 0.225moles), into a one litre stirred autoclave. Ditertiary butyl peroxide (25ml) was also introduced. The stirred autoclave was heated to 80°C and was flushed with nitrogen (three times at a pressure of 20 atmospheres). After evacuation, hexafluoropropene was charged into the autoclave at a pressure of 5 atmospheres. The autoclave was then heated to 140°C and the hexafluoropropene pressure was increased to 20 atmospheres, with stirring. The temperature was maintained between 140-145°C with occasional cooling through water cooling coils for a period of one hour. After cooling, a pale green liquid was withdrawn (882g, after pumping under vacuum for one hour, 857g) which nmr indicated had an average of 13.1 hexafluoroisopropyl groups per molecule. The majority (609g, ca 0.15moles) was reintroduced into the autoclave along with fresh initiator (25ml). After a second reaction an orange oil (869g) was withdrawn. After pumping nmr indicated an average of ca 25.7 hexafluoropropyl units per molecule. A 3rd reaction increased this to about 28 units per molecule.

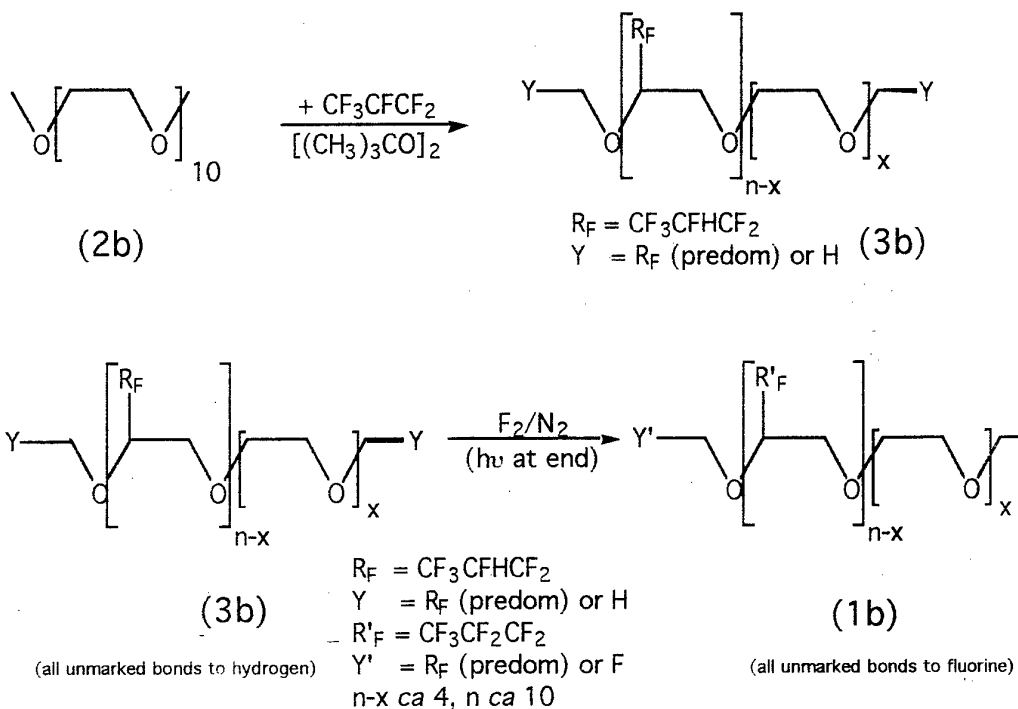
c) Reaction of (3) with fluorine/nitrogen mixtures



(4) (all unmarked bonds to hydrogen)

A solution of (3) (20.7g) in (4) (107.4g) was introduced into a stirred FEP reaction vessel. A F_2/N_2 mixture containing initially 5% F_2 rising to 50% F_2 , was passed into the vessel at room temperature. When the reactivity had decreased the mixture was transferred into an FEP tube through which 50% F_2/N_2 was bubbled. At this time ca 50% of the hydrogen atoms had been replaced by fluorine. Perfluorination was effected by passing 50% F_2/N_2 through the mixture under ultra violet irradiation (100W then 1000W). The volatile, now perfluorinated, solvent (87g) was removed under reduced pressure (150°C , $<1\text{mmHg}$) leaving a colourless viscous oil (14g) (1). A small quantity of higher molecular weight solid polyether was also obtained (ca 0.5g).

In addition dimethylpolyethylene glycol (500) has been modified by grafting with hexafluoropropene (ca 5.5 hexafluoropropyl units per molecule) and then perfluorinated in a similar manner to (3) yielding the perfluorinated polyether (1b).



Sample of (1) (labelled A2000) and of (1b) (labelled B500) (10.0g) have been dispatched to A. Davison, Euro. Off. Aerospace R+D (AFSC), 223/231 Old Marylebone Road, London NW1 5TH for forwarding to Wayne Ward at Wright Patterson AFB, Ohio. The sample container is marked F7LEOA 94W0447.

Characterisation of Intermediates/Products

Estimation of degree of hexafluoropropene incorporation

To an n.m.r. sample (CDCl_3 as solvent) was added 1 to 4 drops of α,α,α -trifluorotoluene. By determining the ratio of high field ^1H & ^{19}F n.m.r. integrals of the sample and trifluorotoluene it was possible to assess the extent of hexafluoropropene incorporation.

Estimation of degree of fluorination

To an n.m.r. sample (CDCl_3 as solvent in early stages of fluorination, neat in later stages) was added 1 to 4 drops of α,α,α -trifluorotoluene. By determining the ratio of high field ^1H & ^{19}F n.m.r. integrals of the sample and trifluorotoluene it was possible to assess the extent of fluorination knowing the extent of hexafluoropropene incorporation.

^{19}F N.M.R. of (1)

See Appendix 1 for 235MHz n.m.r. spectra of the samples

Summary

Perfluorinated polyethers of novel structure have been produced. Aspects of the larger scale synthesis of such materials have been developed.

ID: 11-7-94
 SY: 7335527
 CL: 73350000
 ID: 18384
 SW: 21128.571
 AZ: 15.719
 CC: 1.322
 CF: 1.115
 CR: 1.15
 CB: 5.033
 CC: 3.0
 CD: 33.83
 CE: 3.0
 CF: 33.716
 CG: 5.333
 CH: 3.021 15

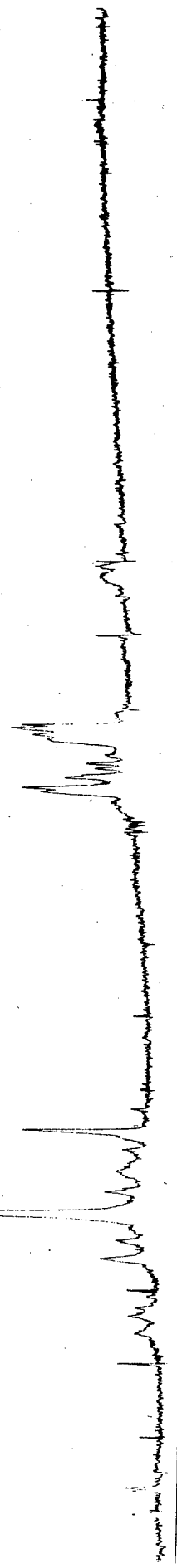
139
 128
 126
 121
 93
 89
 88
 81
 81
 28
 24
 6
 2
 1

Appendix 1

¹⁹F NMR spectrum of sample A2000



-150 -160 -170 -180 -190 -200



3
 60
 70
 80
 90
 100
 110
 120
 130
 140
 150
 160
 170
 180
 190

