



PRODUCTION OF NEW SILOXANE RUBBERS WITH PERFLUOROALKYL SUBSTITUENTS BASED ON HEXAFLUOROPROPYLENE DIMER

Cite this: *INEOS OPEN*, 2024, 7 (1–3), 61–62
DOI: 10.32931/io2426a

Received 9 May 2024,
Accepted 30 May 2024

<http://ineosopen.org>

D. A. Solodukhin,^{*a,b,c} P. D. Shkinev,^{a,c} F. V. Drozdov,^{a,c} and A. M. Muzafarov^a

^a *Enikolopov Institute of Synthetic Polymeric Materials, Russian Academy of Sciences, ul. Profsoyuznaya 70, Moscow, 117393 Russia*

^b *Moscow Institute of Physics and Technology (National Research University), Institutskiy per. 9, Dolgoprudny, Moscow Oblast, 141700 Russia*

^c *Center of National Technological Initiative, Bauman Moscow State Technical University, 2-ya Baumanskaya ul. 5, Moscow, 105005 Russia*

Abstract

Siloxanes with perfluoroalkyl substituents comprise a unique class of compounds that combine superior properties of fluorocarbons and siloxanes. In the present work, the siloxane polymers were synthesized that contain substituents based on hexafluoropropylene dimer. The latter offers several advantages over linear perfluoroalkyl substituents: it is cheaper and fully meets the requirements of the Stockholm Convention on Persistent Organic Pollutants.

Key words: perfluoroalkyl substituents, polyorganosiloxanes, ring-opening polymerization.



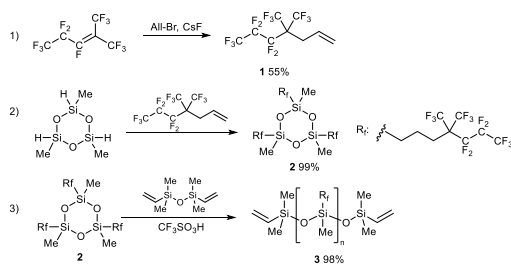
Introduction

Perfluoroalkyl siloxanes amount to a special class of compounds that have a number of unique properties of both fluorocarbons and polyorganosiloxanes. Fluorocarbons are distinguished by the high chemical stability, lubricating ability, and hydrophobicity, while polyorganosiloxanes feature thermal and chemical resistance, as well as chemical and biological inertness. Therefore, perfluoroalkyl-substituted siloxanes combine the best properties of both classes of compounds, rendering them particularly interesting for research and industrial production [1, 2].

Results and discussion

The goal of this work was to obtain siloxane rubbers with perfluoroalkyl substituents.

First, an allyl derivative of hexafluoropropylene dimer was synthesized in an acceptable yield by the known method [3], (Scheme 1.1). Then the hydrosilylation of this derivative afforded a cyclotrisiloxane with perfluoroalkyl substituents (Scheme 1.2).



Scheme 1. Synthesis of the siloxanes featuring perfluoroalkyl substituents in the side chain based on hexafluoropropylene dimer (C_{r5}).

The ring-opening polymerization of **2** was accomplished by the cationic mechanism using trifluoromethanesulfonic acid as a catalyst and tetramethyldivinylsiloxane as a blocking agent in order to obtain the target siloxane rubbers (Scheme 1.3).

The data presented in Table 1 indicate that the molecular weights of the siloxane polymer based on hexafluoropropylene dimer fully comply with the calculated values.

Table 1. Dependence of the number average molecular weights of the resulting polymer on the cyclosiloxane/disiloxane ratio

	Number average molecular weight (M_n)	
	Exp.	Calc. ^a
C_{r5}	12.0	11.8
	6.0	5.9
	3.0	3.0

^a the resulting values were obtained from the theoretical calculations.

Conclusions

The new monomer for the production of siloxanes with perfluoroalkyl substituents was synthesized based on hexafluoropropylene dimer, a commercially available product that fully meets the requirements of the Stockholm Convention on Persistent Organic Pollutants. When studying the polymerization of this monomer by the cationic mechanism, it was found that the calculated molecular weights of the resulting polymer fully comply with the calculated ones. The results obtained indicate the prospects of further development of this field and production of materials based on the siloxane rubbers with perfluoroalkyl substituents derived from hexafluoropropylene dimer.

Acknowledgements

This work was supported by the Russian Science Foundation (project no. 22-13-00459).

Corresponding author

* E-mail: solodukhin.da@phystech.ru. (D. A. Solodukhin).

Electronic supplementary information

Electronic supplementary information (ESI) available online: the experimental section. For ESI, see DOI: 10.32931/io2426a.

References

1. M. O. Riley, Y. K. Kim, O. R. Pierce, *J. Fluorine Chem.*, **1977**, *10*, 85–110. DOI: 10.1016/S0022-1139(00)82677-9
2. Y. Bai, J. Peng, Y. Hu, J. Li, G. Lai, *J. Fluorine Chem.*, **2011**, *132*, 123–127. DOI: 10.1016/j.jfluchem.2010.12.007
3. F. V. Drozdov, A. L. Krapivko, G. V. Cherkaev, L. L. Gervits, N. A. Yashutlov, A. A. Kalinina, A. M. Muzafarov, *J. Organomet. Chem.*, **2020**, *921*, 121398. DOI: 10.1016/j.jorgchem.2020.121398

This article is licensed under a Creative Commons Attribution-NonCommercial 4.0 International License.

