Letters to the Editor

A new approach to the synthesis of dibenzodiazacrown compounds

S. P. Gromov, M. V. Churakova, and S. N. Dmitrieva*

Photochemistry Center, Russian Academy of Sciences,
7a ul. Novatorov, 119421 Moscow, Russian Federation.
Fax: +7 (095) 936 1255. E-mail: gromov@photonics.ru

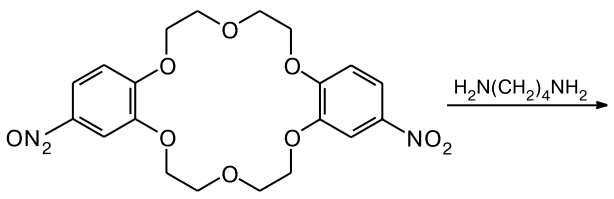
Dibenzocrown ethers are formed due to the condensation of four or two fragments (the so-called 2 + 2 or 1 + 1 condensations).[1—3] The yields of macrocycles obtained by the 1 + 1 condensation are usually[4] much higher than those for the 2 + 2 ring closure. However, disadvantages of the 1 + 1 condensation are many steps of the process and, in many cases of dibenzodiazacrown compounds, poorly available starting compounds.[5,6]. There are only few examples[7,8] on the synthesis of dibenzodiazacrown compounds functionalized at the benzene ring, and their overall yields do not exceed 22%.

Substantial progress has recently been achieved in the chemistry of benzoazacrown compounds due to the development of a new methodology of their synthesis based on the stepwise transformation of the macrocycle of benzocrown ethers used as synthons.[9]

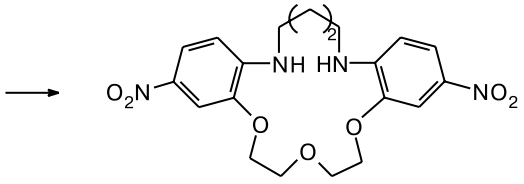
Methods for syntheses of new dibenzocrown compounds based on the one-step transformation of macrocycle in more accessible compounds seem to be among the most promising methods in this direction, although advantages and possibilities of this approach for the synthesis of macroheterocyclic compounds were not discussed in the literature so far.

It has previously[10] been found that the heating of a mixture of isomeric 4′,4″(5″)-dinitrodibenzo-18-crown-6 ethers with a solution of $MeNH_2$ in ethanol induces macroheterocycle opening to form two nitrogen-containing podands corresponding to the opening of the *cis*- and *trans*-isomers in 52% and 44% yields, respectively, and with a molar ratio of 0.6 : 1.

We developed the one-pot synthesis of earlier unknown 4′,4″-dinitrodibenzodiazacrown compound **1** from a mixture of isomeric 4′,4″(5″)-dinitrodibenzo-18-crown-6 ethers by the interaction with diaminobutane. The



2



1

Published in Russian in *Izvestiya Akademii Nauk. Seriya Khimicheskaya,* No. 3, pp. 798—799, March, 2005.

cis-isomer of dinitrodibenzo-18-crown-6 ether **2** under the action of diaminobutane on heating was found to undergo transformation of its macrocycle to form dibenzodiazacrown compound **1** in 19% yield.

The structure of compound **1** was established by ^1H and ^{13}C NMR spectroscopy, including 2D NOESY spectra, and confirmed by the data of mass spectrometry and elemental analysis.

Thus, we proposed the approach that makes it possible to synthesize the previously unknown nitro derivative of the dibenzodiazacrown compound from the available dibenzocrown ether. The discovered reaction is the first example for the one-step transformation of the crown-ether macrocycle into azacrown compounds. This approach provides wide potentialities for syntheses of new promising groups of complexing agents and extragents of metal ions.

^1H and ^{13}C NMR spectra were obtained on a Bruker DRX-500 spectrometer (500.13 and 125.76 MHz, respectively) using $CDCl_3$ and DMSO-d_6 as solvents (solvent served as internal standard). Chemical shifts were measured with an accuracy to 0.01 ppm, and the accuracy of spin-spin coupling constant measuring was to 0.1 Hz. Homonuclear $^1H—^1H$ COSY and NOESY and heteronuclear $^1H—^{13}C$ COSY spectra were used to assign signals of protons and carbon atoms. The IR spectrum was recorded on a Bruker IFS-113V spectrophotometer in KBr pellets. The mass spectrum was obtained on a Varian MAT-311A instrument with an ionization energy of 70 eV using the direct sample injection into the ionization zone. Silica gel (Kieselgel 60, 0.063—0.100 mm, Merck) was used for column chromatography. The reaction course was monitored by TLC on DC-Alufolien Kieselgel 60 F_{254} (Merck). 4′,4″(5″)-Dinitrodibenzo-18-crown-6 ether was synthesized according to a described procedure.[11]

3,13-Dinitro-6,7,9,10,16,17,18,19,20,21-decahydrodibenzo[*h*,*p*][1,4,7,10,15]trioxadiazacycloheptadecine (1). A mixture of 4′,4″(5″)-dinitrodibenzo-18-crown-6 ether (90 mg, 0.2 mmol) and a 5% solution of 1,4-diaminobutane (4 mmol) in anhydrous EtOH was heated in a sealed ampule for 8.5 days at 130 °C in an oil bath. Then the ampule was opened, and the reaction mixture was concentrated *in vacuo*. Water (40 mL) and concentrated HCl (dropwise, to pH 3) were added to the residue. An aqueous solution was extracted with AcOEt, and the extract was concentrated *in vacuo*. The residue was purified by column chromatography on SiO_2 using AcOEt as eluent. Compound **1** was obtained as yellow crystals in a yield of 8 mg (19% based on *cis*-isomer **2**). R_f 0.82 (Kieselgel 60 F_{254}, eluent AcOEt). M.p. 206—208 °C. ^1H NMR ($CDCl_3$), δ: 1.86 (m, 4 H, 2 CH_2); 3.32 (m, 4 H, 2 CH_2N); 3.95 (m, 4 H, 2 $C\underline{H}_2CH_2OAr$); 4.29 (m, 4 H, 2 $C\underline{H}_2OAr$); 5.01 (br.t, 2 H, 2 NH); 6.52 (d, 2 H, H(1), H(15), J = 8.9 Hz); 7.65 (d, 2 H, H(4), H(12), J = 2.2 Hz); 7.93 (dd, 2 H, H(2), H(14), J = 8.9 Hz, J = 2.2 Hz). ^{13}C NMR (DMSO-d_6), δ: 25.62 (2 CH_2); 40.34 (2 CH_2N); 67.80 (2 $\underline{C}H_2OAr$); 68.42 (2 $\underline{C}H_2CH_2OAr$); 105.35 (C(4), C(12)); 106.66 (C(1), C(15)); 119.89 (C(2), C(14)); 135.14 (C(3), C(13)); 143.76 ((C(4a), C(11a)); 145.13 (C(15a), C(21a)). Mass spectrum, m/z I_{rel} (%)): 432 $[M]^+$ (100), 415 (28), 165 (44), 161 (41), 146 (49), 123 (36), 119 (32), 78 (27), 77 (39), 65 (42). Found (%): C, 56.06; H, 5.69. $C_{20}H_{24}N_4O_7$. Calculated (%): C, 55.55; H, 5.59. IR, ν/cm^{-1}: 3417 (NH), 1498 (NO_2).

This work was financially supported by the Russian Foundation for Basic Research (Project No. 03-03-32177), the INTAS (Grant 2001-0267), and the Russian Academy of Sciences.

References

1. *Host Guest Complex Chemistry Macrocycles. Synthesis, Structures, Applications*, Ed. F. Vogtle and E. Weber, Springer Verlag, Berlin, 1985, Ch. 1.
2. M. Hiraoka, *Crown Compounds: their Characteristics and Applications*, Elsevier Science Publishers, 1982.
3. K. B. Yatsimirskii, A. G. Kol´chinskii, V. V. Polishchuk, and G. G. Talanova, *Sintez makrotsiklicheskikh soedinenii* [*Synthesis of Macrocyclic Compounds*], Naukova Dumka, Kiev, 1987, 279 (in Russian).
4. A. A. Formanovskii, *Makrotsiklicheskie soedineniya v analiticheskoi khimii* [*Macrocyclic Compounds in Analytical Chemistry*], Eds Yu. A. Zolotov and N. M. Kuz´min, Nauka, Moscow, 1993, Ch. 1 (in Russian).
5. K. E. Krakowiak, J. S. Bradshaw, and D. J. Zamecka-Krakowiak, *Chem. Rev.*, 1989, **89**, 929.
6. J. S. Bradshaw, K. E. Krakowiak, and R. M. Izatt, *Aza-Crown Macrocycles*, John Wiley & Sons, New York, 1993.
7. R. Crossley, Z. Goolamali, J. J. Gosper, and P. G. Sammes, *J. Chem. Soc., Perkin Trans. 2*, 1994, 513.
8. T. Tozawa, Y. Misawa, S. Tokita, and Y. Kubo, *Tetrahedron Lett.*, 2000, **41**, 5219.
9. S. P. Gromov, S. N. Dmitrieva, A. I. Vedernikov, and M. V. Churakova, *Izv. Akad. Nauk*, *Ser. Khim.*, 2004, 1362 [*Russ. Chem. Bull., Int. Ed.*, 2004, **53**, 1417].
10. S. P. Gromov, S. N. Dmitrieva, and V. E. Krasnovskii, *Izv. Akad. Nauk*, *Ser. Khim.*, 1997, 540 [*Russ. Chem. Bull.*, 1997, **46**, 519 (Engl. Transl.)].
11. V. S. Kalishevich, A. I. Gren´, and O. S. Timofeev, USSR Author´s certificate 1198075, *Byul. Izobret.* [*Invention Bulletin*], 1985, 46 (in Russian).

Received December 28, 2004;
in revised form February 14, 2005