Synthesis of 1,7-di(2'-aminoethyl)-4,10-dimethyl-1,4,7,10-tetraazacyclododecane.

Mircea Vlassa* and Cerasella Afloroaei

"Babes-Bolyai" University, Faculty of Chemistry and Chemical Engineerig,
Department of Organic Chemistry, 11 Arany Janos str., 3400-Cluj-Napoca
Romania

Abstract. The synthesis and complexant properties of a new lariat ether, 1,7-di(2'-aminoethyl)-4,10-dimethyl-1,4,7,10-tetraazacyclododecane is presented.

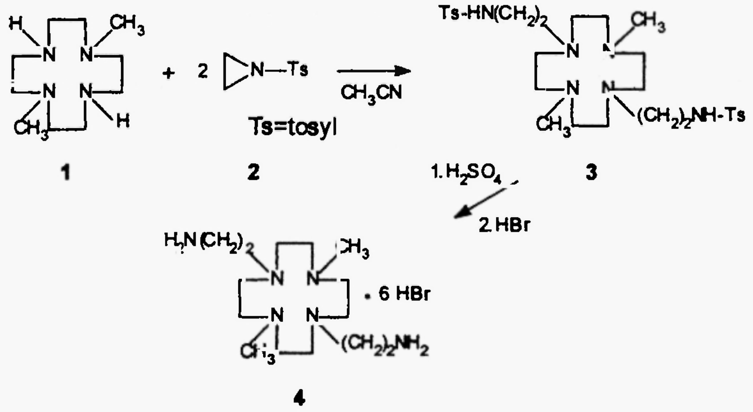
INTRODUCTION

The use of azacryptands which have a higher complexant power, by comparison with crown ethers, allowed the synthesis of the most stable alkalide toward decomposition with no apparent tendency toward decomplexation.[1]

The problem of thermal stability of alkalides and electrides is very important for the potential practical applications. The feature that distinguishes lariat ethers from nonsidearmed crown ethers is the ability of the side arms to augment the cation binding profile. With this goal in mind we intend to use lariat ethers for obtaining of alkalides and electrides, extending the complexant types used in this field. Taking advantage of complexant ability of polynitrogen macrocycles,[2,3] we prepared a new nitrogen-pivot lariat ether, namely 1,7- di(2'aminoethyl)-4,10-dimethyl-1,4,7,10-tetraaza cyclododecane.

RESULTS AND DISCUSSION

The title compound was prepared according to the scheme. The direct functionalization of compound **1** with N-tosylaziridine gave **3** with good yield(77%). The detosylation of **3** in sulfuric acid afforded an oil which was purified by transformation in the corresponding hydrobromide **4**. In contrast with other literature procedures[4] which uses reduction of corresponding amido moiety for obtaining dietilamino arms, working with N-tosylazidridine allowed us to make the same functionalization in only one step.



Scheme

With alkali metal NMR spectrometry as a diagnostic technique, no evidence was found for complexation of Na$^+$ or K$^+$. With the lithium ion, solid complexes were isolated. Li$^+$ is complexed by ligand L and equilibrium (1) was investigated by measuring ^{7}Li NMR spectrum of complex. $\mathrm{L\ (aq) + Li^+\ (aq) = [LLi]^+\ (aq)}$ (1)

The ^{7}Li NMR spectra of the complex in water at high pH values, shows a sharp signal at +0.900 ppm, this is shfited downfield with respect to the solvataed Li$^+$ (+0.400 ppm). The difference ($\Delta\ \delta$ = 0.500 ppm) between complex and solvated Li$^+$, even in such a highly solvating solvent such water, is similar to shifts found previously for other complexants[5] and shows that the complex is stable. The NMR spectrum of Li$^+$ in methanol in the presence of this ligand shows that all cations are bound and this is indicative of a higher stability constant in this solvent.

The alkali metal NMR experiments showed that lithium complex formation is not influenced by the presence of Na^+ ions, even in high concentrations, indicating that this lariat ether is able to discriminate between Li^+ and Na^+.

EXPERIMENTAL.

Melting points are uncorrected. The NMR spectra were recorded on a Varian Gemini 300 spectrometer,in $CDCl_3$ (for compound **3**) or in D_2O(for compound **4**, dioxane was used like reference). Elemental analyses were performed on a Perkin-Elmer 2400 instrument. The compounds **1** and **2** were prepared according to the literature data .[6,7]

1,7di-(Tosylaminoethyl)-4,10-dimethyl-1,4,7,10-tetraazacyclododecane 3. O solution of N-tosylaziridine(3.49 g, 0.02 mol) in acetonitrile(10mL) was added dropwise into a solution of **1**(2g, 0.01 mol) in acetonitrile(60mL) over a period of 1 h under reflux. The the mixture was refluxed ½ h more. Subsequently, the solvent was removed *in vacuo* and the solid residue was dissolved in $CHCl_3$, charcoal was added, the mixture filtered and the solvent removed again *in vacuo*. The residue was recrystallized from a mixture of $CHCl_3$-cyclohexane. Yield 77 %, m.p.=146-148. Anal. Calcd. For $C_{26}H_{40}N_6S_2O_4$: C, 47.69; H, 7.14; N, 14.88 Found: C, 47.90, H, 7.15, N. 15.00.

^{1}H- NMR ($CDCl_3$) δ :2.16(s, 6H, CH_3N), 2.44(s, 6H, CH_3-Ar), 2.65(t, 4H, J=1.6, CH_2-CH_2-NH) 2.95 (m, 12 H, ring CH_2 + CH_2NH), 3.55 (t, 8H, J=4.0, ring CH_2), 7.40 (d, J=8.0, 4 H_{arom}), 2.70(d, J=8.0, 4$H_{arom.}$ ^{13}C-NMR ($CDCl_3$) δ : 20.83, 22.40, 39.50, 50.10, 56.00, 67.50, 128.30, 129.50, 135.60, 142.30.

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Compound **3** (6.4g, 1.077mol) was detosylated with 98% sulphuric acid (11 mL) at 100^{0}C for 98 hr. To the stirred cold solution (ice bath) ethanol (35mL) and then ether (70mL) were added dropwise. The resulted amine sulfate was dissolved in water(20mL) and make alkaline with sodium hydroxide solution. The amine was extracted with chloroform (5x40 mL) and the combined extracts were dried over magnesium sulfate. The chloroform was removed under reduced pressure, the oily residue, which solidified by standing, was dissolved in ethanol (10mL) and cooled. 47%Hydrobromic acid (20 mL) was added to the cold solution and left to cool overnight. The crystalline white precipitate was filtered off, washed with ethanol and dried. Yield 75%, m.p.> 250 ^{0}C. Anal Calcd. For $C_{12}H_{32}N_6Br_6$: C, 19.48 H, 4.30 N, 11.36 Br, 64.80 Found: C, 19.50 H, 4.32 N, 11.38, Br, 65.00.

^{13}C-NMR (D_2O, reference dioxane),δ : 33.24, 42.69, 45.71, 48.91, 53.19.

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