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REACTION OF SUBSTITUTED 1,3,2-DIOXABOROLANES WITH ACETONITRILE

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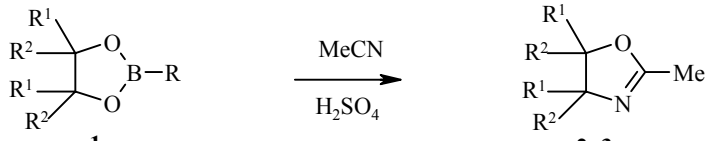
Reaction of 2-alkyl- and 2-alkoxy-4,4,5,5-tetramethyl- and 4,5-diphenyl-1,3,2-dioxaborolanes with acetonitrile leads to the corresponding 2-oxazolines. Their yield is determined by the nature of the substituent on the boron atom in the molecule of the starting cyclic boric ester. The results obtained are consistent with calculated values of the relative stability for the intermediate ions (AM1).

Keywords: 2-alkyl-1,3,2-dioxaboranes, 2-alkoxy-1,3,2-dioxyborolanes.

Known examples of the reaction of 1,3-dioxanes [1-3] and 1,3,2-dioxaborinanes [4-6] with acetonitrile show that the noted transformation, as a modification of the Ritter reaction, follows the basic rules for processes with participation of a nitrile group, leading to formation of a new C–N bond [7, 8]. The goal of our work was to continue a study of the reaction of cyclic boric esters with nucleophilic reagents, for the example of the reaction of substituted 1,3,2-dioxaborolanes **1a-g** with acetonitrile.

We observed that as a result of the noted reaction, the corresponding 2-methyl-2-oxazolines **2,3** are formed.



1

1 a R = OC_4H_9, R^1=R^2 = H; **b** R=OC_4H_9; R^1=R^2=Me; **c** R=OC_4H_9-*i*, R^1=R^2=Me; **d** R = OC_3H_7-*i*, R^1=R^2=Me; **e** R = OC_2H_5, R^1=R^2=Me; **f** R=C_4H_9-*i*, R^1=R^2=Me; **g** R = *i*-C_3H_7, R^1 = C_6H_5, R^2 = H

2, **3**

2 R^1 = R^2 = Me
3 R^1 = C_6H_5, R^2 = H

Their yield is determined both by the number and nature of the substituents in the starting boric ester, and by the synthesis conditions (Table 1). In the case of ester 1**a**, which does not contain substituents in the carbon part of the ring, we were unable to obtain the corresponding oxazoline: we isolated only the starting 1,3,2-dioxaborolane. For the 2-alkoxy derivatives **1b-e**, the maximum yield of 2,4,4,5,5-pentamethyl-2-oxazoline **2** (47-55%) was observed when the starting esters were boiled in excess acetonitrile in the presence of concentrated H_2SO_4. Substituting an alkyl group for the alkoxy group at the boron atom (esters **1f,g**) markedly reduces the yield of the target product. In addition to oxazolines **2** or **3**, boric acid (esters **1b-e**) or the corresponding alkylboric acid (esters **1c,g**) is formed.

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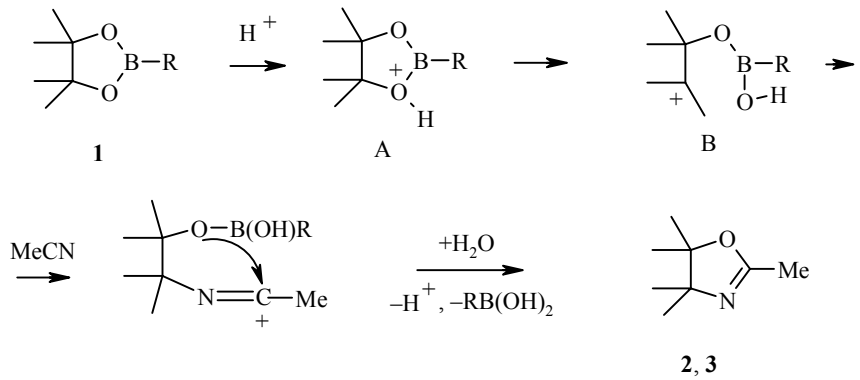
TABLE 1. Dependence of the Yield of 2-Oxazolines **2, 3** on the Number and Nature of Substituents in the Starting 1,3,2-Dioxaborolanes **1** and the Synthesis Conditions

Starting compound	Solvent	T, °C	Yield of **2** and **3**, %
1a	CH_3CN*	80	0
1b	CH_3CN*	80	50
1c	Hexane	10	20
1c	Chloroform	60	13
1c	CH_3CN*	80	55
1d	CH_3CN*	80	53
1e	CH_3CN*	80	47
1f	CH_3CN*	80	25
1g	CH_3CN*	80	15

* Excess.

The observed rules, as in the case of six-membered boric esters [5, 6], are connected with the stability of the probable intermediate, similar in nature to a carbocation. In accordance with common ideas about the mechanism of solvolytic reactions of cyclic boric esters [5, 6, 9], the reaction of 1,3,2-dioxaborolanes with acetonitrile should include initial formation of the oxonium ion A, slowly isomerizing to the carbocation B. Subsequent addition of an acetonitrile molecule leads to 2-methyl-2-oxazoline.

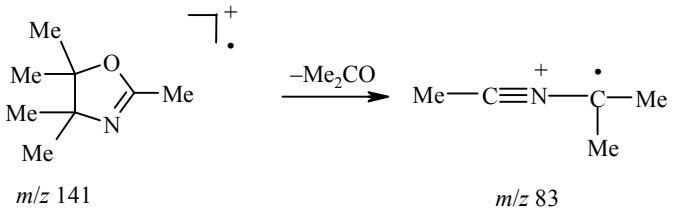


The results of calculation of the energy of A and B by the SCF MO LCAO method in the AM1 parametrization [10, 11] with full optimization of the geometry (Table 2) suggest that an increase in the number of methyl groups in the starting heterocycle, with unchanged substituent at the boron atom, markedly increases the relative stability of the B ion (ΔE_{AB}), while substitution of an alkyl group for the alkoxy group at the boron atom (ester **1f**) destabilizes it. A parallel increase or respectively a decrease in the yield of 2-oxazoline supports the decisive influence of the relative stability of carbocation B on the course of the transformation under study.

The results obtained supplement known methods for synthesis of 2-oxazolines [12-15] and allow us to confidently predict preparative yields of these compounds upon reaction with acetonitrile of 2-alkoxy-1,3,2-dioxaborolanes with *gem*-dialkyl or aromatic substituents in the carbon portion of the ring. The purity, composition, and structure of the 2-oxazolines obtained are supported by GLC, mass spectrometry, and also ^{1}H NMR and IR spectroscopy. In the IR spectra, there is an intense band $\nu_{C=N}$ at 1670-1630 cm^{-1}. The mass spectrum of oxazoline **2** contains a low-intensity signal from a molecular ion with *m*/*z* 141, and mainly shows an ion with *m*/*z* 83, corresponding to decomposition of M^+:

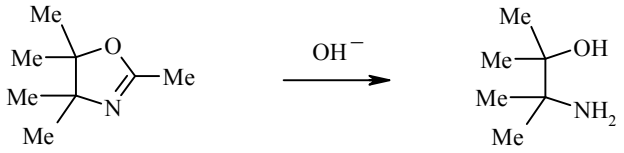
TABLE 2. Relative Energy of Intermediate Ions A, B (kcal/mol) in the Reaction of Substituted 1,3,2-Dioxaborolanes with Acetonitrile

Starting ester	$-E_A$	$-E_B$	ΔE_{AB}	Yield of **2**, %
1a	2108.5	2090.2	18.3	0
1b	3233.5	3235.6	-2.1	55
1f	3115.1	3113.0	2.1	25



m/*z* 141 *m*/*z* 83

In the ^{1}H NMR spectrum of this compound, there are signals from protons of the methyl groups at the $C_{(4)}$, $C_{(5)}$, and $C_{(2)}$ atoms (δ, ppm: 1.79 s (3H), 1.20 s (6H), 1.05 s (6H)). As a result of base hydrolysis of oxazoline **2**, we isolated 3-amino-2,3-dimethyl-2-butanol (**4**).



2 **4**

Its IR spectrum contains a broad absorption band (3200-3400 cm^{-1}) due to stretching vibrations of the N–H and O–H bonds, while the ^{1}H NMR spectrum contains signals from the corresponding groups of protons (δ, ppm: 0.54, s [6H, $(CH_3)_2CN$], 0.62, s [6H, $(CH_3)_2CO$], 0.95, s (3H, OH, NH_2)). In the mass spectrum, there are fragmentary ion peaks (*m*/*z* (*I*, %): 101 (38) $[M–NH_2]^+$, 100 (22) $[M–OH]^+$, 86 (20) $[M–NH_2CH_3]^+$).

The mass spectrum of oxazoline **3**, in addition to the molecular ion peak, contains peaks for the characteristic fragmentary ions (*m*/*z* (*I*, %): 237 (3) $[M]^+$, 195 (12) $[M–H–CH_3CN]^+$, 106 (100) $[M–C_9H_9N]^+$.

EXPERIMENTAL

GLC analysis was performed on a Tsvet-126 with flame-ionization detector; column 3000 × 4 mm; stationary phase 5% OV-17 on a Chromaton N-Super support; carrier gas, argon. The IR spectra were recorded on a Specord IR-75 spectrophotometer in a thin layer and vaseline oil; the mass spectra were recorded on an MI 1321 spectrometer with ionizing electron energy 70 eV; and the ^{1}H NMR spectra were recorded on a Tesla BS-497 (100 MHz) for 15% solutions of the study compounds in $CDCl_3$ relative to TMS (internal standard). The starting 1,3,2-dioxaborolanes were obtained according to the known procedures [9, 16].

Substituted 2-Oxazolines (2,3). Conc. H_2SO_4 (10 ml) was added dropwise to a solution of ester **1** (0.03 mol) in acetonitrile (50 ml) with stirring and cooling with ice water. After this, the reaction mixture was boiled on a water bath for 3 h, the excess acetonitrile was driven off on a rotary evaporator, and the residue was diluted with 70 ml of water and extracted with chloroform (3 × 30 ml). 10-30% of the starting 1,3,2-dioxaborolane and boric (alkylboric) acid were isolated from the chloroform extract after removal of the

solvent. The remaining aqueous solution was treated, while cooled by ice, with solid NaOH to pH 9-10, after which it was extracted with chloroform (4 × 50 ml) and dried with anhydrous $MgSO_4$; the solvent was removed on a rotary evaporator. 2,4,4,5,5-Pentamethyl-2-oxazoline **2**: bp 146-148°C (760 mm Hg). 2-Methyl-4,5-diphenyl-2-oxazoline is a white crystalline material, decomposing on heating above 300°C. A modification of the given procedure is to use chloroform or hexane as the solvents and to change the temperature conditions of the reaction (Table 1).

Hydrolysis of Oxazoline 2. Oxazoline **2** (4.23 g, 0.03 mol) was boiled in 30 ml of 25% aqueous KOH solution for 5 h, then the product was extracted with chloroform and the solvent was driven off. 2.31 g (68%) of aminoalcohol **4** was obtained; mp 87-88°C (acetone).

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