# 5-ALKOXYOXAZOLIDINES. REACTION OF TOSYL AZIDE WITH METHYL VINYL ETHER IN THE PRESENCE OF ALDEHYDES*

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trans-2-Alkyl- and trans-2-aryl-5-methoxy-3-tosyloxazolidines are formed in the reaction of tosyl azide with methyl vinyl ether in the presence of aldehydes.

2-Alkoxy-1-arylsulfonylaziridines, which are formed in the reaction of benzenesulfonyl azides with alkyl vinyl ethers, are converted to 5-alkoxy-2,2-dialkyl-3-arylsulfonyloxazolidines in the presence of ketones [1]. In the present research we investigated the (3 +2)-cycloaddition of 2-methoxy-1-tosylaziridines to aldehydes of the aliphatic and aromatic series.

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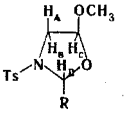
*Communication VI from the series "Reaction of Organic Azides with Unsaturated Compounds;" see [1] for communication V. The results of this study are protected by an author's certificate [2].

TABLE 1. PMR Spectra of Oxazolidines



| Compound | δ, ppm* | | | | | | Spin - spin coupling constants, Hz | | | Percentage of the cis-oxazolidine in the mixture of isomers, % † |
|---|---|---|---|---|---|---|---|---|---|---|
| | $H_A$ | $H_B$ | $H_C$ | $H_D$ | $OCH_3$ | R (J, Hz) | $J_{cis}$ | $J_{trans}$ | $J_{gem}$ | |
| I‡ | 3,31 | 3,56 | 4,64 | 5,34 q | 3,25 | 1,46 d (5,8) | 5,4 | 3,1 | 11,8 | 10 |
| II | 3,22 | 3,65 | 4,54 | 5,15 t | 3,22 | 0,95 t, 1,70 dq (6,2, 7,0) | 5,5 | 3,3 | 12,8 | — |
| III | 3,12 | 3,76 | 4,42 | 4,85 d | 3,25 | 0,95 d, 0,98 d [6H] (6,6), 1,86 m (1H) | 5,8 | 4,2 | 13,5 | — |
| IV | 3,26 | 3,65 | 4,58 | 5,40 dd | 3,29 | 2,97 dd [1H] ($J_{vic}$ =7,5, $J_{gem}$ = 9,8), 3.06 dd [1H] ($J_{vic}$ =5,0, $J_{gem}$=9,8), 7,20 m | 5,8 | 3,6 | 12,4 | 5 |
| V | 3,25 | 3,86 | 4,74 | 6,40 s | 3,20 | 7,30—7,50 m | 5,6 | 3,9 | 12,6 | 7 |
| VI | 3,15 | 3,79 | 4,66 | 6,27 s | 3,21 | 6,95 dd and 7,44 dd [4H] ($J_{H,H}$ =8,5, $J_{H,F}$ =5,5, 8,5) | 5,1 | 4,2 | 12,7 | — |
| VII | 3,12 | 3,76 | 4,62 | 6,24 s | 3,18 | 7,4 m | 5,5 | 4,1 | 12,6 | 3 |
| VIII | 3,26 | 3,86 | 4,80 | 6,38 s | 3,24 | 7,68 d and 8,16 d (8) | 5,5 | 3,7 | 12,7 | — |

*Chemical shifts of Ts in oxazolidines I-VIII (± 0.02 ppm): 2.40 s, 7.25 d, and 7.65 d (J = 8 Hz).

†Relative error ± 30%.

‡For cis-oxazolidine I: $H_A$ and $H_B$ 3.4 m, $H_C$ 5.00 dd ($J_{cis}$ = 3 Hz, $J_{trans}$ = 2 Hz), $OCH_3$ 2.95 s.

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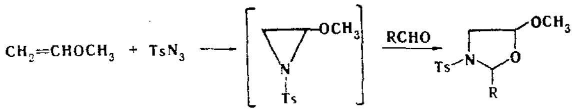
TABLE 2. Properties of Oxazolidines I-VIII

| Compound | mp, °C (from hexane) | Empirical formula | Found, % |  |  |  | Calc., % |  |  |  | Yield, %* |
|---|---|---|---|---|---|---|---|---|---|---|---|
|  |  |  | C | H | N | S | C | H | N | S |  |
| I | 93,5—94,0 | $C_{12}H_{17}NO_4S$ | 53,4<br>53,6 | 6,2<br>6,2 | 5,2<br>5,4 | 12,5<br>12,2 | 53,5 | 6,3 | 5,2 | 11,8 | 38 |
| II | 92—93 | $C_{13}H_{19}NO_4S$ | 54,6<br>54,8 | 6,9<br>6,9 | 4,8<br>4,8 | 11,7<br>11,7 | 54,7 | 6,7 | 4,9 | 11,2 | 28 |
| III | 94,5—95,3 | $C_{14}H_{21}NO_4S$ | 56,1<br>55,8 | 7,3<br>7,2 | 5,1<br>5,1 | 11,1<br>11,3 | 56,2 | 7,1 | 4,7 | 10,7 | 31 |
| IV | 107,1—107,3 | $C_{18}H_{21}NO_4S$ | 62,4<br>62,3 | 6,0<br>6,0 | 4,0<br>3,8 | 9,4<br>9,4 | 62,2 | 6,1 | 4,0 | 9,2 | 19 |
| V | 101,5—102 | $C_{17}H_{19}NO_4S$ | 61,2<br>61,2 | 6,0<br>5,8 | 4,2<br>4,2 |  | 61,2 | 5,7 | 4,2 |  | 21 |
| VI | 112—113 | $C_{17}H_{18}FNO_4S$ | 58,0<br>58,1 | 4,9<br>5,2 | 4,2<br>4.2 | 9,3<br>9,5 | 58,1 | 5,2 | 4,0 | 9,1 | 14 |
| VII | 92,2—93,0 | $C_{17}H_{18}BrNO_4S$ | 49,3<br>49,5 | 4,5<br>4.5 | 3,3<br>3,3 | 8,0<br>8,2 | 49,5 | 4.4 | 3,4 | 7,8 | 11 |
| VIII | 139—139,5 | $C_{17}H_{18}N_2O_6S$ | 54,1<br>53,7 | 4,9<br>4,8 | 7,4<br>7,2 | 9,0<br>8,7 | 54,0 | 4,8 | 7,4 | 8,5 | 1 |

*2,5-Dimethoxy-1,4-ditosylpiperazine and poly(2-methoxy-1-tosylaziridine) were isolated in the synthesis of oxazolidines I-VII in overall yields of, respectively, 48, 56, 59, 71, 69, 81, and 84%.

2-Substituted 5-methoxy-3-tosyloxazolidines I-VIII were obtained by reaction of methyl vinyl ether with tosyl azide in the presence of aldehydes at 40°C.*



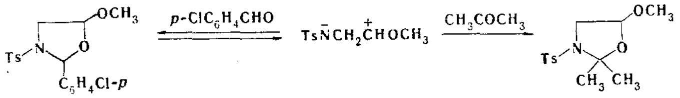
I-VIII

R = $CH_3$; II R = $C_2H_5$; III R = iso-$C_3H_7$; IV R = $C_6H_5CH_2$; V R = $C_6H_5$; VI R = p-$FC_6H_4$; VII R = p-$BrC_6H_4$; VIII R = p-$NO_2C_6H_4$

The data from the PMR spectra (Table 1) of oxazolidines I-VIII are similar to the data from the PMR spectra of 5-alkoxy-2,2-dialkyl-3-tosyloxazolidines [1]. In all cases the percentage of the trans-oxazolidines in the mixtures of isomers exceeded 90%. We were able to firmly establish the presence of small amounts of the cis isomers from the PMR spectra only for oxazolidines I, IV, V, and VII. The percentages of the isomers were determined from the signals of the methoxy groups, which are shielded more strongly in the cis isomer than in the trans isomers; the percentages of the cis isomers in 2-aryloxazolidines can be determined similarly from the 2-H signals.

5-Methoxy-2,2-dimethyl-3-tosyloxazolidine (IX) was isolated by separation of the products of the reaction of methyl vinyl ether, tosyl azide, and p-chlorobenzaldehyde by means of preparative thin-layer chromatography (TLC) with an eluent containing acetone. The 5-methoxy-2-(p-chlorophenyl)-3-tosyloxazolidine formed during the reaction evidently exists in equilibrium with dipolar ion X under the conditions of chromatography on silica gel; similar transformations of oxazolidines to carbonyl compounds and ylids of the X type have previously been observed [1].

Thus the "transalkylation" of oxazolidines, which was observed for the first time, indicates the possibility of their formation from aziridines and carbonyl compounds. However, when 5-ethoxy-2,2-dimethyl-3-tosyloxazolidine is heated with a tenfold excess of 2-methylpropanal and oxazolidines I and II are heated with excess acetone (at 40° for 4 h), the starting oxazolidines do not undergo any transformations. These results indicate that 5-alkoxyoxazolidines are formed irreversibly under the conditions of the described reaction.



IX

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*The corresponding oxazolidines were not obtained in the reaction of methyl vinyl ether with tosyl azide in the presence of formaldehyde, chloral, and anisaldehyde.

## EXPERIMENTAL

The PMR spectra of $CCl_4$ solutions of the compounds were recorded with a Varian HA-100 spectrometer with hexamethyldisiloxane as the internal standard. The IR spectra of mineral oil suspensions of the compounds were obtained with a UR-20 spectrometer. The characteristic frequencies [1] for the oxazolidines were observed over the following ranges: 1350-1355, 1160-1171, 670-685, 600-625, 550-570, 540-555, and 525-545 $cm^{-1}$.

Silufol UV-254 was used for analytical thin-layer chromatography (TLC), and LS 5/40 gel with a luminescence indicator was used for preparative TLC; elution was accomplished in all cases with hexane–acetone (3 : 1). The yields, melting points, and results of elementary analysis of the oxazolidines are presented in Table 2.

5-Methoxy-2-methyl-3-tosyloxazolidine (I). A mixture of 4.0 g (2.0 mmole) of tosyl azide, 4.8 ml (6 mmole) of methyl vinyl ether, and 3.3 ml (6 mmole) of acetaldehyde was heated in a sealed tube at 40° for 2 h, after which it was refluxed with hexane (four 20-ml portions). The hexane-insoluble residue (2.2 g) was treated with hot ethyl acetate, and the solid material was removed by filtration and washed with ether to give 0.44 g (10%) of 2,5-dimethoxy-1,4-ditosylpiperazine with mp 176.5°. Vacuum evaporation of the ethyl acetate gave 1.7 g (38%) of poly(2-methoxy-1-tosylaziridine). The polymer and the piperazine were identified from the results of elementary analysis, TLC, and comparison of the IR spectra with the spectra of authentic preparations [3]. The hexane extracts were cooled at −10° for 40 h, after which they were worked up to give 2.25 g of colorless crystals; recrystallization from hexane yielded 2.1 g (38%) of oxazolidine I with mp 93.5-94° (twice from hexane).

Oxazolidines II, III, V, VI, and VII were similarly obtained.

5-Methoxy-2-(p-nitrophenyl)-3-tosyloxazolidine (VIII). Repeated treatment of the reaction mixture obtained from 3.3 g of tosyl azide, 4.8 ml of methyl vinyl ether and 9.0 g of p-nitrobenzaldehyde with boiling hexane (15 times with 10-ml portions) yielded, after evaporation of the hexane extracts to 50 ml, 3.65 g of crystals, which, according to the TLC data, were a mixture of p-nitrobenzaldehyde and the reaction product. Double chromatography of this mixture yielded 80 mg (0.9%) of oxazolidine VIII with mp 139-139.5°. Oxazolidine IV was also isolated by preparative TLC, since excess high-boiling carbonyl compound interferes with its separation.

Reaction of Tosyl Azide with Methyl Vinyl Ether in the Presence of p-Chlorobenzaldehyde. The reaction mixture remaining after completion of the reaction of 1.97 g of the azide, 2.2 ml of the ether, and 3.9 g of p-chlorobenzaldehyde was separated by means of preparative TLC with an eluent containing acetone. The bulk of the substance was immobile, but 0.23 g (8%) of 5-methoxy-2,2-dimethyl-3-toxyloxazolidine, with mp 56° (mp 58.4° [1]), was isolated from the zone with $R_f$ 0.6. PMR spectrum, $\delta$ ($CCl_4$): 1.5) (s, 3H), 1.56 (s, 3H), 2.37 (2, 3H), 3.25 (s, 3H), 3.32 (m), 3.51 (m), and 4.90 ppm (m, 3H, $J_{gem} = 9.7$ Hz, $J_{cis} = 5.0$ Hz, $J_{trans} = 1.5$ Hz; the long-range spin–spin splitting constant was $0.4 + 0.1$ Hz). The IR spectrum of the oxazolidine was identical to the spectrum of the previously obtained preparation [1].

## LITERATURE CITED

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