Tetrahedron Letters No. 52, pp 5007 - 5010.
0040-4039/79/1222-5007$02.00/0

STEREO- AND REGIO-SELECTIVE FORMATION OF 2-OXAZOLONE TELOMERS AS POTENTIAL SYNTHETIC INTERMEDIATES FOR AMINOSUGARS

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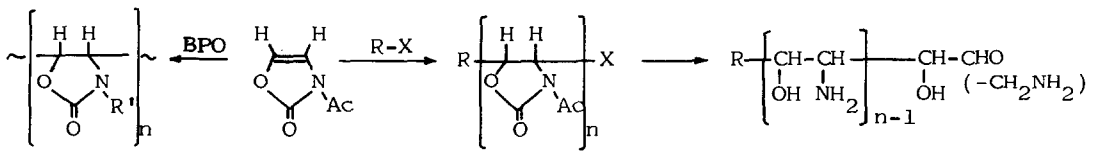
Summary : 3-Acetyl-2-oxazolone readily undergoes free-radical homopolymerization as well as telomerization with polyhalomethanes, in which low telomer formation is highly stereo- and regio-selective.

It has been widely recognized that 1,2-disubstituted olefins cannot be homopolymerized under conventional conditions owing to the steric hindrance imposed by vicinal substituents, with very few exceptions of vinylene carbonate[1] and maleimides[2]. In the course of study on telomerization of vinylene carbonate[3], we have found that 3-acyl-2-oxazolone 1[4] regarded as internal olefin undergoes smooth free-radical homopolymerization to give type 2 polymers with carbon-carbon backbone structure resulting from double bond addition, which would be convertible to poly(1-amino-2-hydroxyethylene). In contrast, 3-methyl substituted heterocycle failed to afford polymeric compounds under the identical conditions.

It has now become feasible to undertake telomerization of such a heterocyclic compound in the presence of chain transfer agents. Radical telomerization of 2-oxazolone proceeds smoothly in the medium of polyhalomethanes to give novel polyfunctional telomers (type 3) not easily otherwise accessible in a high stereo- and regio-selectivity. The products thus controlled in a low molecular weight range have much synthetic potential, particularly for aminosugars 4, since such a ring system is of broad utility as "α-amino-β-hydroxy synthon"[5].



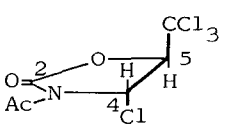
2 (R':Ac,H) 1 3 4

The typical procedures for homopolymerization and telomerization of the five-membered heterocycle, 2-oxazolone are described below.

Polymerization 3-Acetyl-2-oxazolone (1) was heated at 75° for 6hr in the presence of 0.4 wt% of benzoyl peroxide (BPO) under nitrogen atmosphere to yield a clear colorless glassy solid. Purification by reprecipitation with the acetone(or DMF)-CH_2Cl_2(or methanol) solvent system gave homopolymers 2 as a colorless powder (70~80% yield, mp > 300°(decomp.), $[\eta]$=0.24 (DMF at 30°), $\overline{MW}$= 3500 ($\overline{DP}$=30) determined by the vapor pressure osmometric method in acetone, IR 1800 and 1710 cm^{-1}), which was thoroughly deacetylated with methylamine. Pmr spectrum of 2 (R'=Ac) showed broad singlet signals at δ 2.46 and 5.15 in an intensity of 3:2, indicative of no olefinic protons. Hydrolytic cleavage of the rings should provide new polymers with repeating units of $-(-CH(NH_2)-CH(OH)-)_n-$. Copolymers composed of various ratios of 2-oxazolone to vinylene carbonate were also obtainable as a colorless solid in high yields under the free-radical conditions.

Telomerization A solution of 3-acetyl-2-oxazolone (1) (0.04 M) in CCl_4 (0.4 M) was gently refluxed under nitrogen for 30hr, adding catalytic amounts of BPO at 2hr intervals. Chromatography of the products on silica gel gave, among possible four and sixteen isomers, a single compound (5, 35.4%, mp 56°, IR 1810 and 1726 cm^{-1}) as a 1:1 adduct (3, n=1) and two isomers (6, 3.1%, mp 160°, IR 1815 and 1700 cm^{-1}; 7, 9.1%, mp 153°, IR 1795, 1739 and 1722 cm^{-1}) in a 1:3 ratio as n=2 telomers (3, n=2), respectively, in addition to higher telomers (28%) containing an isomeric mixture of n=3 telomers as major component. Such a high stereoselectivity is comparable to that in vinylene carbonate telomer formation[3]. Product distribution depended heavily on the molar ratios of the reactants as expected and thus, initial ratios of 1:5 and 1:15 of taxogen 1 to CCl_4 yielded 14% (70 wt% for higher telomers) and 41% (20 wt% for higher ones) of n=1 telomer 5, respectively.

Reaction of oxazolone 1 with CCl_4 (molar ratio of 1:5) catalyzed by dichlorotris (triphenylphosphine)ruthenium(II) resulted in the exclusive formation of the identical n=1 adduct 5 (91.5%) with negligible amounts of higher telomers, consistent with the previous observations[6].



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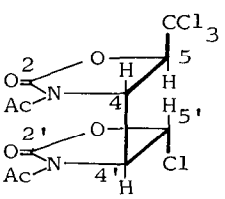

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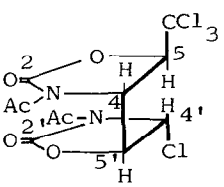
trans-"syn"-trans



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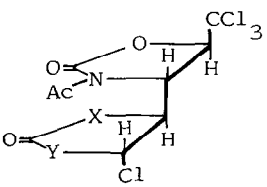

8 (X,Y: O, NAc)

trans-"anti"-trans

Structural assignment of trans n=1 product 5 is based on chemical transformation to the known 4-phenyl-5-trichloromethyl-2-oxazolidone[7] as well as ^{1}H- and ^{13}C-nmr data (Table) involving small coupling constant J=1.7 Hz between the ring protons which is in good accord with trans-values of the similar ring structures, 4-chloro-3-acetyl-2-oxazolidone (J_{trans}=2.3 Hz, J_{cis}=5.0 Hz)[8] and 5-chloro derivative (J_{trans}=2.0 Hz, J_{cis}=4.1 Hz)[8].

The n=2 telomers 6 and 7 were structurally established as "head-to-head" and "head-to-tail" addition products, respectively, by ^{1}H- and ^{13}C-nmr analysis including selective proton decoupling technique. Trichloromethyl group was substituted at 5-position of the heterocycle in all telomers isolated so far and "head-to-tail" addition was preferential, indicative of high regio-selectivity in the present telomerization. Pmr data and the informations from CPK model are in favor of trans-"syn"-trans structures, 6 and 7 for n=2 telomers though trans-"anti"-trans forms 8 can not be precluded, indicating that such a trans addition mechanism is operative as substantiated unequivocally in the formation of a series of vinylene carbonate telomers[3].

Reactivities of the telomers are virtually comparable to those of vinylene carbonate telomers, viz. nucleophilic displacement reactions, reductive conversion of trichloromethyl group etc.[3] Thus, either terminal carbon of the telomer may be converted to formyl group with a view to providing a new route to aminosaccharides. Synthetic utility of type 3 low telomers stereoselectively formed is being explored in our laboratory.

Table. ^{13}C-NMR Data (proton decoupled) and ^{1}H-NMR Data (in parentheses) for 2-Oxazolone Telomers, $\delta(CDCl_3)$ in ppm.

	C_2	$C_4(H_4)$	$C_5(H_5)$	CCl_3	$C_{2'}$	$C_{4'}(H_{4'})$	$C_{5'}(H_{5'})$
5 (n=1)	149.8	66.8 (6.33,d)[a]	89.0 (5.15,d)[a]	94.8			
6 (n=2)	150.2	56.6 (5.11,d,d)[b]	81.8 (4.66,d)[c]	96.5	150.9	65.9 (4.68,d,d)[d]	83.9 (6.27,d)[e]
7 (n=2)	149.5	56.9 (4.77,d,d)[f]	81.8 (4.89,d)[g]	96.5	150.9	67.5 (6.56,d)[h]	81.3 (4.88,d,d)[i]

Coupling constants ($J_{H,H}$) between ring protons : a:J=1.7Hz, b:J=2.4Hz and 2.8Hz, c:J=2.4Hz, d:J=0.7Hz and 2.8Hz, e:J=0.7Hz, f:J=1.5Hz and 7.7Hz, g:J=1.5Hz, h:J=1.0Hz, i:J=1.0Hz and 7.7Hz.

References and Notes

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(Received in Japan 14 September 1979)