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1,4-Addition Reaction of γ,γ-Dialkoxyallylic Zirconium Species as a *gem*-Dialkoxycyclopropyl Anion Equivalent

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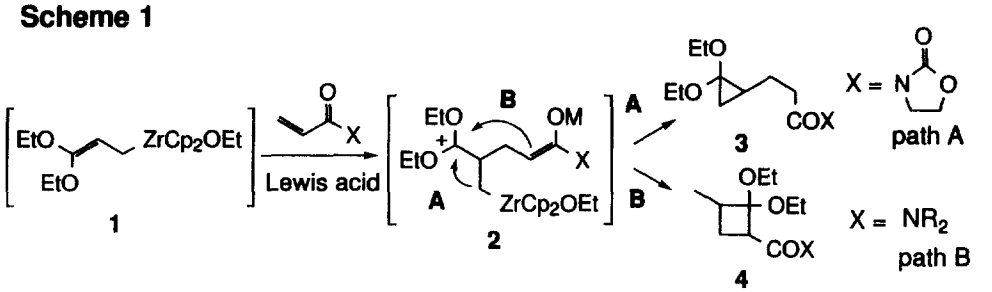
Abstract: In the presence of a Lewis acid (Et_2AlCl), γ,γ-dialkoxyallylic zirconium species reacted with α,β-unsaturated-*N*-acyloxazolidinone to give *gem*-dialkoxycyclopropane derivatives through 1,4-addition reaction.

Cyclopropane derivatives are known as an important class of compounds, which are potentially useful synthetic tools or are often found in biologically active compounds.[1] Recently, we reported a novel preparative method for the *gem*-dialkoxycyclopropane derivatives by the reaction of γ,γ-dialkoxyallylic zirconium species **1** with a carbonyl compound.[2] On further exploration of the reactivity of **1** to α,β-unsaturated carbonyl compounds, we found that, in the reaction with acrylic ester, a mixture of cyclopropane **3** and cyclobutane derivative **4** was formed due to a competitive nucleophilic addition of alkylzirconium (path A) and ketene acetal (path B) to the oxonium intermediate **2** (X = OBn) as shown in Scheme 1. In the preceding paper, we reported the selective preparative method for cyclobutane derivatives **4** by employing acrylamide derivatives to increase the electron density of the ketene *N,O*-acetal moiety of the intermediate **2** (path B).[3] For the selective formation of the cyclopropane derivatives **3** from α,β-unsaturated carboxylic acid derivative, we adopted the *N*-acyloxazolidinones (path A) and the results are reported herein.[4]

Scheme 1



The results of the reaction of γ,γ-diethoxyallylic zirconium species **1** with α,β-unsaturated-*N*-acyloxazolidinone derivatives are summarised in Table 1. For the reaction to proceed, the choice of solvent and Lewis acid was crucial. That is, since the 1,4-addition of **1** did not proceed in toluene in which **1** was prepared, it was needed to change the solvent to dichloromethane before **1** was reacted with *N*-acyloxazolidinones. As a Lewis acid, diethylaluminum chloride worked nicely as compared with other Lewis acid such as trimethylsilyl triflate or titanium chloride. Thus, in the presence of 1.5 equivalent of diethylaluminum chloride in dichloromethane, reaction of **1** with *N*-acyloxazolidinone gave the cyclopropane derivative **3** as the sole product (entry 1).[5] Under similar conditions, methacryloyl- or crotonoyl-*N*-acyloxazolidinone also reacted with **1** to give the cyclopropane **3** selectively in good yield, but the diastereoselectivity was not satisfactory (entries 2 and 3). The high selectivity for the formation of cyclopropane derivative **3** should be accounted for the relatively lower electron density of the *N,O*-acetal moiety

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in the intermediate **2** as compared with that of the acrylamide which produced cyclobutane derivatives **4**.[3] Thus, by changing the electronic nature of the residual group of the enoyl compound, selective formation of the *gem*-dialkoxycyclopropane **3** or cyclobutane **4** can be possible through the 1,4-addition of **1** to an α,β-unsaturated carboxylic acid derivative.

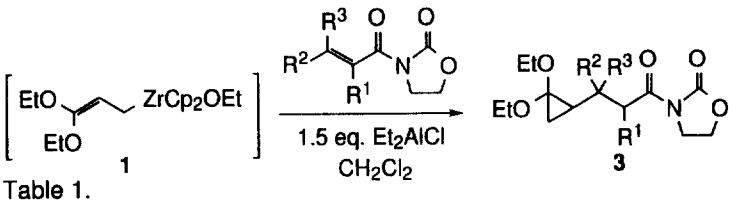


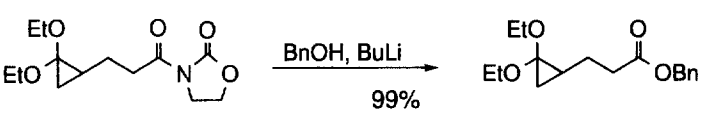
Table 1.

Entry	*N*-acyloxazolidinone	Yield (%)[a]	Cyclopropane/ cyclobutane[b]	Diastereomer ratio[b]
1	$R^1 = R^2 = R^3 = H$	83	> 95 : 5	———
2	R^1 = Me, $R^2 = R^3 = H$	90	> 95 : 5	50 : 50
3	$R^1 = R^3 = H$, R^2 = Me	72	> 95 : 5	70 : 30
4	$R^1 = H$, $R^2 = R^3$ = Me	39[c]	> 95 : 5	———

a) Isolated yield. b) Ratio was determined by 300 MHz ^{1}H NMR. c) $EtAlCl_2$ was employed as Lewis acid.

The removal of the oxazolidinone moiety could be achieved by treatment with benzyl alcohol and n-butyllithium[6] without any effect on the cyclopropane part as shown in Scheme 2.

Scheme 2



We have described here the highly selective construction of cyclopropane derivatives by the reaction of γ,γ-dialkoxyallylic zirconium species with α,β-unsaturated-*N*-acyloxazolidinone derivatives in the presence of diethylaluminum chloride.

References and Notes

1. a) Kuwajima, I.; Nakamura, E. In *Comprehensive Organic Synthesis*; Trost, B. M., Fleming, I., Eds.; Pergamon Press: Oxford, 1991; Vol. 2, Chapter 1.14. b) Suckling, C. J. *Angew. Chem. Int Ed. Engl.* **1988**, *27*, 537.
2. Ito, H.; Kuroi, H.; Ding, H.; Taguchi, T. *J. Am. Chem. Soc.* **1998**, *120*, 6623.
3. Ito, H.; Sato, A.; Taguchi, T., *Tetrahedron Lett.* **1999**, *40*, 3217.
4. Recent examples of the 1,4-addition reaction to the α,β-unsaturated-*N*-acyloxazolidinones. a) Kitajima, H.; Ito, K.; Katsuki, T. *Tetrahedron* **1997**, *53*, 17015. b) Wu, M.-J.; Yeh, J.-Y. *Tetrahedron* **1994**, *50*, 1703. c) Nicolás, E.; Russell, K. C.; Hruby, V. J. *J. Org. Chem.* **1993**, *58*, 766. d) Rück, K.; Kunz, H. *Angew. Chem. Int Ed. Engl.* **1991**, *30*, 694. e) Hayashi, Y.; Otaka, K.; Saito, N.; Narasaka, K. *Bull. Chem. Soc. Jpn.* **1991**, *64*, 2122.
5. New compounds have been satisfactorily characterized.
6. Evans, D. A.; Chapman, K. T.; Bisaha, J. *J. Am. Chem. Soc.* **1988**, *110*, 1238.