

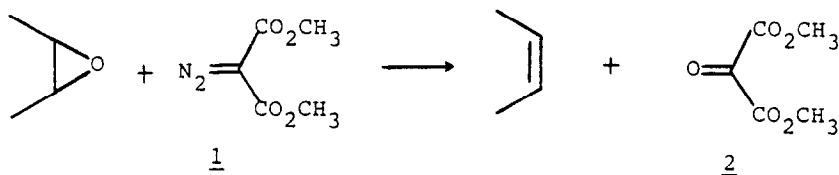
EPOXIDES AS ALKENE PROTECTING GROUPS. A MILD AND EFFICIENT DEOXYGENATION

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Summary: Dimethyl diazomalonate smoothly deoxygenates epoxides to alkenes with rhodium(II) acetate catalysis.

Notably absent from the chemist's repertoire of modern synthetic methods is a reliable, operationally simple (one step), technique for deoxygenating epoxides in high yield under gentle conditions.²⁻³ If such a method were also compatible with complex, functionalized systems, it might ultimately cast the epoxide ring as a practical blocking group for alkenes. Here we report that the combination of dimethyl diazomalonate 1 with catalytic quantities of binuclear rhodium(II) carboxylate salts forms a reagent which rapidly and cleanly deoxygenates most epoxides under neutral conditions without alkene isomerization or cyclopropanation.



Relatively little attention has been paid to the chemistry of 1 and other diazomalonic esters. A recent review of these substances by Peace and Wulfsberg focuses on their photolytic and copper-catalyzed decompositions to carbene and carbenoid species, which can undergo cycloaddition with olefins to form pyrazolines and/or cyclopropanes.⁴ Surprisingly, however, we

observed no cycloadditions in the rhodium-acetate catalyzed reaction of 1 with alkenols, used to construct sensitive enol pyruvates such as chorismic acid and its congeners.⁵ It is now apparent from the results on the facing page that 1 can easily deoxygenate epoxides to alkenes without undergoing subsequent cycloaddition or allylic insertion reactions at the new π -system.⁶ Even 2-cyclohexenone can be prepared from 15 in high yield by this method. The tabulated results warrant several further comments.

Elevated temperatures were required because of the low solubility of $\text{Rh}_2(\text{OAc})_4$ at rt in most solvents. The more soluble rhodium(II) pivalate dimer⁷ catalyzed many reductions in several hours at 25°C. However it is generally more expedient to work at 60-80°C.

The deoxygenation converts 1 into dimethyl oxomalonate 2, an easily hydrated byproduct that can readily be removed along with catalyst by filtration through a short silica column. In fact, the preparation of 2 from 1 using propylene oxide (5 equiv) may be superior to existing methods.⁸ Likewise, ethyl trimethylsilyldiazoacetate⁹ is oxidized to silylketoester 11 in twice the yield of previously reported methods.¹⁰⁻¹¹



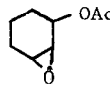
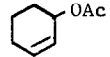
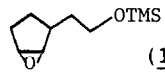
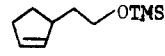


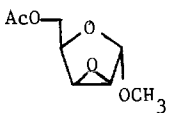
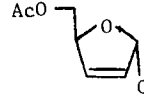
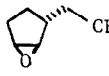
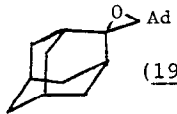
Biochemically important $\Delta^{2,3}$ -nucleosides¹² are difficult to prepare from trans-2,3-diols.¹³ The efficient reduction of methyl 2,3-anhydro- α -D-lyxofuranoside 16¹⁴ to unsaturated sugar 17 underscores the potential utility of this new technique in carbohydrate chemistry.

Some limitations of the method should be noted. Unlike ketones and halides, aldehydes such as 18 undergo competing carbonyl insertion reactions. Epoxide 19 of adamantylideneadamantane¹⁵ was recovered unchanged even after prolonged reaction times.

A representative procedure is annotated below.¹⁶

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TABLE

EPOXIDE	CONDITIONS ^a	PRODUCT (YIELD)
epoxycyclohexane (<u>1</u>)	toluene	cyclohexene (80%) ^b
cis-epoxycyclo- dodecane (<u>4</u>)		cis-cyclododecene ^b (83%)
<u>4</u>	rhodium pivalate/ C ₆ H ₆ /rt/6h	cis-cyclododecene ^b (76%)
1.7:1 cis:trans- epoxycyclododecanes		cyclododecenes: cis/trans=1.7:1 (85%)
cis-2,3-epoxyhexane (<u>6</u>)	C ₆ D ₆	cis-3-hexene (82%) ^d
trans-2,3-epoxyhexane (<u>7</u>)	C ₆ D ₆	trans-3-hexene (80%) ^c
tetramethylethylene oxide (<u>8</u>)	toluene	tetramethylethylene ^b (60%)
propylene oxide (<u>9</u>)		<u>2</u> (84%) ^e
<u>9</u>	TMSC(N ₂)CO ₂ Et/C ₆ H ₆	TMS-C(=O)-CO ₂ Et (78%)
 Br (<u>12</u>)	<u>10</u> toluene	 Br (84%) ^b
 (<u>13</u>)		 (76%)
 (<u>14</u>)		 (75%)
 (<u>15</u>)		 (80%)
 (<u>16</u>)		 <u>17</u> (82%)
 (<u>18</u>)		—
 (<u>19</u>) mp 181-82°		recovered <u>19</u> (95%)

(a) Unless otherwise indicated, benzene, reflux, 30-45 min, using 5mg Rh₂(OAc)₄.(b) Yield determined by GC, using pure products and C₆H₅Br as internal stds.(c) No trace of cis-3-hexene was detected. (d) No trace of trans-3-hexene was detected. (e) Yield of distilled 2.

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16. A solution of scrupulously pure dimethyl diazomalonate (0.15-0.3 mmol) in C₆H₆ (5mL, dried over CaH₂) was added dropwise to a mixture of Rh₂OAc₄ (5mg) and epoxide (0.1 mmol) in C₆H₆ (5mL) at reflux. Upon completion of addition (10 min), the reaction mixture was heated another 30 min, then cooled and filtered through a pipetteful of SiO₂. Removal of solvent in vacuo afforded the product which could be purified, if necessary, by column chromatography.

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