## A FACILE SYNTHESIS OF 1,3-CYCLOALKADIONES

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1,3-Cycloalkadiones were prepared by the reaction of 1,2-bis(trimethylsiloxy)cycloalkenes with chloromethyl methyl ether followed by treatment of the resulting 2-hydroxy-2-methoxymethyl cycloalkanones with potassium hydrogen sulfate. The first step of the reactions was effectively catalyzed by active zinc reagents prepared from zinc-copper and alkyl iodides.

Our previous studies on the chemical behavior of the active zinc reagents prepared from zinc-copper couple and alkyl iodides have shown that regioselective introduction of a methoxymethyl group to the  $\alpha$ -position of a carbonyl group of ketones<sup>1</sup> can be promoted by the active zinc reagents. On the other hand, because of their high potentiality, 1,3-cycloalkadiones are undoubtedly the important targets in the study on organic synthesis.<sup>2</sup> In this study, we wish to report a novel synthesis of 1,3-cycloalkadiones 3 from 1,2-bis(trimethylsiloxy)cycloalkenes 1 through the reaction of 1 with chloromethyl methyl ether 4 in the presence of the active zinc reagents, followed by acid-catalyzed ring enlargement of the resulting 2-hydroxy-2-methoxymethylcycloalkanones 2, as shown in the following equation.<sup>3</sup>



Since the 1,2-bis(trimethylsiloxy)cycloalkenes 1 are easily prepared from the corresponding  $\alpha,\omega$ -dicarboalkoxyalkanes 5,<sup>4</sup> the present reaction seems to be equivalent to joining two carboalkoxyl group of 5 with the methylene group of 4.

A typical procedure is as follows: To a solution of zinc-copper couple<sup>5</sup> prepared from 2.54 g (0.04 mol) of zinc dust and 0.40 g (0.004 mol) of cuprous chloride in methylene chloride was added 3.40 g (0.02 mol) of isopropyl iodide,<sup>6</sup> and the solution was refluxed for 30 min with stirring under an atmosphere of nitrogen. Then, to the solution was added 5.12 g (0.02 mol) of 1,2-bis(trimethylsiloxy)cyclohexene **1c** at 0-5 °C and subsequently a solution of 1.77 g (0.022 mol) of chloromethyl methyl ether **4** in 5 ml of methylene chloride at 0-2 °C in a dropwise manner with stirring. The mixture was stirred for 1 hr at 0 °C and for 2 hr at room temperature successively. Usual working up of the reaction mixture and fractional distillation gave 2-hydroxy-2-methoxy-methylcyclohexanone **2c** in a 67% yield: bp 75 °C/3 mmHg; IR (neat) 3090, 1720, 1130 cm<sup>-1</sup>; NMR (CCl<sub>4</sub>, ppm) & 3.84, 3.75 (d, J = 8.0 Hz, 2H), 3.60 (br s, 1H), 3.39 (s, 3H), 2.62-1.80 (m, 8H); Anal. Calcd for C $_8H_{14}O_3$ : C, 60.74; H, 8.92. Found: C, 60.91; H, 8.93.

Dropwise addition of 1.58 g (0.01 mol) of 2c to a catalytic amount (0.2-0.3 g) of potassium hydrogen sulfate at 170-180 °C under reduced pressure (20-25 mmHg) gave 0.95 g (Y = 75%) of 1,3-cycloheptadione 3c, which was identical with an authentic sample<sup>7</sup> in spectroscopic and gas chromatographic analyses.

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A variety of 1,3-cycloalkadiones **3a-e** was obtained from the corresponding 1,2-bis(trimethylsiloxy)cycloalkenes **1a-e** by using similar procedures. The yields are shown in Table 1.<sup>8</sup>

	<b>1</b> n	<b>2</b> Yield (%) <sup>a)</sup> Bp (°C/mmHg)		Yield (%) <sup>a)</sup>	<b>3</b> Yield (%) <sup>a)</sup> Bp (°C/mmHg)		nmHg)
a	2	51	92/10	52	151 <sup>b)</sup>	(lit. <sup>9</sup>	151 - 152) <sup>b)</sup>
Ъ	3	59	99/10	61	105 <sup>b)</sup>	(lit. <sup>10</sup>	105 - 106) <sup>b)</sup>
C	4	67	75/3	75	122/10	(lit. <sup>7</sup>	84 - 85/1)
đ	5	48	80/3	51	95/3	(lit. <sup>2c</sup>	110 - 112/8)
e	6	47	84/3	50	99/3	(lit. <sup>2c</sup>	122/10)

Table 1. Synthesis of 1,3-Cycloalkadiones 3.

a) Isolated yield.

b) Mp (°C).

On the basis of the simple procedure, generality and moderate yields, the present method is reasonably promising in the synthesis of 1,3-cycloalkadiones.

## References and Notes

- 1) T. Shono, I. Nishiguchi, T. Komamura, and M. Sasaki, J. Am. Chem. Soc., 101, 984 (1979).
- 2) Recent papers on synthesis of 1,3-cycloalkadiones:
  - a) Y. Ito, S. Fujii, and T. Saegusa, J. Org. Chem., 41, 2073 (1976); *ibid.*,
    42, 2326 (1977).
  - b) E. Nakamura and I. Kuwajima, J. Am. Chem. Soc., 99, 961 (1977).
  - c) K. Schank and B. Eistert, Chem. Ber., 99, 1414 (1966), and others cited therein.
- 3) Ring enlargement of 1,2-bis(trimethylsiloxy)-1-cyclobutene to 2,2-dialkyl-1,3-cyclopentadiones has been reported.<sup>2b</sup> The application of this method to synthesis of nonsubstituted cyclic 1,3-diones may be difficult.
- 4) J. J. Bloomfield, D. C. Owsley, and J. M. Nelke, "Organic Reactions", John Wiley & Sons, Inc., New York (1976), Vol. 23, Chap. 2, P. 259.
- 5) R. J. Rawson and I. T. Harrison, J. Org. Chem., 35, 2057 (1970).
- 6) Substitution of isopropyl iodide with methyl iodide or methylene iodide resulted in decrease in the yield of 2b. Employment of zinc chloride or iodide instead of the active zinc reagents gave only a trace amount of 2b and much tarry material.
- 7) M. W. Cronyu and J. E. Goodrich, J. Am. Chem. Soc., 74, 3331 (1952).
- 8) All the products showed satisfactory spectral data for assigned structures.
- 9) T. Waller, J. Am. Chem. Soc., 74, 4978 (1952).
- 10) T. Merling, Liebigs Ann. Chem., 278, 28 (1894).

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