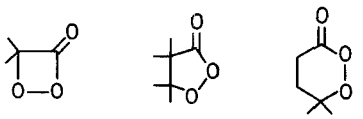
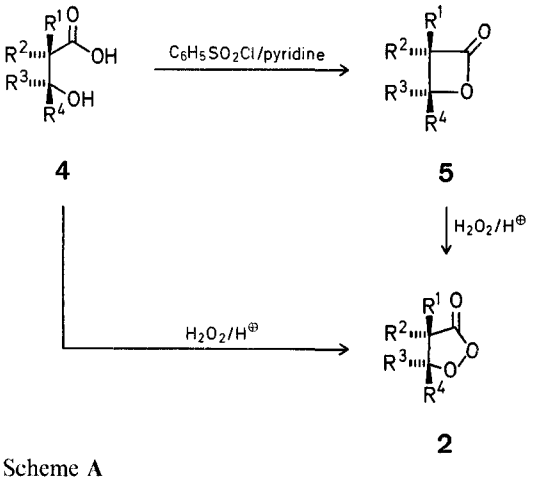


1 2 3

Previously, we prepared β-peroxylactones **2** directly from β-hydroxy acids **4** by acid-catalyzed cyclization with 98% hydrogen peroxide in ether (Scheme A)[5].



4 5 2

Scheme A

While this method worked reasonably well for β-aryl-β-alkyl systems (R^4 = aryl, R^3 = alkyl, $R^1 = R^2 = H$), poor results, i.e. low yields and impure products, were obtained in the case of β-hydroxy acids **4** with mono- or di-substitution at the α-carbon, and dialkyl- and diaryl-substitution at the β-carbon. Since such β-hydroxy acids **4** can now be conveniently cyclized in high yields into the respective β-lactones **5**[6], we have explored the utilization of the perhydrolysis of β-lactones **5** as a synthetic route to β-peroxylactones **2**. Treatment of β-lactones **5a–e**, the latter prepared by cyclization of the β-hydroxy acids **4a–e**, which were readily available by condensation of α-lithiocarboxylates with the appropriate ketone[6], with 98% hydrogen peroxide in the presence of catalytic amounts of sulfuric acid (see General Procedure), afforded the β-peroxylactones **2a–e** in high yields. The purity of the β-peroxylactones was established by iodometric titration, and their structures confirmed on the basis of I.R., N.M.R., and mass spectral data (Table 1).

Of mechanistic interest is to mention that perhydrolysis of *erythro*-β-lactone **5a** gave a 60:40 mixture, while *threo*-β-lactone **5b** gave a 40:60 mixture of *erythro*- and *threo*-β-peroxylactones **2a** and **2b**, respectively, as confirmed by N.M.R. analysis of the crude reaction mixture[7]. This indicates that the perhydrolysis of **5** proceeds with partial stereospecific retention of the initial β-lactone configuration. Presumably, the internally solvated carbonium ion derived by protonation of the β-lactone **5** suffers preferential front-side collapse with hydrogen peroxide, in order to explain the observed stereochemistry.

Novel Synthesis of β-Peroxylactones via Perhydrolysis of β-Lactones[1]

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In our studies on the thermolysis and photolysis of cyclic peroxyesters such as the α-peroxylactones **1**[2], β-peroxylactones **2**[3], and γ-peroxylactones **3**[4], we required a convenient synthesis of β-peroxylactones **2** which are mono- and di-substituted at the α-carbon.

Preparation of β-Hydroxy Acids 4a–e:

3-Hydroxy-2,2,3-trimethylbutanoic Acid (**4a**) was prepared by the addition[6] of lithium α-lithioisobutyrate (50 mmol) to acetone (50 mmol) in dry ether (50 ml); yield: 68%; m.p. 156° (Ref.[8], m.p. 152–153°).

2,2-Dimethyl-3,3-diphenyl-3-hydroxypropanoic Acid (**4b**) was prepared by the addition[6] of lithium α-lithioisobutyrate (25 mmol)

Table 1. Important Physical and Spectral Data of the β-Peroxylactones

	R^1	R^2	R^3	R^4	Yield %	m.p.	Carbonyl Stretch (C=O, cm^{-1}, CCl_4)	N.M.R. (60 MHz) δ(ppm, TMS)	Solvent
2a	CH_3	CH_3	CH_3	CH_3	60	85–86°	1795	1.24 (s, 6H), 1.30 (s, 6H)	CCl_4
2b	C_6H_5	CH_3	CH_3	C_6H_5	83	76–76°	1800	1.40 (s, 6H) 7.35 (m, 10H)	CCl_4
2c	C_6H_5	CH_3	CH_3	$-CH_2-C_6H_5$	100	118° (dec.)	1795	1.03 (s, 3H), 1.56 (s, 3H) 3.26 (s, 2H), 7.20 (m, 10H)	$CDCl_3$
2d	C_6H_5	CH_3	H	$-CH_2-C_6H_5$	50[a]	95–96°	1795	1.02 (d, 3H, J = 7.0 Hz), 2.77 (q, 1H, J = 7.0 Hz), 2.77 (AB, 2H, J = 13 Hz), 6.90 (m, 10H)	C_6D_6
2e	C_6H_5	CH_3	CH_3	$-CH_2-C_6H_5$	50[b]	73–74°	1800	0.73 (d, 3H, J = 7.0 Hz), 2.77 (q, 1H, J = 7.0 Hz), 2.88 (m, 2H), 6.90 (m, 10H)	C_6D_6

[a] Obtained by fractional recrystallization of a 60:40 *erythro-* and *threo*-mixture.
[b] Obtained by fractional recrystallization of a 60:40 *threo-* and *erythro*-mixture.

to benzophenone (25 mmol) in dry ether (45 ml); yield: 19%; m.p. 160–162° (Ref.[6], m.p. 166–170°).

2,2-Dimethyl-3,4-diphenyl-3-hydroxypropanoic Acid (**4c**) was prepared by the addition[6] of lithium α-lithioisobutyrate (25 mmol) to deoxybenzoin (25 mmol) in dry tetrahydrofuran (50 ml); yield: 30%; m.p. 185° (Ref.[6], m.p. 185–186°).

erythro- *and* threo-*3,4-Diphenyl-3-hydroxy-2-methylbutanoic Acids* (**4d** and **4e**) were prepared by the addition[6] of lithium α-lithiopropanoate (50 mmol) to deoxybenzoin (50 mmol) in dry tetrahydrofuran (50 ml), and separating the *erythro-threo* mixture by fractional recrystallization from heptane. Yield of **4d**: 27%; m.p. 114–115° (Ref.[6], m.p. 113–114°). Yield of **4e**: 27%; m.p. 182–183° (Ref.[6], m.p. 182–183°).

Preparation of β-Lactones 5a–e:

3,3,4,4-Tetramethyloxetan-2-one (**5a**) was prepared by cyclization[6] of β-hydroxy acid **4a** (7.4 mmol) with benzenesulfonyl chloride (14.8 mmol) in dry pyridine (30 ml); yield: 78%; m.p. 129–130°. The structural characterization rests on the following spectral data.

I.R. (CCl_4): ν_{max} = 1820 (strong, C=O), 1380 and 1365 cm^{-1} (medium, *gem*-dimethyl).

N.M.R. (CCl_4, TMS, 60 MHz): δ = 1.26 (s, 6H, 3,3-di-CH_3), 1.46 ppm (s, 6H, 4,4-di-CH_3).

3,3-Dimethyl-4,4-diphenyloxetan-2-one (**5b**) was prepared by cyclization[6] of β-hydroxy acid **4b** (3 mmol) with benzenesulfonyl chloride (6 mmol) in dry pyridine (25 ml); yield: 80%; m.p. 101° (Ref.[6], m.p. 101°).

4-Benzyl-3,3-dimethyl-4-phenyloxetan-2-one (**5c**) was prepared by cyclization[6] of β-hydroxy acid **4c** (4 mmol) with benzenesulfonyl chloride (8 mmol) in dry pyridine (30 ml); yield: 95%; m.p. 146° (Ref.[6], m.p. 145–146°).

erythro-*4-Benzyl-3-methyl-4-phenyloxetan-2-one* (**5d**) was prepared by cyclization[6] of *erythro*-β-hydroxy acid **4d** (0.7 mmol) with benzenesulfonyl chloride (1.4 mmol) in dry pyridine (5 ml); yield: 98%; m.p. 119° (Ref.[6], m.p. 119°).

threo-*4-Benzyl-3-methyl-4-phenyloxetan-2-one* (**5e**) was prepared by cyclization[6] of *threo*-β-hydroxy acid **4e** (1.0 mmol) with benzenesulfonyl chloride (2.0 mmol) in dry pyridine (8 ml); yield: 97%; m.p. 101–102° (Ref.[6], m.p. 103–104°).

General Method for the Perhydrolysis of β-Lactones 5a–e:

A 25-ml stoppered Erlenmeyer flask is charged with dry ether (4 ml) containing conc. sulfuric acid (0.4 ml) and cooled to 0–5° by means of an ice bath. The solution is stirred magnetically and 98% hydrogen peroxide (2.0 ml; *Caution!*) is added dropwise by remote control. After 5 min, pulverized β-lactone **5** (2.0 mmol) is added in small portions within 10–15 min with stirring at 0–5°. The reaction mixture is allowed to come to room temperature while continuing stirring. The progress of the perhydrolysis is monitored by I.R., following the disappearance of the β-lactone carbonyl (1830 cm^{-1}) and the appearance of the β-peroxylactone carbonyl (1800 cm^{-1}). Once all the lactone is consumed, the reaction mixture is diluted 10× with ether, washed with saturated aqueous ammonium sulfate (3 × 10 ml), saturated aqueous sodium hydrogen carbonate (3 × 10 ml), and water (2 × 10 ml), dried ($MgSO_4$), and the solvent evaporated at reduced pressure. Recrystallization from hot hexane affords the pure β-peroxylactones.

4,4,5,5-Tetramethyl-1,2-dioxolan-3-one (**2a**); yield: 60%; m.p. 85–86° (Ref.[9], m.p. 85–86°); purity: 99% (iodometric titration).

4,4-Dimethyl-5,5-diphenyl-1,2-dioxolan-3-one (**2b**); yield: 83%; m.p. 75–76°; purity: 99% (iodometric titration).

5-Benzyl-4,4-dimethyl-5-phenyl-1,2-dioxolan-3-one (**2c**); yield: 100%; m.p. 118° (dec.); purity: 99% (iodometric titration).

erythro-*5-Benzyl-4-methyl-5-phenyl-1,2-dioxolan-3-one* (**2d**). The crude product (60:40 mixture of *erythro-* and *threo*-isomers by N.M.R.) obtained in quantitative yield by perhydrolysis of **5d** was purified by fractional recrystallization from hot hexane; yield: ~50%; m.p. 95–96° (Ref.[7], m.p. 94–97°); purity: 99% (iodometric titration).

threo-*5-Benzyl-4-methyl-5-phenyl-1,2-dioxolan-3-one* (**2e**). The crude product (60:40 mixture of *threo-* and *erythro*-isomers by N.M.R.) obtained in quantitative yield by perhydrolysis of **5e** was purified by fractional recrystallization from hot hexane; yield: ~50%; m.p. 74–76° (Ref.[7], m.p. 74–76°); purity: 99% (iodometric titration).

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