INVESTIGATION OF ELECTROCHEMISTRY

OF

HIGH ENERGY COMPOUNDS IN ORGANIC ELECTROLYTES

BIBLIOGRAPHY ON PROPYLENE CARBONATE, γ-BUTYROLACTONE, AND RELATED SUBJECTS

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by

J. P. MARCINISZYN, JR. and R. T. FOLEY

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BIBLIOGRAPHY ON PROPYLENE CARBONATE AND γ-BUTYROLACTONE

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Preface

In the investigation of new high energy electrochemical systems the cyclic esters such as propylene carbonate and γ-butyrolactone have been demonstrated to possess exceptional characteristics. This stems from their chemical, physical, and electrochemical properties. With respect to electrochemical properties, it has been observed that the decomposition voltages for solutions of lithium perchlorate in these solvents are in the 5-6 volt range.

The employment of these solvents in electrochemical systems requires a rather complete knowledge of the chemistry of the compounds. For example, it is intended to use organic depolarizers at cathodes in certain cells. The question arises as to possible condensations, couplings, etc. that these organic depolarizers can undergo with the cyclic esters. Further, it has been observed that aluminium chloride forms highly conducting solutions in these solvents. However, aluminium chloride also catalyzes certain condensations and decompositions of the cyclic esters. It must be known how these catalytic reactions affect the stability of the electrolytic solutions.

Much work has been done and reported in the literature on questions of this type and the purpose of this bibliography is to organize the references in the open literature so that all this previous work will be available. It is expected that this bibliography will furnish a good starting point for future investigations on these solvent systems.

Whereas, the bibliography is fairly extensive, many references in the categories set out below were not included because they did not appear pertinent to the topic of interest, namely, the investigation of the electro-

chemistry of high energy compounds in organic electrolytes. On the other hand, some references were included because they appeared to discuss analogous reactions of interest.

Bibliography

I. Lactones.

Angell, C. L., Gallagher, B. S., Ito, T., Smith, R. J. D., and Jones, R. N.
Infrared spectra of lactones.
National Research Council of Canada, NRC Bull. No. 7; 59 pp. (1960). C. A. 55, 10067 (1961).

Barbier, P. and Loquin, R.
Action of $SOCl_2$ on certain lactones.
Bull. soc. chim. 13, 223-9. J. Chem. Soc. 104, I, 336-7. C. A. 7, 3313 (1913).
γ-Lactones + $SOCl_2$ + benzene = esters of γ-hydroxy acids.

Blaise, E. E. and Koehler, A.
Lactonization of alcohol acids.
Compt. rend. 148, 1772. C. A. 3, 2675-6 (1909).

Britton, E. C. and Vander Veele, J. C.
Halogenated derivatives of aliphatic acids and lactones.
U. A. 2,530,348, Nov. 14, 1950. C. A. 45, 1969 (1951).
Direct halogenation at elevated temperatures.

Cherdron, H., Ohse, H., and Korte, F.
Polymerization of lactones. I. Homopolymerization of 4-, 6-, and 7-membered lactones with cationic initiators. II. Homopolymerization of 4-, 6-, and 7-membered lactones with anionic initiators.
Makromol. Chem. 56, 179-94 (1962). C. A. 58, 580 (1963).

Cox, E. F. and Hostettler, F.
Lactone polymers.
Brit. 981,199 (Cl. C08g), Jan 20, 1965, Appl. Feb. 21, 1962; 13 pp. C. A. 62, 11936 (1965).

Darzens, G.
New general method of synthesis of γ- and δ-lactones.
Compt. rend. 228, 185-7 (1949). C. A. 43, 3786 (1949).

Feofilaktov, V. V. and Onishchenko, A. S.
Reaction of α-cyanobutyrolactone with phenyldiazonium chloride.
J. Gen. Chem. (U. S. S. R.) 9, 304-13 (1939). C. A. 34, 379 (1940).
Disubstituted derivatives.

Fleck, F., Rossi, A., and Schinz, H.
Some reactions of α-keto-β-bromo-γ-lactones.
Helv. Chim. Acta 32, 998-1012 (1949) (in German). C. A. 43, 6980-1 (1949).

Fleck, F., Rossi, A., Hender, M., and Schinz, H.
The catalytic hydrogenation of enolizable α-keto-γ-lactones.
Helv. Chim. Acta 33, 130-9 (1950) (in German). C. A. 44, 5316-7 (1950). C. A. 42, 1198 (1948).
The catalysts are Pd-$CuCO_3$, Pt, and Raney Ni.

Hindes, M., Schinz, H., and Seidel, C. F.
Thermal decomposition of γ-lactones.
Helv. Chim. Acta 30, 1495-01 (1947) (in German). C. A. 42, 2929 (1948).

Holmberg, B.
Lactone acids.
Svensk. Kem. Tidskrift 30, 190-22 (1918). C. A. 13, 1582 (1919).

Jacobs, W. A. and Scott, A. B.
Hydrogenation of unsaturated lactones to desoxy acids.
J. Biol. Chem. 93, 139-52 (1931). C. A. 26, 86 (1932). C. A. 24, 5721 (1930).

Kailan, A.
Formation and hydrolysis of lactones. II.
Z. physik. Chem. 101, 63-93 (1922). C. A. 16, 2439 (1922).
Dependence on hydrogen ion concentration.

Kapp, R., Pickel, F. D., and Rosenbery, J. L.
Aldehydes and lactones.
U. S. 2,434,246, Jan. 13, 1948. C. A. 42, 2271 (1948). C. A. 34, 6225 (1940).

Klug, H.
Tetrachlorosuccinic acid and its derivatives. I. Tetrachlorosuccinic acid and its derivatives by chlorination of γ-lactones and γ-lactims.
Ann. Chem. 677, 67-71 (1964). C. A. 62, 439-40 (1965).

Kohn, M.
Ractions of lactones. I.
Monatsh. Chem. 34, 1729-40. C. A. 8, 499 (1914).

Kohn, M. and Ostersetzer, A.
Reactions of lactones. II.
J. Chem. Soc. 110, I, 605-6. C. A. 10, 3070 (1916).

Marc, J., Sylvestre, J., and Bémont, B.
Preparation of cyclopropane acids from γ-lactones.
Compt. rend. 245, 2304-6 (1957). C. A. 52, 9969 (1958).

Lactones.
Brit. 306,352, June 26, 1928. C. A. 23, 4950, 4483, 2187 (1929).

Lactones.
Brit. 579, 169, July 25, 1946. C. A. 41, 2450-2 (1947).
Synthesis.

Lactones by dehydrogenation of diols.
Brit. 583,344, Dec. 16, 1946. C. A. 41, 2746-7 (1947).
Synthesis.

Lactones.
Fr. 716,890, May 11, 1931. C. A. 26, 2199 (1932).
Lactonization by acidification.

Lactones.
Fr. 1,139,239, Feb. 22, 1963; Ger. appl. April 8, 1961; 13 pp.
C. A. 59, 8600 (1963).
Preparation.

Monocyclic lactones.
Ger. 511,884, June 19, 1928. C. A. 25, 1260 (1931). C. A. 23, 4483 (1929).

Plieninger, H.
α-Halo-γ-lactones.
Ger. 800,297, Oct. 25, 1950 (Cl. 12o, 11). C. A. 45, 1622 (1951).
Preparation by distillation of α, γ-dihalo fatty acids.

Rambaud, R. and Fritz, M.
Preparation of alkoxy lactones.
Compt. rend. 222, 744-6 (1946). C. A. 40, 4027 (1946). C. A. 30, 3404 (1936).
Preparation.

Reppe, W. et al.
Ethynylations. VI. Dehydrogenation of γ-diols and reactions of γ-lactones.
Ann. 596, 158-224 (1955). C. A. 50, 16783-9 (1956).

Rossi, A. and Schinz, H.
α-Keto-γ-alkyl-γ-lactones.
Helv. Chim. Acta 31, 473-92 (1948) (in Italian). C. A. 42, 1198, 4937-9 (1948).
Synthesis.

Ruggli, P., Weis, P., and Rupe, H.
Ketones, ketone acids, and enol lactones. XI. Synthesis of the 1, 4-diphenylbutane series.
Helv. Chim. Acta 29, 1788-98 (1946) (in German). C. A. 41, 1638-40 (1947). C. A. 40, 4681 (1946).

Scheuing, G. and Walach, B.
Lactones.
Ger. 584,372, Oct. 18, 1933. C. A. 28, 175 (1934). C. A. 27, 3484, 3945 (1933).

Schinz, H. and Hinder, M.
Preparation and properties of various α-keto-β-lactones.
Helv. Chim. Acta 30, 1349-73 (1947) (German). C. A. 42, 1198-1200 (1948).
Preparation.

Schroeter, G. and Gluschke, A.
Lactones.
Ger. 508,482, Oct. 15, 1926. C. A. 25, 967 (1931).
Lactones of aliphatic naphthalene acids.

Schroeter, G. and Gluschke, A.
Lactones.

Ger. 511,887, Jan. 20, 1928. C. A. 25, 967 (1931).
Lactones of aliphatic naphthalene acids.

Schroeter, G. and Gluschke, A.
Lactones.
Fr. 659,119, Aug. 17, 1928. C. A. 23, 5195 (1929).

Schroeter, G. and Gluschke, A.
Alicyclic lactones.
Brit. 323,187, Aug. 23, 1928. C. A. 24, 3022 (1930). C. A. 23, P5195 (1929).

Searles, S., Tamres, M., and Barrow, G. M.
Hydrogen bonding of esters and lactones. Site of bonding and effect of ring size.
J. Am. Chem. Soc. 75, 71-3 (1953). C. A. 47, 11243-4 (1953).

Semmles, F. W.
Preparation of γ-, δ-, ε-, etc., glycols and their derivatives from the corresponding γ-, δ-, ε-, etc., lactones.
Ber. deut. chem. Ges. 39, 2851-57. C. A. 1, 50 (1907).
Lactones are easily reduced by means of sodium and boiling ethanol, the yield of glycol being 20-60%.

Syhora, K.
Five-membered ring enol lactones.
Chem. Listg. 53, 311-64 (1959).
A review of 295 references.

Toresell, K. and Dahlquist, K.
Addition of dibromomalononitrile to double bonds. Route to γ-lactones.
Acta Chem. Scand. 16, 346-50 (1962) (English). C. A. 57, 5842 (1962).
Synthesis.

von Oettingen, W. F.
Comparison of various lactones with santonin. I.
J. Pharmacol. 36, 335-54 (1929). C. A. 24, 1156 (1930).

Zhukov, A. A. and Shestakov, P. I.
Formation of γ-lactones.
J. Russ. Phys. Chem. Soc. 40, 830-9. C. A. 3, 1148 (1909).

II. BUTYROLACTONES.

A. Purification and Properties.

Ham, G. E.
Separation of γ-valerolactone from water.
U. S. 2,503, 200, April 4, 1950. C. A. 44, 7869 (1950).
Butyrolactone is separable from aqueous solutions by mixing with the aqueous solution a hydrocarbon of the group consisting of benzene, toluene, xylene in sufficient amounts to produce two liquid phases, separating these phases, evaporating the hydrocarbon from the nonaqueous phase and recovering the lactone.

Ishida, H.
Purification of γ-butyrolactone.
Japan 8662 ('58), Sept. 27. C. A. 54, 43932 (1960).

Keeney, P. G.
Paper chromatographic separation of aliphatic lactones.
J. Am. Oil Chemists' Soc. 34, 356-8 (1957). C. A. 51, 14155-6 (1957).
R_f values for γ-butyrolactone for three solvent systems.

Mc Kinley, C. and Copes, J. P.
Some properties of pure γ-butyrolactone.
J. Am. Chem. Soc. 72, 5331 (1950). C. A. 45, 4655 (1951).

Mizukami, S. and Nagata, K.
Determination of γ-butyrolactone and its derivatives. I. Colorimetric determination of γ-butyrolactone.
J. Pharmacol. Soc. Japan 76, 1129-33 (1956). C. A. 51, 952 (1957).
1. 370-480 mg. in 250 ml. of water.
2. Take 10 ml. and dilute to 100 ml. with water.
3. Take 5 ml. and add 10 ml. hydroxylamine-hydrochloride/sodium hydroxide reagent (25 ml. 3N hydroxylamine-hydrochloride with two drops indicator containing 100 mg. each of phenolphthalein and thymolphthalein in 100 ml. 95% ethanol, 3N sodium hydroxide added to turn purple, then 10-20 drops of indicator added).
4. Heat 20 min. at 40°, cool and shake with 10 ml. ferric allum reagent (25 g. alum in 125 ml. 3.5N nitric acid up to 250 ml. with water), then let stand 10 min.
5. Absorbancy at 505 millimicrons.
   % by weight = (11093 A + 77.5)/mg. sample.

Pickel, F. D. and Rosenberg, L. T.
Purifying lactones.
U. S. 2,439,905, April 20, 1948. C. A. 42, 5467 (1948).
Purification of α-hydroxy-β, β-dimethyl-γ-butyrolactones.

B. Preparation of γ-Butyrolactone.

Blicke, F. F., Wright, W. B., Jr., and Zienty, M. F.
Action of γ-alkoxybutyryl chloride.
J. Am. Chem. Soc. 63, 2488-90 (1941). C. A. 35, 7372-3 (1941).
Methyl γ-chlorobutyrate is refluxed 48 hours with ethanol and potassium hydroxide to yield γ-butyrolactone.

Dunlop, A. P. and Sherman, E.
γ-Hydroxybutyraldehyde and γ-butyrolactone.
U. S. 3,074,964 (Cl. 260-343.6), Jan. 22, 1963, Appl. April 3, 1961; 4 pp. C. A. 58, 11223 (1963).
Synthesis.

Elderfield, R. C.
Butyrolactone and hydroxybutyrolactone derivatives.
U. S. 2,359,096, Sept. 26, 1944. C. A. 39, 1883-4 (1945).
Preparation.

Folkers, K.
Butyrolactones.
U. S. 2,659,773, Nov. 17, 1953. C. A. 49, 2489-90 (1955). C. A. 46, 8676 (1952).

Hart, H. and Curtis, O. E., Jr.
Aluminum chloride catalyzed reaction between ethylene oxide and malonic ester.
J. Am. Chem. Soc. 77, 3138-9 (1955). C. A. 50, 4024 (1956).
C. A. 49, 8109 (1955).
Quantitative yields of γ-butyrolactone.

Huisgen, R., Moebius, L., and Szeimies, G.
1, 3-dipolar cycloadditions. XIV. Addition of organic azides to enol ethers: Orientation and triazoline decomposition.
Chem. Ber. 98 (4), 1138-52 (1965). C. A. 62, 13147 (1966).
C. A. 62, 16247-9 (1965).

Infiesta, J. L., Guzman, G. M., and Alberola, A. R.
Synthesis of γ-butyrolactone.
Anales real. soc. espan. fis. y quim. 47B, 4 3-8 (1951). C. A. 46, 3953 (1952).

Johnston, J. D.
Butyrolactones.
U. S. 2,986,568, May 30, 1961. C. A. 56, 3420 (1962).
Preparation.

Jones, D. G. and Dean, F.
γ-Butyrolactone from saturated furans.
Brit. 610,166, Feb. 7, 1949. C. A. 43, 3029 (1949).

Nishigori, I., Tatsuya, B., and Marahashi, S.
Plasticizers. I. Synthesis of γ, γ'-oxydibutyric acid and its esters.
Chem. High Polymer (Japan) 8, 249-53 (1951). C. A. 47, 6345 (1953).
Preparation of γ-butyrolactone from 1, 4-butanediol.

γ-Butyrolactone.
Japan 3421 ('64), April 2, Appl. July 25, 1961; 2 pp. C. A. 61, 2977 (1964).
Preparation.

Robertson, A.
Tetrahydrofuran hydroperoxides.
Nature 162, 153 (1948). C. A. 42, 8792 (1948).
γ-Butyrolactone is formed as a decomposition product.

Shostakovskii, M. F., Sidel'kovskaya, F. P. and Zelenskaya, M. G.
Synthesis of γ-butyrolactone.
Zhur. Priklad. Khim. 30, 324-9 (1957). C. A. 51, 12826-7 (1957).

Shostakovskii, M. F., Sidel'kovskaya, F. P. and Zelenskaya, M. G.
Synthesis of γ-butyrolactone.
J. Appl. Chem. U. S. S. R. 30, 339-44 (1957) (in English). C. A. 52, 15426 (1958). C. A. 51, 12826 (1957).

Sweeney, W. M. and Patterson, J. A.
γ-Butyrolactone.
U. S. 3,061,614 (Cl. 260-343.6), Oct. 30, 1962, Appl. Dec. 4, 1958; 2 pp. C. A. 58, 6700 (1963).

Sugiyamu, N.
Reagents for the identification of organic acids. Colored derivatives of carboxylic acids.
J. Chem. Soc. Japan, Pure Chemistry Section, 72, 152-4 (1951).
C. A. 46, 3447-8 (1952).

Thierfelder, H. and Schempp, E.
Specific rotation of active sodium phenyl-γ-hydroxybutyrate and the reduction of benzoylpropionic acid in the body.
J. Phys. Chem. 117, 94-100 (1921). C. A. 16, 264 (1922).
Details of synthesis in original article.

Tishler, M. and Beutel, R. H.
Resolution of racemic α-hydroxy-β, β-dimethyl-γ-butyrolactone.
Brit. 605,444, July 23, 1948. C. A. 43, 1056 (1949).

Trochimowski, E. G., Sprozynski, A., and Wnuk, J.
Organic fluorine compounds in the aliphatic series. IV. Synthesis of β-fluoropropionic and γ-fluorobutyric acids.
Rec. trav. chim. 66, 430-1 (1947) (in French). C. A. 42, 866 (1948).
Distillation of γ-fluorobutyric acid yields γ-butyrolactone.

Valentin, F.
The γ-lactone of 3, 6-anhydro-d-mannonic acid.
Collection Czechoslov. Chem. Commun. 9, 315-26 (1937). C. A. 32, 497 (1938). C. A. 30, 3409 (1936).

Wagner, R. P. and Guirard, B. M.
Gene-controlled reaction in neurospora involving the synthesis of pantothenic acid.
Proc. Natl. Acad. Sci. U. S. 34, 398-402 (1948). C. A. 43, 715 (1949).
Synthesis.

Whitmore, F. C. and Otterbacher, T.
Heptan-2-ol.

Org. Syn. 10, 60-1 (1930). C. A. 24, 1840 (1930).
RCOR + sodium + 95% ethanol = RCHOHR.

Wieland, L.
Ketopantothenic acid.
Chem. Ber. 81, 323-6 (1948). C. A. 43, 4223-4 (1949).
Preparation.

Williams, R. J., Mitchell, H. K., Weinstock, H. H., Jr., and Snell, E. E.
VII. Partial and total synthesis studies.
J. Am. Chem. Soc. 62, 1784-5 (1940). C. A. 34, 6225 (1940).

Williams, R. J.
Lactone from pantothenic acid.
U. S. 2,465,303, March 22, 1949. C. A. 43, 5037 (1949).

Windaus, A. and Klanhardt, F.
A method for the degradation of acids of the glutaric acid series.
Ber. deut. chem. Ges. 54B, 581-7 (1921). C. A. 15, 2627-8 (1921).
$CH_2(CH_2CO_2Ag)_2$ = γ-butyrolactone + carbon dioxide.

C. Synthesis of Substituted γ-Butyrolactones.

Anker, R. M. and Cook, A. H.
Piperidine series. VI.
J. Chem. Soc. 1948, 806-10. C. A. 42, 7772-4 (1948). C. A. 40, 2883 (1946).

Baddar, F. G. and El Assal, L. S.
β-Aroylpropionic acids. II. Action of ortho- and para-methoxyphenyl magnesium bromide on succinic anhydride.
J. Chem. Soc. 1951, 431-3. C. A. 45, 9005, 7054 (1951).
Synthesis of substituted butyrolactones.

Bhatt, B. L. and Nargund, K. S.
Synthetic anthelmintics. XI. 4-alkoxy-3tolyl-γ-butyrolactones.
J. Univ. Bombay, Sect. A, 15, Pt. 3 (Sci. No. 20), 31-41 (1946).
C. A. 41, 6200-01 (1947). C. A. 39, 2289 (1945).

Borsche, W., Kethner, S., Gilles, M., Kuhn, H., and Manteuffel, R.
Syntheses in the naphthalene series. I. Synthesis of 1-aryl-4-hydroxynaphthalene-2-carboxylic acids, 1-aryl-4-hydroxynaphthalene, and 3, 4-benzo-2-hydroxyfluorenones.
Ann. 526, 1-22 (1936). C. A. 31, 387-8 (1937).
Substituted butyrolactones are side products of the reaction.

Borshe, W. and Schmidt, H.
Synthesis according to Friedel-Crafts with tricarballylyl chloride and α-phenyltricarballylyl chloride.
Ber. deut. chem. Ges. 72B, 1827-33 (1939). C. A. 34, 719-20 (1940).
Synthesis of several substituted butyrolactones.

Boyle, J. S. W., Mc Kenzie, A., and Mitchell, W.
Action of phenyl magnesium bromide on chloroacetyl chloride and related compounds.
Ber. deut. chem. Ges. 70B, 2153-60 (1937). C. A. 32, 138 (1938).
C. A. 15, 3101 (1911).
Grignard synthesis of some substituted butyrolactones.

Carter, H. E. and Ney, L. F.
α-Hydroxy-β, β-dimethyl-γ-butyrolactone.
J. Am. Chem. Soc. 63, 312-13 (1941). C. A. 35, 1382 (1941).
Syntheses.

Chipalkati, H. R. and Nargund, K. S.
Synthetic anthelmintics. XXI. γ, γ-Disubstituted butyrolactones.
J. Univ. Bombay 18, Pt. 5, Sect. A, Sci. No. 27, 12-14 (1950).
C. A. 45, 1974-5 (1951).
Synthesis.

Clark, R. L. and Mooradian, A.
Pyrolysis of some amino acids.
J. Am. Chem. Soc. 71, 2825-6 (1949). C. A. 44, 2952 (1950).
Synthesis of substituted butyrolactones.

Cocker, W., Hayes, D. H., and Williamson, W. R. N.
Rearrangement of 2, 4-xylyl hydrogen maleate.
J. Chem. Soc. 1955, 824-7. C. A. 50, 1791-2 (1956).
Synthesis of some substituted butyrolactones.

Cordies, P. and Cogniant, D.
para-nitrophenylpyruvic acid and its derivatives.
Compt. rend. 228, 1130-2 (1949). C. A. 43, 5766 (1949).
Preparation of γ-substituted butyrolactones.

Glattfield, J. W. E., Leavell, G., Spieth, G. E., and Hutton, D.
C-4-saccharinic acids. V. Preparation of 2, 3-dihydroxybutyric acid lactone. 3-hydroxyisocrotonic acid lactone. An attempt to prepare 2, 2'-dihydroxyisobutyric acid.
J. Am. Chem. Soc. 53, 3164-7 (1931). C. A. 25, 4849-50 (1931).
C. A. 21, 3350 (1927).

Haworth, W. N. and Mitchell, J. G.
Constitution of disaccharides. VII. Sucrose.
J. Chem. Soc. 123, 301-10 (1923). C. A. 17, 1626-7 (1923).
Tetramethyl-γ-fructose in the presence of potassium permanganate and sodium hydroxide yields dimethylbutyrolactone and its potassium salt.

Hillstrom, W. W.
Syntheses toward α, β-unsymmetrically disubstituted γ-butyrolactones.
Univ. Microfilms (Ann Arbor, Michigan), Order No. 64-4648, 111 pp.
Dissertation Abstract 25, (2), 837 (1964). C. A. 61, 14522 (1964).

Horeau, A.
α, α, β-Trisubstituted butyrolactones; α, α-dimethyl-β-(6-methoxy-2-naphthyl)butyrolactone.

Compt. rend. 241, 205-8 (1955). C. A. 50, 7045 (1956).
Preparation.

Irani, K., Phalnikas, N. L., and Nargund, K. S.
Synthetic anthelmintics. XIV. γ-(2-methoxy-5-alkyl-phenyl)-γ-butyrolactones. XV. γ-(4-methoxy-3-alkyl-phenyl)-γ-butyrolactone. XVI. γ-(2, 4-dimethoxy-5-alkyl-phenyl)-γ-butyrolactone.
J. Univ. Bombay A, 16, Pt. 5 (Sci. No. 23), 37-40 (1948).
C. A. 43, 1032-3 (1949). C. A. 39, 4153 (1945). C. A. 36, 3801 (1942).

Irani, K. R., Phalnikas, N. L., Patel, N. Z., Chipalkati, H. R., and Nargund, K. S.
Synthetic anthelmintics. XVIII. 2, 4-dialkoxyphenylbutyrolactone. XIX. 2, 5-dialkoxyphenylbutyrolactones. XX. 3, 4-dialkoxy-phenylbutyrolactones.
J. Univ. Bombay 18, Pt. 5, Sect. A, Sci. No. 27, 1-11 (1950).
C. A. 45, 1974 (1951). C. A. 44, 1480 (1950). C. A. 43, 1032 (1949). C. A. 41, 6200 (1947). C. A. 37, 2005 (1943).
Synthesis.

Keimatsu, S. and Ishiguro, T.
Constitution of Hinokiol. VII. The constitution of hinokinin.
J. Pharmacol. Soc. Japan 56, (Abstract in German 19-23) (1936).
Chem. Zentr. 1936, II, 1743-4. C. A. 31, 2208 (1937). C. A. 29, 7961 (1935).
Syntheses of substituted butyrolactones.

Kuhn, R. and Wieland, T.
Biogenesis of pantothenic acid.
Ber. deut. chem. Ges. 75B, 121-3 (1942). C. A. 37, 2717 (1943).
Synthesis of substituted butyrolactones.

Ladd, E. C. and Harvey, M. P.
γ-Lactones.
U. S. 2,569,064, Sept. 25, 1951. C. A. 46, 5077 (1952).
Synthesis of substituted butyrolactones.

Linville, R. G. and Elderfield, R. C.
Synthesis of β-substituted $\Delta^{\alpha,\beta}$-butenolidenes from omega-acetoxy-methyl ketones.
J. Org. Chem. 6, 270-? (1951). C. A. 35, 403 (1941).
Synthesis of some substituted butyrolactones.

Mc Elvain, S. M. and Laughton, P. M.
Piperidene derivatives. XXIV. 1-methyl-4-phenyl-3-piperidone and related compounds.
J. Am. Chem. Soc. 73, 448-52 (1951). C. A. 46, 982-3 (1952).
C. A. 45, 1592 (1951).
Synthesis of some substituted butyrolactones.

Mc Graw, W. J.
α-Acyl, α-(α'-hydroxyalkyl), and α-alkylidene lactones.
U. S. 2,624,723, Jan. 6, 1953. C. A. 47, 11232-3 (1953).
Synthesis of several butyrolactones.

Michael, F. and Jung, F.
Hydroxytetronic acid.
Ber. deut. chem. Ges. 67B, 1660-4 (1934). C. A. 29, 456-7 (1935). C. A. 27, 5723 (1933).
Formation of γ-butyrolactone derivatives.

Mumm, O. and Brodersen, K.
Course of reduction of pyridinecarboxylic acids to nitrogen-free products.
Ber. deut. chem. Ges. 56B, 2295-2301 (1923). C. A. 18, 1128 (1924).
Production of several butyrolactones.

Nemec, J. W.
Substituted butyrolactones.
U. S. 2,839,538, June 17, 1958. C. A. 52, 17114 (1958).
Synthesis.

Obata, S.
γ-Butyrolactone derivatives. I. Synthesis of γ- and α, γ-substituted butyrolactones. II. Synthesis of β, γ- and α, β, γ-substituted butyrolactones. III. Synthesis of γ, γ-substituted butyrolactones. IV. Relation between chemical structure and odor of butyrolactone derivatives.
J. Pharmacol. Soc. Japan 75, 1295-1306 (1953). C. A. 49, 175-6 (1955).
Initial reactions are with zinc metal.

Patel, N. Z. and Nargund, K. S.
Synthetic anthelmintics. XII, XIII. 4-alkoxy-2-tolyl-γ-butyrolactones, 2-alkoxy-5-tolyl-γ-butyrolactones.
J. Univ. Bombay, Sect. A, 15, Pt. 3, Sci. No. 20, 31-41 (1946). C. A. 41, 6200-01 (1947).
Synthesis.

α-Amino-γ-butyrolactones.
Brit. 659,483, Oct. 24, 1951. C. A. 47, 3338, 606 (1953).

α-Hydroxy-β, β-dimethyl-γ-butyrolactone.
Swiss. 215,143, Sept. 1, 1941. C. A. 42, 3775 (1948).
Preparation.

Pattison, F. L. M. and Saunders, B. C.
Toxic fluorine compounds containing the carbon-to-fluorine link. VII. Evidence for the β-oxidation of omega-fluoro carboxylic acids in vivo.
J. Chem. Soc. 1949, 2745-9. C. A. 44, 3887 (1950).
Preparation of β, β-dimethyl-γ-butyrolactone.

Puetzer, B., Nield, C. H., and Barry, R. H.
Synthesis of a clavacin isomer and related compounds.
J. Am. Chem. Soc. 67, 832-7 (1945). C. A. 39, 2995-7 (1945).
disodium salt of (ortho-hydroxyphenyl-carbonyl)pyruvic acid ester = α-keto-β-(ortho-hydroxyphenyl-carbonyl)butyrolactone in the presence of water and formaldehyde.

Rambaud, R. and Ducher, S.
γ-Isocrotonolactone.
Bull. soc. chim. France 1956, 466-76. C. A. 50, 14535 (1956).
Synthesis of some substituted γ-butyrolactones as intermediates.

Rosenmund, K. W., Zymalkowski, F., and Engels, P.
Synthesis of γ-(hydroxyphenyl- and dihydroxyphenyl)butyrolactones.
Chem. Ber. 84, 711-18 (1951). C. A. 46, 3012-20 (1952).

Rothe, J. and Zimmer, H.
Substituted γ-lactones. III. General route to β-substituted-γ-butyrolactones.
J. Org. Chem. 24, 586-9 (1959). C. A. 54, 6541, 18421-2 (1960).

Salmon-Legagneur, W.
2, 2-diphenylbutanoloic isomers and their olides.
Compt. rend. 227, 437-9 (1948). C. A. 43, 3396-7 (1949).
Preparation of 3, β-diphenyl-γ-butyrolactones.

Saotome, K. and Yamazaki, T.
γ-Alkylbutyrolactones.
Japan 26,417-('65), Nov. 16, Appl. July 27, 1963; 2 pp. C. A. 64, 9600 (1966).
Hexanol + ethyl acrylate + t-butyl peroxide $\xrightarrow{150\text{-}155^{\circ} \text{ for 1 hr.}}$ γ-amylbutyrolactone.

Schroeter, G.
ortho-phenol fatty acids and their derivatives.
Ger. 562,827, Dec. 21, 1928. C. A. 27, 1224-5 (1933).
Discusses the synthesis of several substituted γ-butyrolactones.

Schuster, C. and Simon, A.
Chlorobutyrolactones.
Ger. 810,025, Aug. 6, 1951 (Cl. 12o, 11). C. A. 47, 2769 (1953).

Schuster, C.
α-Amino-γ-butyrolactones.
Ger. 812,077, Aug. 27, 1951 (C. 12q, $6o_1$). C. A. 47, 606 (1953).

Schuster, C.
α-Amino-γ-butyrolactones.
U. S. 2,605,268, July 29, 1952. C. A. 47, 3872, 606 (1953).

Soffer, M. D. and Hunt, M. C.
Methyl esterification of an easily lactonized hydroxy acid.
J. Am. Chem. Soc. 67, 692-3 (1945). C. A. 39, 2498 (1945).
Synthesis of a β-substituted γ-butyrolactone.

Sonne, W.
Substituted γ-butyrolactones.
Ger. 1,018,856, Nov. 7, 1957 (Cl. 12o). C. A. 54, 1364 (1960).
Preparation.

Stiller, E. J., Kerenztesy, J. C., and Finkerstein, J.
VI. Isolation and structure of the lactone moiety.
J. Am. Chem. Soc. 62, 1779-84 (1940). C. A. 34, 6224-5 (1940).
Isolation of a substituted butyrolactone.

Sudo, R., Akiyama, Y., Kato, T., and Ohta, M.
Studies of γ-butyrolactone derivatives. I. Synthesis of α-amino-γ-butyrolactone.
J. Chem. Soc. Japan, Pure Chem. Sect. 74, 1009-11 (1953). C. A. 49, 6829 (1955).
Synthesis.

Tomita, M., Fushimi, J., and Shibakawa, M.
Synthesis of diphenyl ester butyrolactones.
J. Pharmacol. Soc. Japan 64, No. 11A, 65 (1944). C. A. 45, 5660 (1951).
Synthesis via the Friedel-Crafts reaction.

Trivedi, J. J. and Nargund, K. S.
Synthetic anthelmintics. II. γ-Substituted butyrolactones.
J. Univ. Bombay 10, Pt. 3, 99-101 (1941). C. A. 36, 3801 (1942).
Synthesis.

Trivedi, J. J. and Nargund, K. S.
Synthetic anthelmintics. V. γ-(para-alkoxyphenyl)butyrolactones.
J. Univ. Bombay 11, Pt. 3, 127-30 (1942). C. A. 37, 2005-6 (1943).
Preparation.

Van Tamelen, E. E. and Bach, S. R.
α-Methylene-γ-phenyl-γ-butyrolactone.
J. Am. Chem. Soc. 77, 4683-4 (1955). C. A. 50, 6381 (1956).
Synthesis.

Vyas, V. A., Bokil, K. V., and Nargund, K. S.
Synthetic anthelmintics. I. α-Substituted-γ-butyrolactones.
J. Univ. Bombay 9, Pt. 3, 145-9 (1940). C. A. 35, 6574-5 (1941).
Synthesis.

Wachs, H.
Synthesis of a new lactone.
Riechstoffind 7, 196-7 (1932). C. A. 27, 2685 (1933).
Preparation of γ-tolyl-γ-butyrolactone.

Wagner, A. F., Walton, E., Hoffman, C. H., Peterson, L. H., Holly, F. W., and Folkers, K.
Synthesis of DL-dimethyldihydro-α-lipoic acid.
J. Am. Chem. Soc. 77, 5140-3 (1955). C. A. 50, 8456-8 (1956).

Walton, E. and Green, M. B.
Production of 3-aryl-1, 5-dibromopentane-3-carboxylic acid.
U. S. 2,421,729, June 3, 1947. C. A. 41, 5550 (1947).

Weizmann, C., Bergmann, A. B., and Bergmann, F.
Reactions of Grignard reagents with some succinic anhydrides.
J. Chem. Soc. 1935, 1370-1. C. A. 30, 94 (1936).

Weston, A. W.
Amino alkyl phenyl lactones.
U. S. 2,409,937, Dec. 13, 1949. C. A. 44, 2516 (1950).
Synthesis of some α, α-disubstituted-γ-butyrolactones.

Zimmer, H., Rothe, J., and Holbert, J. M.
Substituted γ-lactones. V. Synthesis of certain α, β-disubstituted γ-lactones. Route to lignans of the α, β-dibenzylbutyrolactone class.
J. Org. Chem. 25, 1234-5 (1960). C. A. 55, 5409, 2560 (1961).
Makes use of sulfuric acid.

D. Reactions of Unsubstituted γ-Butyrolactones.

Berti, F. A.
Amino derivatives of γ-butyrolactone.
Gazz. chim. ital. 84, 420-7 (1954). C. A. 49, 8120-1 (1955).

Bischoff, G.
α, γ-Dibromobutyryl bromide.
Swiss. 260,302, July 1, 1949 (Cl. 360). C. A. 44, 2549 (1950).
Butyrolactone + red phosphorus + Br_2 $\xrightarrow[20\text{-}60^\circ]{}$ Title product.

Bischoff, G.
α-Bromobutyrolactone.
Swiss. 264,598, Jan. 16, 1950 (Cl. 36o). C. A. 45, 1622 (1951).
At 160-170° for 8 hours followed by cooling and distillation under reduced pressure.

Blicke, F. F. and Brown, B. A.
Interaction of an Ivanov and an Ivanov-like reagent with γ-butyrolactone and γ-valerolactone.
J. Org. Chem. 26, 3685-91 (1961). C. A. 56, 5909-11 (1962).
Reactions.

Dashunin, V. M., Maeva, R. V., Kazaletova, G. A., and Belov, V. N.
Substituted lactones and their transformations. III. Hydrogenation of the aromatic nucleus in α-alkylidenebutyrolactones.
Zhur. Obshchei Khim. 34 (9), 3096-3101 (1964). C. A. 61, 15984-5 (1964). C. A. 58, 470 (1963).
γ-Butyrolactone reacts with aldehydes to yield α-alkyl derivatives.

Dashunin, V. M., Samotuga, G. A., and Belov, V. N.
Substituted lactones and their transformations. V. Hydroxy and oxo derivatives of α-cyclohexylmethylbutyrolactone.
Probl. Organ. Sinteza, Akad. Nauk. S. S. S. R., Otd. Obshchei i Tekkn. Khim. 1965, 64-8 (Russian). C. A. 64, 6513 (1966).
C. A. 63, 17980 (1965).

Ebel, F. and Weissbarth, O.
α-Acyl lactones.
Ger. 801, 276, Dec. 28, 1950 (Cl. 12o, 15). C. A. 45, 2972-3 (1951).
γ-Butyrolactone reacts with esters in the presence of sodium metal to yield α-acyl derivatives.

Henry, L.
On butyrolactones and unsymmetrical dimethyltetramethyleneglycol.
Compt. rend. 143, 1221-25. C. A. 1, 714-15 (1907).
γ-Butyrolactone reacts with the appropriate Grignard reagent to yield α, α-dimethyltetrahydrofuran.

Isham, R. M.
Succinic and maleic acids from butyrolactones.
U. S. 2,385,518, Sept. 25, 1945. C. A. 40, 1173 (1946).
Oxidation of butyrolactone in the vapor phase with V_2O_5 or CuO.

Isham, R. M.
Electrolytic oxidation of butyrolactone to succinic acid.
U. S. 2,420,954, May 20, 1947. C. A. 4727 (1947). C. A. 40, 1173 (1946).

Kadyrov, Ch. Sh.
Synthesis of arylbutyric acids. I. Reaction of benzene and chlorobenzene with butyrolactone.
Uzbeksk. Khim. Zhur. 8 (2), 52-7 (1964) (Russian). C. A. 61, 4254 (1964).
γ-Butyrolactone reacts with benzene in the presence of aluminum chloride to yield β-phenylbutyric acid.

Knobler, Y., Livergand, S., and Frankel, M.
Preparation of O-phenyl-DL-homoserine and of DL-homoserine from α-phthalimido-γ-butyrolactone.
J. Org. Chem. 24, 1794-5 (1959). C. A. 55, 13325 (1961).
Uses sodium metal, phenol, and γ-butyrolactone.

Korte, F. and Machleidt, H.
Syntheses in the pyran series. I. Rearrangement of α-hydroxymethylene-δ-lactones to 2-methoxy-3-tetrahydropyrancarboxylic acid esters.
Chem. Ber. 88, 136-43 (1955). C. A. 50, 5615-16 (1956). C. A. 49, 12453 (1955).
γ-Butyrolactone and ethyl formate and sodium in ether yield α-hydroxymethyl-γ-butyrolactone.

Krzikalla, H. and Dornheim, O.
Esters of etherified aliphatic hydroxy carboxylic acids.
Ger. 745,312, Dec. 2, 1943 (Cl. 12o, 11). C. A. 40, 3130 (1946).
Synthesis from butyrolactone in the presence of acids.

Krzikalla, H., Plieninger, H., and Maier, K.
Lactone-like products.
Ger. 844,292, July 17, 1952 (Cl. 12o, 11). C. A. 52, 10199 (1958).
Synthesis of benzylidene derivatives of γ-butyrolactone.

Mayhew, R. L. and Williams, E. P.
Nematocidal α-halogenated-γ-butyrolactones.
U. S. 2,974,084, March 7, 1961. C. A. 55, 14807 (1961).

Michael, A. and Weiner, N.
Formation of enolates from lactonic esters.

J. Am. Chem. Soc. 58, 999-1005 (1936). C. A. 30, 5183-4 (1936).
γ-Butyrolactone does not react with sodamide in diethyl ether. It reacts with pulverized sodium or with 40% sodium amalgam only slightly upon long standing. No experimental data is given to substantiate this statement.

Oelshlaeger, H., Schmersahl, P., and Toporski, W.
Synthesis of new local anesthetics. IV. γ-Halobutyric acids from γ-butyrolactone and several new omega-amino-3-alkyl-6-halo-acrylanalides.
Arch. Pharmacol. 294, 488-98 (1961). C. A. 56, 3342-3 (1962).
C. A. 55, 19835 (1961). C. A. 53, 3136 (1959).
γ-Butyrolactone + $SOCl_2$ = γ-chlorobutyryl chloride.
γ-Butyrolactone + HCl = γ-chlorobutyric acid.
γ-Butyrolactone + HBr = γ-bromobutyric acid.
γ-Butyrolactone + HCO_2H = pentanedioic acid.
γ-Butyrolactone + HI with P_2O_5 = γ-iodobutyric acid.

Petrov, G. I.
Free radical addition of butyrolactone and unsaturated compounds.
Izvest. Akad. Nauk S. S. S. R., Otd. Khim. Nauk. 1962, 146-51.
C. A. 57, 16390 (1962). C. A. 56, 308, 7155 (1962). C. A. 55, 22093 (1961).

Plieninger, H.
Cleavage of γ-butyrolactone and α-amino-γ-butyrolactone with sodium methyl mercaptide or selenide. A synthesis of methionine.
Chem. Ber. 83, 265-8 (1950). C. A. 44, 9919 (1950).
γ-Butyrolactone + RSNa → $RS(CH_2)_3COOH$.

Rambaud, R., Ducher, S., and Boudet, R.
Butenolide. III.
Bull. soc. chim. France 1956, 1419-24. C. A. 51, 3602 (1957).
C. A. 25, 4850 (1931).
Reactions.

Schotte, L.
γ-Butyrolactone reactions involving ring fission.
Arkiv. Kemi 8, 457-61 (1955). C. A. 51, 1838 (1957).

Späth, E. and Lintner, J.
Formation of lactams from lactones.
Ber. deut. chem. Ges. 69B, 2727-31 (1936). C. A. 31, 2172 (1937).
γ-Butyrolactone to γ-butyrolactam.

Stacey, M., Barker, S. A., Ward, R. B., Grant, P. M., and Lloyd, I. R. L.
Polyamino and polyhydroxycarboxylic acids.
Brit. 901,037, July 11, 1962, Appl. Jan. 7, 1959; 8 pp. C. A. 58, 3519 (1963).
Polymerization of γ-butyrolactone by irradiation.

Stepanov, F. N.
3-indolebutyric acid.
U. S. S. R. 66,681, July 31, 1946. C. A. 41, 2087 (1947).

Suzuki, K.
Synthesis of resorcylbutyrolactone mono- and dimethyl esters.
Bull. Inst. Phys. Chem. Research (Tokyo) 15, 71 (1936). C. A. 31, 6640 (1937).
Treatment of the acid form with sodium amalgam and dilute acetic acid results in formation of the lactone.

Takayama, Y. and Mizuno, S.
Formation of succinic acid from tetrahydrofurfuryl alcohol and γ-butyrolactone by electrolysis.
J. Electrochem. Soc. Japan 18, 298-301 (1950). C. A. 45, 8923 (1951).

Talbot, G, Gauaby, R., and Berlinguet, L.
Synthesis of 4-aminobutyric acid and 2, 4-diaminobutyric acid from butyrolactone.
Can. J. Chem. 36, 593-6 (1958). C. A. 52, 15425-6 (1958).

Tani, H. and Fudo, K.
Reaction of γ-butyrolactone with alkyl mercaptans.
Mem. Inst. Sci. Ind. Res., Osaka Univ. 6, 100-1 (1948). C. A. 45, 10198 (1951).

Wagner, A. F.
Substituted butyric acids.
U. S. 2,842,587, July 8, 1958. C. A. 52, 18221 (1958).
γ-Butyrolactone reacts with PBr_3 at 90-135° to yield α, γ-dibromobutyric acid.

Wagner, A. F.
Addition product of metal hydrocarbon mercaptide with an α-halo-γ-butyrolactone.
U. S. 2,872,458, Feb. 3, 1959. C. A. 53, 12184 (1959).

Yur'ev, Yu. K., Vendel'shtein, E. G., and Zinov'eva, L. A.
Pyrrole derivatives. XXXV. Transformation of butyrolactone into 2-thiophanone, 2-pyrrolidone, and 1-phenyl-2-pyrrolidone.
Zhur. Obshchei Khim. (J. Gen. Chem.) 22, 509-13 (1952). C. A. 47, 2747-8 (1953). C. A. 46, 8086 (1952). C. A. 44, 5869 (1950).

Zimmer, H. W. and Holbert, J. M.
Butyrolactone derivatives.
U. S. 3,030,361, April 17, 1962, Appl. July 14, 1958; 5 pp. C. A. 57, 9742-3 (1962).

Zimmer, H. W. and Walter, R.
Substituted γ-lactone. XX. Reaction of α-benzylidene-γ-butyrolactones with bromine and some chemical properties of the resulting products.
J. Heterocyclic Chem. 2.(4), 477-8 (1965) (English). C. A. 64, 9631 (1966). C. A. 63, 1728 (1965). C. A. 63, 4236 (1965).

E. Reactions of Substituted γ-Butyrolactones.

Bremer, K. H. and Seidel, L.
The enolization of γ-lactones.
Angew. Chem. 76 (9), 376 (1964). C. A. 61, 1751-2 (1964).
Grignards.

Bryusova, L. Ya., Simanovskaya, E., and Ul'yanova, A.
Substituted butyrolactones and their transformation into cyclopentanone derivatives.
Sintezy Dushistykh Veshchestv, Sbornik Statei 1939, 165-77; Khim. Referat. Zhur. 1940, No. 4, 115. C. A. 36, 3784 (1942).
Synthesis.

Curtius, T. and Sauerberg, H.
Action of hydrazine upon butyrolactone-α-carboxylic esters.
J. prakt. chem. 125, 139-51 (1930). C. A. 24, 3215 (1930).
Carbethoxybutyrolactone + hydrazine + water = ethyl β-hydroxyethylmalonyl hydrazine. Carbethoxybutyrolactone + an excess of hydrazine + water = the dihydrazide. Carbethoxybutyrolactone + nitrous acid = butyrolactone-α-carboxylic azide. Carbethoxybutyrolactone + para-methylaniline = β-hydroxyethyl-malonyl di-para-toluidide.

Feofilaktov, V. V. and Onishchenko, A. S.
Action of nitrous acid on α-substituted butyrolactones. I.
J. Gen. Chem. (U. S. S. R.) 9, 304-13 (1939). C. A. 34, 378 (1940).
Action depends on the nature of the α-substituent.

Feofilaktov, V. V. and Onishchenko, A. S.
Action of phenyl diazonium chloride on α-substituted butyrolactones. II.
J. Gen. Chem. (U. S. S. R.) 9, 314-24 (1939). C. A. 34, 378-9 (1940).
Similar to the action of nitrous acid but no polymerization or isomerization.

Fischhoff, G.
Derivatives of α-keto-γ-butyrolactone. Ethyl ester of α-keto-γ-butyrolactone-β-carboxylic acid (α-keto-paraconic ester) and its β-hydroxymethyl derivative.
Ann. chim. (12), 6, 227-45 (1951). C. A. 45, 9475-78 (1951).

Gault, H.
Derivatives of α-keto-γ-butyrolactone. γ-Alkyl- and γ-aryl-α-keto-γ-butyrolactone-β-carboxylic esters. Introduction.
Ann. chim. (12), 6, 220-6 (1951). C. A. 45, 9475-78 (1951).

Harradence, R. and Lions, F.
Indoles. VIII. 3-hydroxymethylindole-2-carboxylic lactone.
J. Proc. Royal Soc. N. S. Wales 72, 221-7 (1939). C. A. 33, 6338-9 (1939).
Acetobutyrolactone is the starting material.

Kawasaki, H.
Vitamin B_1 and related compounds. LXXVI. Thioltype thiamine

derivatives. 7. S-acylation of thiazolium compounds.
J. Pharm. Soc. Japan 76, 702-5 (1956). C. A. 51, 429-30 (1957).
C. A. 50, 13044 (1956).
Treat α-benzoylbutyrolactone with SO_2Cl_2 to get α-chloro derivatives.

Kohles, E. P. and Kimball, R. H.
Hydroxy derivatives of α, γ-diphenylbutyric acid.
J. Am. Chem. Soc. 55, 4632-9 (1933). C. A. 28, 130 (1934).

Krzikalla, H. and Tartter, A.
Sulfur-containing lactone derivatives.
Ger. 801,992, Feb. 1, 1951 (Cl. 12o, $23o_3$). C. A. 45, 5179 (1951).

Mitchell, H. K., Weinstock, H. H., Jr., Snell, E. E., Stanbery, S. R., and Williams, R. J.
Pantothenic acid. V. Evidence for structure of non-β-analine portion.
J. Am. Chem. Soc. 62, 1776-9 (1940). C. A. 34, 6224 (1940).
C. A. 33, 6368 (1939).
Decomposition of hydroxyl substituted butyrolactones using sulfuric acid and/or potassium permanganate.

Moss, A. R.
A resolution in the pantothenic acid series.
Jubilee Vol. Emil Barell 1946, 79-81 (in English). C. A. 41, 6199 (1947).
Synthesis from substituted butyrolactones and Raney nickel.

Nef, J. U.
Dissociation reactions of the sugar group. II. Behavior of sugars towards caustic alkalies.
Ann. chim. 376, 1-119. C. A. 5, 85-8 (1911). C. A. 2, 799 (1908).
dl-1-hydroxybutyrolactone + HNO_3 = dl-malic acid.
dl-2-hydroxybutyrolactone + HNO_3 = brucine salt.

Opferman, A. J.
2-hydroxybutyrolactone.
Brit. 688, 253, March 4, 1953. C. A. 48, 3996-7 (1954).
Synthesis from the 2-bromo derivative in two steps.

Ozawa, T. and Nagaoka, S.
New utilization of α-acetyl-γ-butyrolactone. I. A new synthesis of quinoline derivatives.
J. Pharm. Soc. Japan 75, 1405-7 (1955). C. A. 50, 10001-2 (1956).

Ozawa, T., Nagaoka, S., Mitsuno, K., and Tsukiyama, T.
New Utilization of α-acetyl-γ-butyrolactone. II. A new synthesis of quinoline derivatives.
J. Pharm. Soc. Japan 75, 1407-10 (1955). C. A. 50, 10001-2 (1956).

Ozawa, T. and Nagaoka, S.
Syntheses of heterocyclic compounds derived from 2-acetyl-γ-butyrolactone. V. Synthesis of dihydrofuro[3, 2-c] quinoline

compounds.
Yakugaku Zasshi 79, 226-30 (1959). C. A. 53, 13146-8 (1959).
C. A. 51, 8749 (1957).

Halogenated organic compounds.
Brit. 490,571, Aug. 17, 1938. C. A. 33, 813 (1939).
Halogenation of α-aceto-γ-butyrolactone.

Butyrolactones.
Brit. 600,865, April 21, 1948. C. A. 42, 7324 (1948). C. A.
40, 1872 (1946).

Pantothenic acid.
Swiss. 215,779, Oct. 16, 1941. C. A. 42, 4606 (1948).

Price, C. C. and Kaplan, W.
Reactions of γ-anisyl-γ-butyrolactone with potassium cyanide.
6-Methoxy-1, 2, 3, 4-tetrahydro-2-naphthoic acid.
J. Am. Chem. Soc. 66, 477-8 (1944). C. A. 38, 2031-2 (1944).
Preparation.

Schnider, O.
Synthesis of panthenol and its transformation into pantothenic
acid.
Jubilee Vol. Emil. Barell 1946, 85-91 (in German). C. A. 41,
6199 (1947).
Synthesis from substituted butyrolactones and Raney nickel.

Stepanov, F. N. and Smirnov, O. K.
Butyrolactone and its derivatives. II. Some reactions of acyl
derivatives of butyrolactone.
Zhur. Obshchei Khim. 27, 1041-4 (1957). C. A. 52, 2747-8 (1958).
C. A. 51, 7344 (1957).
α-Acetyl-γ-butyrolactone + sodium metal refluxed with methanol
and methyl iodide yields α-acetyl-α-methyl-γ-butyrolactone.

Stepanov, F. N. and Smirnov, O. K.
Butyrolactone and its derivatives. II. Some reactions of acyl
derivatives of butyrolactone.
J. Gen. Chem. U. S. S. R. 27, 1124-6 (1957) (in English).
C. A. 53, 4126 (1959). C. A. 52, 2447 (1958).
English translation to the above Russian article.

Sudo, R.
Studies on γ-butyrolactone derivatives. III. Acylation of α-
amino-γ-butyrolactone.
Nippon Kagaku Zasshi 79, 81-4 (1958). C. A. 54, 5448 (1960).
C. A. 49, 12298 (1955).

Sudo, R.
γ-Butyrolactone derivatives. VI. Reactions of α-amino-γ-
butyrolactone with aromatic aldehydes.
Nippon Kagaku Zasshi 80, 924-6 (1959). C. A. 55, 4528 (1961).
C. A. 54, 5448 (1960).

Sudo, R.
γ-Butyrolactone derivatives. V. The α-ureido- and α-thioureido-γ-butyrolactone derivatives.
Nippon Kagaku Zasshi 80, 924-6 (1959). C. A. 55, 4528 (1961). C. A. 54, 5448 (1960).

Von Zyl, G. and Von Tamelen, E. E.
Preparation of 5-alkyl-5-(2-phenyl- and 2-vinyl-2-hydroxyethyl) barbituric acid via the corresponding α-carbethoxy-γ-butyrolactone.
J. Am. Chem. Soc. 72, 1357-9 (1950). C. A. 44, 5816-7 (1950).

Zumbrunn, R.
α-Chloro-α-acetyl-γ-butyrolactone.
U. S. 2,440,229, April 20, 1948. C. A. 42, 5467 (1948).
Preparation from the unchlorinated compound.

F. Hydrolysis.
(a) General.

Adickes, F.
Addition of alkali alcoholates to acid esters. II.
Ber. deut. chem. Ges. 59B, 2522-33 (1926). C. A. 21, 734 (1927). C. A. 20, 737 (1926).
The addition of alcoholate can apparently always take place when the grouping RCOCOR' is present, even when none of the carbon atoms forms part of a COOH group, but one of these CO unions cannot be replaced by an aliphatic carbon-to-carbon double bond.

Adickes, F.
Addition of alkali alcoholates to acid esters. III. Addition of alkali alcoholates to formic esters.
Ber. deut. chem. Ges. 60B, 272-7 (1927). C. A. 21, 1628 (1927).

Adickes, F. et al.
Addition of alkali alcoholates to acid esters. IV. Addition of sodium ethanolate to formic acid esters.
Ber. deut. chem. Ges. 63B, 3012-27 (1930). C. A. 25, 2115-16 (1931). C. A. 21, 1628, 1795 (1927). C. A. 20, 2824 (1926).

Adickes, F. and Schäfer, G.
Kinetics and statics of the decomposition reaction of ethyl formate by sodium ethoxide.
Ber. deut. chem. Ges. 65B, 950-5 (1932). C. A. 26, 4793 (1932).
$KOEt > NaOEt > Ca(OEt)_2 > Al(OEt)_3$

Bunnett, J. F.
Kinetics of reactions in moderately concentrated aqueous acids. II. An empirical criterion of mechanism.
J. Am. Chem. Soc. 83, 4968-73 (1961). C. A. 57, 1598 (1962).

Evans, D. P., Gordon, J. J., and Watson, H. B.
Influence of alkyl groups upon reaction velocities in solutions. The alkaline hydrolysis of saturated aliphatic esters.
J. Chem. Soc. 1938, 1439-44. C. A. 33, 457 (1939).
Kinetic study.

Gyngell, E. S.
The alkaline hydrolysis of esters in aqueous alcohols. I. The interaction of phenoxides and aliphatic esters in alcoholic solutions.
J. Chem. Soc. 1926, 2484-91. C. A. 21, 12 (1927).
There is no evidence to show that the reaction proceeds according to the equation:
Potassium phenoxide + Ethyl acetate = ethyl phenoxide + potassium acetate.
There is also no evidence in favor of the view that the reaction proceeds as a result of "alcoholysis" of the phenoxide. The reaction is a hydrolysis of the phenoxide by water.

Kokatnur, V. R.
Saponifying organic esters.
U. S. 1,813,454, July 7, 1931. C. A. 25, 5176 (1931).

Lukes, R., Nemec, J., and Jury, J.
Lactones. IV. Alkaline hydrolysis of α-hydroxy-β-bromo-γ-valerolactone.
Collection Czechoslov. Chem. Commun. 25, 138-45 (1960) (in Russian). C. A. 54, 8622-3 (1960).

Olsson, H.
Relationship between velocity of hydrolysis by alkali and structure of esters.
Z. physik. Chem. 133, 233-52 (1928). C. A. 23, 1337 (1929).
C. A. 21, 1581 (1927).

Scheibler, H. and Voss, J.
Metal compounds of the enol forms of carbonyl compounds and their use for syntheses. I. Preparation and properties of the metal compounds of the enol forms of aliphatic acid esters. Reaction of potassioacetic ester with halogen-acyl compounds.
Ber. deut. chem. Ges. 53B, 388-409 (1920). C. A. 14, 2931-2 (1920). C. A. 9, 3245 (1915).
Butyric acid + potassium metal + diethyl ether + ligroin yields a potassium ester.

Wegscheider, R. and Amann, W. W.
Saponification of esters by alkalies, especially of ethyl phthalate.
Monatsh. Chem. 36, 549-610. C. A. 9, 3007 (1915).

F. Hydrolysis.
(b) γ-Butyrolactone.

Arendaruk, A. P., Serebryakov, L. A., Skoldinov, A. P.
Synthesis and some problems of pharmacodynamics of γ-amino- and γ-hydroxybutyric acids.
Med. Prom. S. S. S. R. 17 (6), 6-8 (1963). C. A. 59, 11234 (1963).
To a hot solution of 225 ml. of rectified ethanol, 45 ml. water, and 220 g. sodium hydroxide, 489 g. γ-butyrolactone was slowly added with stirring and the mixture kept boiling for 30 min. The precipitate was recrystallized from ethanol. Yield = 560 g. salt.

Atterburrow, J., Elko, J., Hems, B. A., and Speyer, K. N.
Analgesics. II. Synthesis of amidone and some of its analogs.
J. Chem. Soc. 1949, 510-18. C. A. 43, 9053-4 (1949).
Preparation of the sodium salt of α, α-diphenyl-γ-butyrolactone.

Bender, M. L., Matsui, H., Thomas, R. J. and Tobey, S. W.
Concurrent alkaline hydrolysis and isotopic oxygen exchange of several alkyl benzoates and lactones.
J. Am. Chem. Soc. 83, 4193-6 (1961). C. A. 56, 14158-9 (1962).
K_h/K_{ex}(γ-butyrolactone) = 30 (water); calculated value.

Coffin, F. D. and Long, F. A.
Arrhenius parameters for acid hydrolysis of γ-butyrolactones; search for a reaction with water.
J. Am. Chem. Soc. 74, 5767-8 (1952). C. A. 47, 10977 (1953).
C. A. 45, 9345 (1951).

Grace, J. A. and Symons, M. C. R.
Kinetic study of hydrolysis of certain alkyl acetates and lactones.
J. Chem. Soc. 1961, 47-52. C. A. 55, 11034 (1961).
Bimolecular alkaline hydrolysis in aqueous acetone at 20°.

Haga, T.
Hydroxy acids having a substituent group in the β position to the hydroxyl group.
Japan 10,666 ('57), Dec. 21. C. A. 52, 17115 (1958).
Potassium salt of γ-hydroxybutyric acid.

Haga, T.
Hydroxy carboxylic acids. VII. Reactions of potassium γ-hydroxybutyrate with benzyl alcohol.
Nippon Kagaku Zasshi 81, 1113-6 (1960). C. A. 56, 5827-8 (1962).
C. A. 56, 311 (1962).
γ-butyrolactone + potassium hydroxide = potassium γ-hydroxybutyrate.

Hollo, E.
Influence of the oxygen atom of the ring on the reaction velocity of several lactones.
Ber. deut. chem. Ges. 61B, 895-906 (1928). C. A. 22, 3085 (1928).
Hydrolysis and lactonization velocities determined in acid, water, and acetone solutions at 25°.

Johansson, H. and Sebelius, H.
Ester catalysis of γ-lactones.
Ber. deut. chem. Ges. 51, 480-5 (1918). C. A. 12, 2566 (1918).
γ-Butyrolactone is reacted with nitric acid. Hydrolysis is the normal case of ester catalysis.

Kailan, A.
Formation and hydrolysis of lactones.
Z. physik. Chem. 94, 111-28 (1920); 10, 96. C. A. 14, 1777 (1920).
Autocatalytic effect of undissociated γ-hydroxybutyric acid in acid solution is very much less than that of the hydrogen ion of the acid catalyst.

Kohler, E. P. and Conant, J. B.
Cyclopropane series.
J. Am. Chem. Soc. 39, 1404-20 (1917). C. A. 11, 2194-6 (1917).
Alcoholic sodium hydroxide and β-benzoyl-γ-phenylbutyrolactone.

Long, F. A. and Friedman, L.
Determination of the mechanisms of γ-lactone hydrolysis by a mass spectrometric method.
J. Am. Chem. Soc. 72, 3692-5 (1950). C. A. 45, 1514 (1951).
Both acid catalyzed and base catalyzed hydrolyses go by an acyl-oxygen cleavage.

Long, F. A., Mc Devit, W. F., and Dunkel, F. B.
Salt effects on the acid catalyzed hydrolysis of γ-butyrolactone. I. Chemical activity and equilibrium.
J. Phys. and Colloid Chem. 55, 813-29 (1951). C. A. 45, 9345-9346 (1951). C. A. 33, 5730 (1939).

Long, F. A., Mc Devit, W. F., and Dunkel, F. B.
Salt effects on the acid catalyzed hydrolysis of γ-butyrolactone. II. Kinetics and reaction mechanism.
J. Phys. and Colloid Chem. 55, 829-42 (1951). C. A. 45, 9345-6 (1951). C. A. 33, 5730 (1939).

Nelson, W. L. and Aetcher, L. H.
Preparation of certain γ-lactones.
J. Am. Chem. Soc. 52, 3702-4 (1930). C. A. 24, 5022 (1930).
γ-Butyrolactone + sodium hydroxide + water (hot) = sodium γ-hydroxybutyrate.

Spencer, E. Y. and Wright, G. F.
Action of sodium alcoholate on lactones.
J. Am. Chem. Soc. 63, 1281-5 (1941). C. A. 35, 4348 (1941).
Against Fittig (Ann. 267, 191 (1891)). γ-Lactone + NaOR = γ-hydroxy-COOR.

Taylor, H. S. and Close, H. W.
Acid catalysis in lactone formation.
J. Phys. Chem. 29, 1085-92 (1925). C. A. 19, 3411 (1925).
C. A. 18, 2219 (1924). C. A. 11, 1811 (1917).
γ-Methyl-γ-hydroxybutyric acid to γ-butyrolactone.

Wheeler, O. H. and Gamble, D. S.
Saponification of methyl substituted γ-butyrolactones.
J. Org. Chem. 26, 3221-3 (1961). C. A. 56, 11439 (1962).
Rates of saponification of substituted and unsubstituted butyrolactones with (92.3%) ethanol at 0° and 25°C.

G. Condensations.
(a) General.

Adickes, F.
Compounds and acetoacetic ester condensation.
Ber. deut. chem. Ges. 65B, 522-5 (1932). C. A. 22, 387 (1928).
Mechanism.

Antia, M. B. and Kaushal, R.
Reformatskii condensation of ketonic esters with halo esters.
Agra Univ. J. Res., Sci. 3, 197-201 (1954). C. A. 49, 6121 (1955).
Preparation of substituted butyrolactones.

Bodendorf, K.
Mechanism of aldehyde, ketone, and ester condensations.
Ber. deut. chem. Ges. 67B, 1338-43 (1934). C. A. 28, 6700 (1934).

Bouveault, L. and Locquin, R.
New condensations of the acetic esters with their homologs under the influence of sodium.
Ann. chim. phys. 19, 186-206. C. A. 4, 1481 (1910).

Chelintzev, G. V.
Mechanism of ester condensations.
Ber. deut. chem. Ges. 67B, 955-63 (1934). C. A. 28, 5046 (1934).
A review.

Chelintzev, G. V.
Condensations of organic substances under the influence of the alkali metals.
Uspekhi. Khim. 7, 5-78 (1938). C. A. 33, 6231 (1939).
A review of the Wurtz-Fittig reaction and sodium or sodium ethanolate condensations according to Schlenck-Ziegler-Lebedev.

Christian, R. V., Jr.
Condensations of lactones with benzene.
J. Am. Chem. Soc. 74, 1591-2 (1952). C. A. 48, 122 (1954).

Franklin, M. C. and Short, W. F.
Acetoacetic ester condensations.
J. Chem. Soc. 1928, 591-5. C. A. 22, 1956 (1928). C. A. 16, 3067 (1922).

Harsley, V. L.
Condensation promoters.
Ger. 709,227, July 3, 1941 (Cl. 120.27). C. A. 37, 3106 (1943).

Henecka, H.
Ester condensations.
Forstschr. Chem. Forsch. 1, 685-724 (1950. C. A. 45, 6155 (1951).
Review with 103 references.

Hull, K. H., Jr. and Schneider, A. K.
Polymerization of cyclic esters, urethans, and imides.
J. Am. Chem. Soc. 80, 6409-12 (1958). C. A. 53, 14119-20 (1959).

Johnson, W. S., Petersen, J. W., and Schneider, W. P.
Extension of the modified Stobbe condensation. Acid catalyzed decomposition of the products and a lacto-enoic tautomerism.
J. Am. Chem. Soc. 69, 74-9 (1947). C. A. 41, 2408-9 (1947).
C. A. 39, 4867-8 (1945).

Johnson, W. S. and Miller, M. W.
Decarboxylation and lacto-enoic tautomerism. III. Stobb condensation with para, para'-dimethoxybenzophenone.
J. Am. Chem. Soc. 72, 511-13 (1950). C. A. 45, 1985-6 (1951). C. A. 44, 8887 (1950). C. A. 41, 2408 (1947).
Preparation.

Morton, A. A. and Stevens, J. R.
Condensations by sodium instead of by the Grignard reaction. I. Tertiary carbinols.
J. Am. Chem. Soc. 53, 2244-7 (1931). C. A. 25, 3643 (1931).
An active hydrogen or halogen is necessary.

Morton, A. A. and Stevens, J. R.
Condensations by sodium instead of by the Grignard reaction. II. Reaction with cyanobenzene. Preparation of diphenylketazine.
J. Am. Chem. Soc. 53, 2769-72 (1931). C. A. 25, 4248 (1931).

Morton, A. A. and Stevens, J. R.
Condensations by sodium instead of by the Grignard reaction. III. Tertiary carbinols and acids.
J. Am. Chem. Soc. 53, 4028-32 (1931). C. A. 26, 122 (1932).

Morton, A. A. and Stevens, J. R.
Condensations by sodium instead of by the Grignard reaction. IV. The probable existence of a new intermediate "metal halyl" in the reaction.
J. Am. Chem. Soc. 54, 1919-24 (1932). C. A. 26, 3249 (1932).

Morton, A. A. and Emerson, W. S.
Condensations by sodium. IX. Preparation and properties of trixenyl and trimethyltrixenyl carbinols and some of their derivatives.
J. Am. Chem. Soc. 59, 1947-9 (1937). C. A. 32, 136 (1938). C. A. 31, 671 (1937).

Morton, A. A. and Fallwell, F., Jr.
Condensations by sodium. X. Some side reactions occurring in the Wurtz synthesis and a novel formation of phenyliodide.
J. Am. Chem. Soc. 59, 2387-90 (1937). C. A. 32, 481 (1938).

Morton, A. A. and Emerson, W. S.
Condensations by sodium. XI. Trimethoxytrixenylcarbinol and comparisons of colors of some carbonium salts in this series.
J. Am. Chem. Soc. 60, 284-5 (1938). C. A. 32, 2524 (1938).

Morton, A. A., Fallwell, F., Jr., and Palmer, L.
Condensations by sodium. XII. Mechanism of formation of phenylmalonic acid and the synthesis of butyl- and phenylmalonic acids from monocarboxylic acids.
J. Am. Chem. Soc. 60, 1426-9 (1938). C. A. 32, 5807 (1938). C. A. 31, 671 (1937).

Morton, A. A. and Fallwell, F., Jr.
Condensations by sodium. XIII. Phthalic acids and some factors

influencing yields of butyl- and dimethylmalonic acids.
J. Am. Chem. Soc. 60, 1924-7 (1938). C. A. 32, 7473 (1938).

Morton, A. A. and Brachman, A. E.
Condensations by sodium. XXXI. Effects of salts and other substituents on the alkylation of toluene, a modified Wurtz reaction.
J. Am. Chem. Soc. 73, 4363-7 (1951). C. A. 47, 109-10 (1953).
C. A. 40, 1448 (1946). C. A. 46, 10095 (1952).

Morton, A. A. and Claff, C. E., Jr.
Condensations by sodium. XXXVII. Dimetalation of benzene, thiophene, para-t-butylphenol, i-propylbenzene and the effect of alkoxides on the meta:para ratio for benzene.
J. Am. Chem. Soc. 76, 4935-8 (1954). C. A. 49, 13169-70, 8861 (1955).

Condensation of organic metal derivatives with acylated compounds.
Brit. 489,026, July 14, 1938. C. A. 33. 282 (1939).
Discusses condensations of esters of acids of four or less carbon atoms and alcoholates.

Scheibler, H.
Metal compounds of the enol forms of monocarbonyl compounds. XIV. Action of sodium alcoholate on acid esters, ester condensations and substitution reactions of the metal compounds of acid esters.
Ber. deut. chem. Ges. 65B, 994-9 (1932). C. A. 26, 4794 (1932).
C. A. 26, 1898 (1932).
BzOEt + NaOEt = BzONa + C_2H_4 + EtOH.

Schorigin, P.
Contribution to our knowledge of condensations produced by sodium.
Ber. deut. chem. Ges. 40, 3111-18 (1907). C. A. 1, 2690-1 (1907).

Snell, J. M. and Mc Elvain, S. M.
Acetoacetic ester condensation. II. Reactions of aliphatic esters with sodium.
J. Am. Chem. Soc. 53, 750-60 (1931). C. A. 25, 1218 (1931).
C. A. 23, 5468, 2935 (1929). C. A. 18, 389 (1924).

Snell, J. M. and Mc Elvain, S. M.
Acetoacetic ester condensation. III. Role of sodium in the condensations.
J. Am. Chem. Soc. 53, 2310-16 (1931). C. A. 25, 3625, 1218 (1931).
The role of the sodium metal in the ethyl acetoacetate condensation is to generate, by reduction of the ester, sodium ethanolate, which is the real condensing agent.

Snell, J. M. and Mc Elvain, S. M.
Acetoacetic ester condensations. IV. The reaction product of certain aliphatic esters and sodium ethanolate.
J. Am. Chem. Soc. 55, 416-21 (1933). C. A. 27, 955 (1933).
C. A. 25, 3625 (1931). C. A. 22, 387 (1928).

Von Heijnenyen, E. M.
Acyloin condensation. II. Free redical formation accompanying the decarbonylation of an aliphatic ester by sodium.
J. Am. Chem. Soc. 77, 4016-19 (1955). C. A. 50, 6317-18 (1956). C. A. 47, 12270 (1953).

Wacker, A.
Condensation of esters.
Fr. 674,005, April 25, 1929. C. A. 24, 2469 (1930).
Metallic alcoholates, such as sodium ethanolate, are used for the condensation of esters, the alcohol formed during the reaction being separated by distillation.

Zimmer, H., Gracian, D., and Rothe, J.
Substituted γ-lactones. IV. Some aldehyde condensations with $\Delta^{\beta,\gamma}$-angelica with γ-valerolactone.
J. Org. Chem. 25, 238-9 (1960). C. A. 55, 2560 (1961). C. A. 54, 18421 (1960).
Synthesis.

G. Condensations.
(b) γ-Butyrolactone.

Cannon, G. W., Carler, J. J., Jr., and Gaines, W. A.
Acylation studies. II. Condensation of γ-butyrolactone and γ-valerolactone with methyl ketones.
J. Org. Chem. 17, 1245-51 (1952). C. A. 47, 8059-60, 161 (1953).
Reaction mechanism discussed.

Glacet, C.
Condensing reductions. Synthesis of 2-hydroxytetrahydrofurans of the type $RCHCHR'CH_2CH(OH)O$ through intermediate glycols of the type $RCH(\overline{OH)CHR'CH_2CH_2OH}$.
Ann. Chim. (12), 2, 293-353 (1947). C. A. 43, 4253-5 (1949). C. A. 41, 2722 (1947).
Synthesis.

Haworth, R. D. and Atkinson, J. R.
Constituents of natural phenolic resins. X. Structure of 1-matairesinol dimethyl ether and observations on the condensation of reactive methylene groups with O-methyleugenol oxide.
J. Chem. Soc. 1938, 797-808. C. A. 32, 6656-8, 548 (1938).
Synthesis of some substituted butyrolactones.

Haya, J.
Studies on hydroxycarboxylic acids. I. Condensation of γ-hydroxybutyric acid.
Nippon Kagaku Zasshi 81, 272-4 (1960). C. A. 55, 6370 (1961).
Use is made of nickel or copper.

Hudson, B. E., Jr. and Hauser, C. R.
Condensations. XVI. Various acylations and alkylations of the sodium enolates of aliphatic esters. Methods for the synthesis of α, α-disubstituted-β-keto esters and of certain other compounds.

J. Am. Chem. Soc. 63, 3156-62 (1941). C. A. 36, 410 (1942).
C. A. 34, 7876 (1940).
Synthesis of substituted butyrolactones by condensation reactions of aliphatic esters with such compounds as ethylene oxide.

Munch, W., Notarbartolo, L., and Lomma, R.
Institution of polymerization of caprolactone with butyrolactone.
U. S. 2,832,757, April 29, 1958. C. A. 52, 11472 (1958).
C. A. 57, 86216 (1957).

Pakendorf, K. G.
A new type reaction of ethylene oxide. II. By-products from the condensation of ethylene oxide with malonic ester.
Compt. rend. acad. sci. U. R. S. S. 27, 956-9 (1940) (in German).
C. A. 35, 1382 (1941). C. A. 34, 4381 (1940).
Preparation of α-(β-hydroxyethyl)butyrolactone.

Pakendorf, K. G. and Machus, F. F.
A new reaction of ethylene oxide; condensation of ethylene oxide with ethyl acetoacetate.
Compt. rend. acad. sci. U. R. S. S. 29, 579-81 (1940) (in German).
C. A. 35, 3627-8 (1941).
Preparation of some substituted butyrolactones.

Initiation of the polymerization of caprolactone with butyrolactone.
Brit. 757,539, Sept. 19, 1956. C. A. 51, 6216 (1957).
Uses thoroughly dry butyrolactone.

Shchukina, M. N. and Preobrazhenskii, N. A.
Products of condensation of α-formyl carboxylic esters with esters of α-halo acids. II. Carboxylation of vinylalkyl esters.
J. Gen. Chem. (U. S. S. R.) 10, 1363-8 (1940). C. A. 35, 3606-7 (1941). C. A. 30, 1030 (1936).
Preparation of some substituted butyrolactones.

Skinnes, G. S., Anderson, E., and Bogart, R. F.
Condensation of α-carbethoxy-γ-butyrolactone with amidines and guanidines.
J. Am. Chem. Soc. 71, 1482-3 (1949). C. A. 43, 6172-3 (1949).
C. A. 42, 5029 (1948).
Preparation.

Spinner, G. S., Stokes, A., and Spiller, G.
Condensation of α-alkyl-α-carbethoxy-γ-butyrolactone.
J. Am. Chem. Soc. 69, 3083-6 (1947). C. A. 42, 5029-30 (1948).
C. A. 39, 4845 (1945).
Uses sodium metal in ethanol.

Stacy, G. W., Cleary, J. W., and Gortstowski, M. J.
Alkylation of α-enol-γ-butyrolactones derived from condensation of ketones with diethyl oxalacetate.
J. Org. Chem. 22, 765-9 (1957). C. A. 52, 2764-5 (1958).
C. A. 51, 10412 (1957).

Stepanov, F. N.
Butyrolactone and its derivatives. I. Oxide condensations---synthesis of derivatives of butyrolactone.
Zhur. Obshchei Khim. 25, 2480-5 (1955). C. A. 50, 9291-2 (1956).

Stepanov, F. N.
Butyrolactone and its derivatives. I. Oxide condensations---Synthesis of derivatives of butyrolactone.
J. Gen. Chem. U. S. S. R. 25, 2369-74 (1955) (in English). C. A. 51, 7344 (1957). C. A. 50, 9291 (1956).

Tada, K., Numata, Y., Saegusa, T., and Furukawa, J.
Copolymerization of γ-butyrolactone and β-propiolactone.
Makromol. Chem. 77, 220-8 (1964) (English). C. A. 61, 12095 (1964).
Catalyst is Et_3Al-H_2O.

Truce, W. E. and Olson, C. E.
The aluminum chloride catalyzed condensation of γ-butyrolactone with benzene.
J. Am. Chem. Soc. 74, 4721 (1952). C. A. 48, 6397 (1954).

Tsuda, T., Shimizu, T., and Yamashita, Y.
Synthesis of aliphatic polyesters. VII. Cationic copolymerization of γ-butyrolactone and ε-caprolactone.
Kogyo Kagaku Zasshi 67 (12), 2150-3 (1964). C. A. 62, 14831-32 (1965). C. A. 62, 10519 (1965). C. A. 61, 9586 (1965).
Catalyst is BF_3-OEt_2.

Walter, R. and Zimmer, H.
Substituted γ-lactones. XVII. Synthesis of 3, 4-dihydrocoumarins by hydrogenation of α-(2-hydroxybenzylidene)-γ-lactones.
J. Heterocyclic Chem. 1, (4), 217-8 (1964). C. A. 62, 5247, 2769 (1965).
Condensation reactions of γ-butyrolactone with aldehydes.

Zimmer, H. and Rothe, J.
Substituted γ-lactones. I. Preparation of α-substituted γ-butyrolactones by condensation of γ-butyrolactone with aldehydes. Hydrogenation of the condensation products.
J. Org. Chem. 24, 28-32 (1959). C. A. 54, 6541-4 (1960).
Base catalyzed.

H. Miscellaneous.

Auell, E.
Action of some γ-butyrolactones on worm musculature.
Kiel Dissertation 1930; 27 pp. Ber. ges. Physiol. exptl. Pharmakol. 66, 502. C. A. 26, 5151 (1932).

Beckmann, C. O.
Racemization of d-α-hydroxy-β, β-dimethyl-γ-butyrolactone.
U. S. 2,463,734, March 8, 1949. C. A. 43, 4291 (1949).

Beer, A. A. and Preobroyhensky, N. A.
Chemistry of pantothenic acid and its synthesis.
Vitamin Research News (U. S. S. R.) 1946, No. 1, 43-7. C. A. 42, 2579 (1948).
A review with 18 references.

Bergel, F., Cohen, A., Morrison, A. L., and Moss, A. R.
Resolution of α-hydroxy-β, β-dimethyl-γ-butyrolactone.
U. S. 2,423,062, June 24, 1947. C. A. 41, 6278 (1947).

Benzi, S. and Angeli, B.
Transformation of cyclic esters into linear polyesters.
Gazz. chim. ital. 68, 215-24 (1938). C. A. 32, 8364-5 (1938).
C. A. 30, 2457 (1936). C. A. 29, 4328 (1935).

Bockmühl, M. and Ekrhart, G.
Spasmolytic and analgesic compounds.
Ann. 561, 52-85 (1948). C. A. 43, 4243-5 (1949).
Preparation.

Brue, F., Laborit, H., and Baron, C.
Immediate tensional effects of sodium γ-hydroxybutyrate in the rabbit and their modification by injection of hydroquinone.
Agressologie, 2(6), 627-30 (1961). Biol. Abstracts 39 (1), Abstract No. 2208 (1962). C. A. 61, 6223 (1964).

Cass, I. W.
Chemical intermediates from furfural.
Ind. Eng. Chem. 40, 216-19 (1948). C. A. 42, 4564-6 (1948).
Synthesis.

Chaikin, S. W. and Brown, W. G.
Reduction of aldehydes, ketones, and acid chlorides by sodium borohydride.
J. Am. Chem. Soc. 71, 122-5 (1949). C. A. 43, 2570 (1949).
Preparation.

Crawford, J. W. C. and Plant, D.
Pyrolysis of poly (sec-butyl α-chloroacrylate).
J. Chem. Soc. 1952, 4492-5. C. A. 48, 1254 (1954).
Preparation.

Duffin, G. F. and Kendall, J. D.
Isomerization of 2, 3-bis(arylhydrazone)-γ-butyrolactones.
J. Chem. Soc. 1955, 3969-71. C. A. 50, 9394-5 (1956).

Fenzi, C.
Synthesis of organic derivatives.
Giorn. chim. ind. I, 68-75 (1919). C. A. 14, 1120 (1920).
A review.

Fleck, F. and Schinz, H.
Stereoisomerism of α-hydroxy-β-alkyl-γ-lactones.
Helv. Chim. Acta 33, 140-5 (1950) (in German). C. A. 44, 5317 (1950).

Funabaski, S. and Michi, K.
Pantothenic acid. I. Crystalline dl- and d(+)-calcium pantothenate.
Bull. Inst. Phys. Chem. Research (Japan) 22, 681-6 (1943).
C. A. 41, 6199-6200 (1947). C. A. 35, 1382, 2474 (1941). C. A. 34, 6225 (1940).

Gerard, J., Weber, B., Janin, J. C., and Le Riguer, J.
Action of glucose on sleep and ketonuria produced by sodium γ-hydroxybutyric acid in fasting rats.
Agressologie, 2 (6), 611-14 (1961). C. A. 61, 6223 (1964).

Guka-Sircal, S. S.
Influence of groups and associated rings on the stability of certain heterocyclic systems. IV. Substituted butyrolactone and valerolactone.
J. Chem. Soc. 1928, 898-903. C. A. 22, 2368 (1928). C. A. 21, 2877 (1927).
Preparation.

Harris, W. W.
Electrochemical studies in cyclic esters.
U. S. Atomic Energy Commission UCRL-8381, 77 pp. (1958). C. A. 53, 4966 (1959).
Solubilities and conductivities of 54 salts in propylene carbonate and γ-butyrolactone.

Hayworth, R. D. and Richardson, T.
Constituents of natural phenolic resins. IV. Synthesis of dehydroanhydropicropodophyllin.
J. Chem. Soc. 1936, 348-52. C. A. 30, 3812 (1936). C. A. 30, 1049 (1936).

Holly, F. W., Barnes, R. A., Koniusky, F. R., and Folkers, K.
Amino analog of pantothenic acid.
J. Am. Chem. Soc. 70, 3088-90 (1948). C. A. 43, 574-5 (1949).
Preparation.

Illing, G.
Paper chromatographic separation with cation-exchange papers.
Arch. Pharm. 290, 581-2 (1957). C. A. 52, 7005 (1958).
5% Dowex 50W on paper with n-propanol-water (3:1) separates carboxylic acids and lactones after neutralization and saponification with normal sodium hydroxide. Air dry and spray with 0.05% alcoholic bromophenol blue.

Jonany, J. M., Gerard, J., Broussolle, B, Reynier, M., Orsetti, A., Vermuth, C., Baron, C., and Corbel, M.
Comparative pharmacology of the salts of butyric and of 4-hydroxybutyric acids.
Agressologie 1 (4), 417-27 (1960). C. A. 61, 6223 (1964).

Jujs, J. A.
Pantothenic acid and its allied compounds.
J. Pharm. Soc. Japan 63, 236-9 (1943). C. A. 45, 553 (1951).

C. A. 35, 4350 (1941).
Synthesis.

Kohler, E. P., Hill, G. A., and Bigelow, L. A.
Cyclopropane series. III.
J. Am. Chem. Soc. 39, 2405-18 (1917). C. A. 11, 3268-9 (1917).

Korte, F. and Machleidt, H.
Syntheses in the pyran series. II. Oxymethylenelactone rearrangement. III. Hydroxymethylene rearrangement of γ-butyrolactone.
Chem. Ber. 88, 1676-89 (1955). C. A. 50, 16760-2, 5615 (1956).

Major, R. L. and Finkelstein, J.
Resolution of dl-α-hydroxy-β, β-dimethyl-γ-butyrolactone.
J. Am. Chem. Soc. 63, 1368-71 (1941). C. A. 35, 4348-9 (1941).
Derivatives.

Mannich, C. and Bauroth, M.
Synthesis of aminoketonic acids.
Ber. deut. chem. Ges. 57B, 1108-15 (1924). C. A. 18, 3361 (1924).
C. A. 16, 2497 (1922).

Mc Rae, J. A., Bannard, R. A., and Rose, R. B.
β-Aroyl-α, β-diphenylpropionic acids from diphenylsuccinic anhydride.
Can. J. Research 28B, 73-82 (1950). C. A. 44, 4454-5 (1950).
C. A. 33, 3365 (1939).
Synthesis.

Michael, A. and Haag, W.
Esters of hydroxy acids.
Ger. 562,390, July 6, 1928. U. S. 1,831,025. C. A. 27, 731 (1933). C. A. 26, 735 (1932).

Michael, A.
Course of the addition of malonic enolates to α, β-unsaturated esters.
J. Org. Chem. 2, 303-7 (1937). C. A. 32, 1656 (1938). C. A. 31, 1364 (1937). C. A. 27, 2436 (1933). C. A. 26, 3483, 5916 (1932). C. A. 25, 82, 1802 (1931).

Nikishin, G. I. and Varob'ev, V. D.
Free radical addition of low molecular weight alcohols to unsaturated compounds.
Izvest. Akad. Nauk. S. S. S. R. Ser. Khim. 1964 (5), 894-7.
C. A. 61, 5510-16 (1964).
Preparation.

Nishigori, I. and Marahashi, S.
Plasticizers. II. Synthesis of γ, γ'-thiobutyric acid, γ, γ'-sulfonyldibutyric acid, and their esters.
Chem. High Polymer (Japan) 8, 253-6 (1951). C. A. 47, 6345 (1953).

Polymers with lactone and carboxylic ester groups.
Belg. 584,365, Nov. 30, 1959. C. A. 54, 16014 (1960).

Hydroxy carboxylic acid esters.
Brit. 366,443, July 29, 1929. C. A. 27, 1891 (1933). C. A. 25, 3359 (1931).

Cyclic esters.
Brit. 471,914, Sept. 13, 1937. Addition to 433,632. C. A. 32, 1408 (1938). C. A. 30, P576, P6138 (1936).

N-(3-hydroxypropyl)-α, γ-dihydroxy-β, β-dimethylbutyramide.
Brit. 582,156, Nov. 6, 1946. C. A. 41, 2432 (1947).
Preparation.

α-Hydroxy-β, β-dimethyl-γ-butyrolactone.
Brit. 597,648, Jan. 30, 1948. C. A. 42, 4606 (1948).
Preparation.

Esters.
Ger. 523,189, Dec. 4, 1928. C. A. 25, 3359 (1931). C. A. 23, P307, 137 (1929).

Petersen, R. C., Ross, S. D., and Finkelstein, M.
Electrolytic capacitors.
U. S. 2,965,690, Dec. 20, 1960. C. A. 55, 7112 (1961).
Salts in propylene carbonate and γ-butyrolactone.

Pickel, F. D., Foss, J. I., and Closroff, S.
Resolution of racemic α-hydroxy-β, β-dimethyl-γ-butyrolactone.
U. S. 2,460,239, Jan. 25, 1949. C. A. 43, 3448-9 (1949).

Plieninger, H.
Dihalo fatty acid halides.
Ger. 800,404, Nov. 6, 1950 (Cl. 120, 11). C. A. 45, 1620 (1951).
Halogenation in the presence of red phosphorus, or $SOCl_2$ at 50-150°.

Richter, R.
1, 3-cyclopentadiones and isomeric enol-lactones. II. Ethyl γ-butanolidieneacetate.
Helv. Chim. Acta 32, 2318-27 (1949) (German). C. A. 44, 3483 (1950). C. A. 43, 7910 (1949).

Rinker, I. F. and Von Scheloen, Th.
α-Hydroxy-β, β-bis(hydroxymethyl)butyrolactone.
Rec. Trav. Chem. 66, 758 (1947) (in English). Ann. 276, 80 (1893). C. A. 42, 4937 (1948).

Salamon, A.
Preparation of dl-pantothenic acid.
Müegyetemi Közlemények 1949, 72-6 (in English). C. A. 45, 552 (1951).
Preparation.

Scheibler, H. and Stein, H.
Ester enolates and ketene acetals. XVII. Reactions of ester enolates with halogenoacyl compounds.
J. prakt. Chem. 139, 105-12 (1934). C. A. 28, 1683 (1934).

Schildknecht, C. E. and Wallace, M. L.
Solution polymerization of acrylonitrile.
U. S. 2,768,148, Oct. 23, 1956. C. A. 51, 6178 (1957).
Preparation of propylene carbonate and γ-butyrolactone.

Spanagel, E. W.
Cyclic esters.
U. S. 2,092,031, Sept. 7, 1937. C. A. 31, 7443 (1937). C. A. 30, P6138 (1936).

Stiller, E. T., Harris, S. A., Finkelstein, J., Keresztesy, J. C., and Folkers, K.
Total synthesis of pantothenic acid.
J. Am. Chem. Soc. 62, 1785-90 (1940). C. A. 34, 6225 (1940).

III. Metal-organic Reactions.

Balueva, G. A. and Ioffe, S. T.
Organic compounds of berillium, calcium, stroncium, and barium.
Uspekhi. Khim. 31, 940-62 (1962). C. A. 58, 2462 (1963).
A review with 93 references through 1961 of all known organic compounds of the above listed metals.

Becher, K. and Jancke, W.
X-ray spectroscopic investigations with organic compounds.
Z. physik. Chem. 99, 242-74 (1921). C. A. 16, 872 (1922).
Discusses 23 lithium salts of fatty acids and of 24 other organic compounds.

Belcher, R., Gibbons, D., and Sykes, A.
Determination of metals in organic compounds.
Mikrochemie ver. Mikrochim. Acta 40, 76-103 (1952). C. A. 47, 998 (1953).
Includes 172 references.

Brace, P. H.
Some notes on calcium.
J. Inst. Metals 1921, Adv. copy No. 2; 16 pp. Engineering 111, 308-10 (1921). C. A. 15, 1237 (1921).

Bradley, O. L.
Recent advances in science: General and organic chemistry.
Science Progress 28, 476-81 (1934). C. A. 28, 1583 (1934).
A review of organic compounds of lithium.

Chelintzev, G.
The organo-sodium compounds and their role in organic synthesis.
Compt. rend. acad. sci. U. R. S. S. (N. S.), 2, 269-73 (1936).
C. A. 31, 94 (1937).
A review.

Collins, H.
Constitution and structure of the chemical elements.
Chem. News 121, 219-22 (1920). C. A. 15, 795, 11 (1921).
C. A. 14, 1255, 2123, 2748 (1920).
Specific gravities of sodium and potassium compounds---calculations.

Condorelli, L.
Micro-methods for the determination of calcium and magnesium in organic liquids.
Arch. form. sper. 40, 71-80 (1925). C. A. 20, 351 (1926).

Dehn, W. M. and Merteny, R. E.
Organic additive compounds of potassium hydroxide.
J. Am. Chem. Soc. 39, 2646-57 (1917). C. A. 12, 278 (1918).
Clean, dry lumps of potassium hydroxide are added to solutions of organic compounds in dry ether and allowed to stand. All organic compounds containing carbonyl groups add whole molecules of potassium hydroxide.

Fachini, S. and Dorta, G.
Separation of the liquid from the solid fatty acids. Behavior of the sodium and potassium salts of the liquid and solid fatty acids towards acetone.
Rendi. soc. chim. ital. (2), 4, 51-9. C. A. 7, 1427 (1913).
C. A. 6, 939 (1912).

Fenton, H. J. H. and Sisson, H. A.
Action of metallic magnesium on certain aliphatic acids and the detection of formic acid.
Proc. Cambridge Phil. Soc. 14, 385. C. A. 2, 1691, 1907, 2084 (1908).
Metallic magnesium has been shown to reduce both formic and carbonic acids to formaldehyde.

Frank, C. E., Hansley, V. L., and Nobis, J. F.
Alkali metal derivatives of organic compounds.
U. S. 2,954,410, Sept. 27, 1960. C. A. 55, 10322 (1961).

Frankenburger, W.
The chemical union of nitrogen to lithium and the mechanism of the reaction.
Z. Electrochem. 32, 481-91 (1926). C. A. 21, 689 (1927).
6 Lithium + N_2 = 2 $Lithium_3N$

Fry, H. S. and Otto, E.
Liberation of hydrogen gas from carbon compounds. III. The interaction of monoatomic alcohols and esters with fused caustic alkalies.
J. Am. Chem. Soc. 50, 1122-31 (1928). C. A. 22, 1949 (1928).
C. A. 20, 1588 (1926).

Fry, H. S. and Butz, R. J.
A reaction mechanism rule and its application to the action of fused caustic alkalies upon carbon compounds.
Rec. trav. chim. 52, 129-38 (1933). C. A. 27, 2367 (1933).
Reaction of fused caustic alkalies with carbon compounds results in the liberation of hydrogen gas and/or methane gas.

Frydlender, J. H.
Lithium and its compounds.
Rev. prod. chim. 33, 97-100, 161-5 (1930). C. A. 24, 3610 (1930).
A review.

Gilman, H. and Brown, R. E.
Some mechanisms for the formation of organo-magnesium and other organometallic compounds.
Rec. trav. chim. 50, 184-7 (1931). C. A. 25, 2687 (1931).
Grignards.

Gilman, H. and Dietrich, J. J.
Lithium cleavage of heterocycles in tetrahydrofuran.
J. Org. Chem. 22, 815-23 (1957). C. A. 52, 2863-4 (1958).
C. A. 48, 8217 (1954).

Gilman, H. and Dietrich, J. J.
Lithium cleavages of some heterocycles in tetrahydrofuran. II.
J. Am. Chem. Soc. 80, 380-3 (1958). C. A. 52, 2863, 10093-4 (1958).

Gontmakher, A. R. and Spirin, Yu. L.
Anionic polymerization under the influence of alkali metals and their compounds.
Uspekhi Khim. 29, 629-47 (1960). C. A. 54, 17942 (1960).
A review with 90 references.

Grignard, V.
Use of magnesium in organic chemistry.
Chemiker-Ztg. 34, 529. Bull. soc. chim. 7, 453. C. A. 4, 2105 (1910).
General discussion.

Grignard, V.
Magnesium in organic chemistry.
Bull. soc. chim. 13, No. 11, pp. 1-37. C. A. 3117 (1913).

Hansley, V. L.
Sodium reduction of fatty acid esters.
Ind. Eng. Chem. 39, 55-62 (1947). C. A. 41, 1202-3 (1947).
$RCO_2Et + 2\ EtOH + 4\ Na \rightarrow RCH_2ONa + 3\ EtONa$.

Huttig, G. F. and Krajewski, A.
Chemistry of lithium. III. Lithium hydride.
A. anorg. allgen. Chem. 141, 133-60 (1924). C. A. 15, 1104 (1925).

Ivanov, D. and Vasilev, G.
Synthesis of organo-lithium compounds by substitution at a labile hydrogen atom. I. Syntheses with sodium α-lithiophenylacetate obtained from aryl-lithium compounds.
Compt. rend. acad. bulgare sci. 7, 29-32 (1954) (Pub. 1955) (in German). C. A. 51, 5020 (1957).

Keiser, E. H. and Mc Master, Le Roy.
Action of magnesium upon the vapor of organic compounds.
J. Am. Chem. Soc. 32, 388-91 (1910). C. A. 4, 1467 (1910).
Magnesium heated with C_4H_9OH AND $C_4H_8O_2$.

Kharasch, M. S., Sternfeld, E., and Mays, F. R.
Reaction of esters with sodium in liquid ammonia.
J. Am. Chem. Soc. 61, 215 (1939). C. A. 33, 1690 (1939).

Kocheshkev, K. A. and Talalaeva, T. V.
Metallo-organic compounds of lithium, sodium, potassium, rubidium, and cesium.
Sintet. Metody v Oblasti Metalloorg. Soedinenii. Inst. Org. Khim., Akad. Nauk. S. S. S. R. 1949, No. 1, 378 pp. C. A. 46, 11102 (1952).

Krollpfeiffer, F. and Rosenberg, A.
Action of alkali metals on dialkylmalonic esters.
Ber. deut. chem. Ges. 69B, 465-70 (1936). C. A. 30, 3783 (1936).
Sodium and potassium under ether.

Liganik, L.
Activating alkali metals.
U. S. 2,577,289, Dec. 4, 1951. C. A. 46, 2987 (1952).
Sodium and potassium metals are passivated by excess purity. The passivation results in retardation of organic substitution reactions.

Lloyd, H. H. and Pardee, A. M.
A study of the electrical conductance of the sodium salts of certain organic acids in absolute alcohol at 15, 25, and 35°.
Carnegie Institute Publication 260, 99-118 (1918). C. A. 13, 3060 (1919).

Martin, J. and Krchma, I. J.
Catalysts for the preparation of esters.
U. S. 1,869,761, Aug. 2, 1932. C. A. 26, P5310 (1932).
Calcium and magnesium are among the catalysts discussed.

Marvel, C. S. and Birklimer, E. R.
Preparation of sodium salts of omega-hydroxybutyric, -valeric, and -caproic acids.
J. Am. Chem. Soc. 51, 260-2 (1929). C. A. 23, 818 (1929).
γ-Butyrolactone + NaOH $\xrightarrow[\text{heat for 3 hrs.}]{}$ 40% sodium γ-hydroxybutyrate.

Matignon, C.
Reactions for the preparation of magnesium metal.
Compt. rend. 172, 381-2 (1921). C. A. 15, 1664 (1921).

Michael, A. and Weines, N. W.
Partition principle as applied to the structure of enolic sodium derivatives of β-diketones and β-keto esters. III.
J. Org. Chem. 3, 372-84 (1938). C. A. 33, 1711 (1939). C. A. 26, 974 (1932).

Moncrieff, R. W.
Organo-lithium compounds.
Chem. Age (London) 63, 159-61, 190-2 (1950). C. A. 45, 6570 (1951).
A review with 12 references.

Morris, L. H.
Reaction between water and magnesium.
School Sci. Rev. 43, 451 (1962). C. A. 57, 1845 (1962).
Reaction is slow.

Niessnes, M.
Microanalytical research in metallurgy.
Angew. Chem. 52, 721-6 (1939). C. A. 34, 3204 (1940).
Table of spot tests for 21 metals.

Oda, R.
Action of caustic alkalies on organic compounds.
Chem. Rev. (Japan) 3, 491-507 (1937). C. A. 32, 9037 (1938).
A review.

Painter, E. P.
Synthesis of selenium analogs of dl-methionine and dl-homocystine.
J. Am. Chem. Soc. 69, 232-4 (1947). C. A. 41, 3759 (1947).
Synthesis.

Pappas, A. C.
Purification of clacium.
Acta Chem. Scand. 3, 36-40 (1949) (in French). C. A. 43, 7851 (1949).

Brit. 19,463, Aug. 28, 1913. C. A. 9, 694P (1915).
Organo-metallic compounds are formed by addition of alkali and alkaline earth metals to aldehydes, in the absence of water.

Brit. 270,060, March 24, 1926. C. A. 22, 1321 (1928).
Calcium and magnesium are purified by rapid vaporization or sublimation at pressures of not more than 2 mm. mercury.

Pisarzhevskii, L. V.
Catalysis by metals and by metallic oxides.
J. Russ. Phys. Chem. Soc. 61, 1609-34 (1929). C. A. 24, 2368 (1930).

Prins, H. J.
Catalytic action of sodium and its applications.
Chem. Weekblad 10, 474-87. C. A. 8, 3656 (1914).

Rojahn, C. A. and Schelten, J.
Applicability of lithium instead of sodium in organic synthesis.
Ber. deut. chem. Ges. 59B, 499-501 (1926). C. A. 20, 2320 (1926).
C. A. 19, 221 (1925).
In general lithium gives smaller yields than sodium. With several esters, however, yields with lithium are comparable to or greater than those with sodium.

Ruggli, P. and Maeder, A.
Ketone acids, enol-lactones, and ring ketones. I. Reactions of succinyl chloride with sodium malonic ester. I. The so-called succinyl-malonic ester.
Maeder. Helv. Chim. Acta 26, 1476-98 (1943). C. A. 38, 2934-5 (1944).

Scheibler, H., Zieynel, H., and Pfeffer, E.
Formation of hydrocarbons during action of potassium on ethyl acetate.
Ber. deut. chem. Ges. 55B, 3921-31 (1922). C. A. 17, 2873 (1923).
Reaction of the metal with the ester in diethyl ether.

Scheibler, H. and Emlen, F.
Formation of 1, 2-diketones by action of alkali metals upon the esters of fatty acids.
Ann. 434, 265-84 (1923). C. A. 18, 389 (1924).
Mechanism of reactions is discussed.

Smith, L. I. and Pritchard, W. W.
The chemistry of vitamin E. X. The reaction between quinones and metallic enolates. IX.
J. Org. Chem. 4, 342-50 (1939). C. A. 33, 7790-1, 585 (1939). C. A. 32, 3363 (1938). C. A. 30, 3797 (1936). C. A. 20, 2320 (1926).

Stadnikov, G. L.
Reactions of esters with magnesium organic compounds.
J. Russ. Phys. Chem. Soc. 46, 868-87 (1914). C. A. 9, 1754-5 (1915).

Suhbmann, R. and Clusius, K.
Purification of alkali metals.
Z. anorg. allgem. Chem. 152, 52-8 (1926). C. A. 20, 1962 (1926).
Alkali metals are obtained by thermal decomposition of their azides.

Tronov, B. V. and Kulev, L. P.
Determination of the reactivity of unsaturated organic compounds by the electromotive force and the reaction with sodium metal.
J. Gen. Chem. (U. S. S. R.) 5, 1007-15 (1935). C. A. 30, 1044-1045 (1936). C. A. 29, 448 (1935).
$\Phi_2C{=}O$ + sodium $\rightarrow [\Phi_2\overline{C}{-}O]^- Na^+$.

von Antropoff, A. and Germann, E.
Kinetics of the reaction between metallic calcium and nitrogen gas.
Z. physik. Chem. 137, 209-37 (1928). C. A. 23, 2095 (1929).
$3\ Ca + N_2 = Ca_3N_2$

von Girsewald, F.
Lithium.
Metallgesellschaft Periodic Rev. No. 2, 13-19 (1929). C. A. 24, 1827 (1930).
A review.

Wiemann, J.
Mechanism of the reduction of ketones with sodium. General process for the synthesis of asymmetric pinacols.
Compt. rend. 212, 764-5 (1941). C. A. 37, 3050 (1943). C. A. 27, 2720 (1933).

Wiemann, J., et al.
Comparative reduction of the carbonyl group of ketones, aldehydes, and esters according to the nature of the reaction medium.
Bull. soc. Chim. France 1954, 63-4. C. A. 48, 7547 (1954).
Mechanisms of sodium reactions under several conditions.

Wren, H.
Organometallic compounds of zinc and magnesium.
J. Chim Phys. 18, 248 (1920); 100 pp. C. A. 14, 3251 (1920).
A review.

Ziegler, K.
Organic compounds of lithium.
Ger. 512,882, Oct. 15, 1929. C. A. 25, 2154 (1931).
$RCl + 2\ Li^{0} = RLi + LiCl$.

Zollinger-Jenny, E. H.
Polyfatty acid esters.
Brit. 112,624, Jan. 8, 1918. C. A. 12, 1195 (1918).
Polymerization assessed by passage of gases or addition of metals.

IV. Cyclic Carbonates.

Anderson, J. R. and Van Dohlen, W. C.
Refining cyclic organic carbonates.
U. S. 2,894,957, July 14, 1959. C. A. 54, 573 (1960).
Separation of water and water-soluble impurities.

Choryles, L. A. and Sarel, S.
Alkaline hydrolysis of the carbonates of 2, 2-disubstituted 1, 2-alkanediols and 1, 3-propanediol.
Compt. rend. 245, 2321-3 (1957). C. A. 52, 8951-2 (1958).
Rate constants given.

Kemps, R. and Lee, W. H.
Dipole moments of some cyclic carbonates.
J. Chem. Soc. 1958, 1936-8. C. A. 52, 15164 (1958).

Koren'kova, O. P. and Kvasha, V. B.
Alkylene carbonates and their use.
Khim. Prom. 1961, 625-30. C. A. 56, 5820 (1962).
A review with 88 references.

Levin, S. Z, Shapiro, A. L., and Pritsker, A. A.
Preparation of alkylene carbonates.
U. S. S. R. 165,435 (Cl. C07c), Oct. 12, 1964, Appl. July 24, 1963. C. A. 62, 6395 (1965).

Pohoryles, L. A. and Sarel, S.
Infrared absorption spectra of some cyclic carbonates.
Bull. Research Council Israel 7A, 42-3 (1957). C. A. 52, 6932 (1958).

Rehberg, C. E., Dixon, M. B., Dietz, T. J., and Fisker, C. H.
Diglycol bis(carbonate) of lactic esters.
Ind. Eng. Chem. 42, 1409-11 (1950). C. A. 44, 8158 (1950).

Searles, S., Jr., Hayes, H. R., and Lutz, E. F.
Synthesis of cyclic sulfides from cyclic carbonate esters. II. Thiuranes. Mechanism of reaction.
J. Org. Chem. 27 (8), 2832-4 (1962). C. A. 60, 15699 (1964).
C. A. 58, 5600 (1963).

Shapiro, A. L., Lyubovskii, I. S., and Figel, A. A.
Preparation of alkylene carbonates.
U. S. S. R. 165,694 (Cl. C07c), Oct. 26, 1964, Appl. Aug. 1, 1962. C. A. 62, 6395 (1965).

Yakubovich, A. Ya., Gordon, G. Ya., Mashennekova, L. I., Tret'yakova, K. I., Grobmann, E., Kokoreva, N. I., and Veshnyakov, I. I.
Bis(hydroxyphenyl)propane polycarbonate.
U. S. S. R. 132,402, Oct. 5, 1960. C. A. 55, 9949-50 (1961).

V. Propylene Carbonate.

Chabrier, P., Najer, H., and Guidicelli, R.
A new procedure for the preparation of internal carbonates of 1, 2-propylenediol and 2, 3-butylenediol.
Compt. rend. 238, 108-10 (1954). C. A. 49, 1556 (1955).
Propylene carbonate is synthesized from 1, 2-propanediol, ethylene carbonate, and sodium metal.

Cline, W. K.
Cyclic carbonates.
U. S. 2,667,497, Jan. 26, 1954. C. A. 49, 1785 (1955).
Propylene oxide reacts with carbon dioxide in the presence of magnesium iodide at 190° to yield propylene carbonate.

Dreher, E. and Muenster, W.
Alkylene carbonates.
Ger. 1,135,490 (Cl. 12q), Aug. 30, 1962, Appl. Oct. 24, 1958; 2 pp. C. A. 58, 2373 (1963).
Propylene oxide + CO_2 = propylene carbonate.

Fiemasoni, S., Pochetti, F., and Roberti, G.
Reactions of ethylene and propylene carbonates. I. Reaction with bisphenol A (4, 4'-isopropylidene-dl-phenol).
Ann. Chim. (Rome) 54 (1-2), 73-9 (1964). C. A. 61, 3211 (1964).
Reaction results in polyethers and carbon dioxide.

Fuoss, R. M., Berkowitz, J. B., Hirsch, E., Petrucci, S.
Conductance of tetrabutylammonium tetraphenylbromide.
Proc. Nal. Acad. Sci. U. S. 44, 27-32 (1958). C. A. 52, 8692 (1958).
Propylene carbonate has a dielectric constant of 65.1.

Fuoss, R. M. and Hirsch, E.
Single-ion conductances in non-aqueous solvents.
J. Am. Chem. Soc. 82, 1013-17 (1960). C. A. 54, 14880-1 (1960).
Propylene carbonate.

Jones, E. I. and Todd, S. M.
Solutions of acrylonitrile polymers in mixtures of propylene carbonate and water.
U. S. 2,733,987, Feb. 7, 1956. C. A. 50, 14239 (1956).

Kowolik, E. J. and Fisher, J. W.
Solutions of acrylonitrile polymers in mixtures of ethylene and 1, 2-propylene carbonate.
U. S. 2,764,469, Sept. 25, 1956. C. A. 51, 4015 (1957).

Kronick, P. L. and Fuoss, R. M.
Quaternization kinetics. II. Pyridine and 4-picoline in propylene carbonate.
J. Am. Chem. Soc. 77, 6114 (1955). C. A. 50, 4606, 2257 (1956).
Propylene carbonate has a dielectric constant of 65 at 25° C.

Levin, S. Z. and Shapiro, A. L.
Synthesis and uses of propylene carbonate.
Khim. Prom. 41 (4), 264-6 (1965) (in Russian). C. A. 63, 478 (1965). C. A. 58, 11208 (1962). C. A. 51, 9677 (1957).

Malkemus, J. D.
Recovery of alkylene carbonates.
U. S. 2,766,258, Oct. 9, 1956. C. A. 51, 11380 (1957).
Preparation of propylene carbonate.

Mc Dowell, W. B.
Mephenesin carbonate hemihydrate.
U. S. 2,813,104, Nov. 12, 1957. C. A. 52, 4688 (1958).
Condensations with propylene carbonate.

Meredity, R. E. and Tobias, C. W.
Conductivities in emulsions.
J. Electrochem. Soc. 108, 286-90 (1961). C. A. 55, 12977 (1961).
Water-propylene carbonate emulsions.

Millikan, A. F. and Crosby, G. W.
Alkylene carbonates.
U. S. 2,993,908, July 25, 1961. C. A. 55, 25982 (1961).
Preparation of propylene carbonate.

Millikan, A. F. and Crosby, G. W.
Alkylene carbonates.
U. S. 2,994,704, Aug. 1, 1961. C. A. 55, 25982 (1961).
Preparation of propylene carbonate.

Mohler, D. and Ritter, J. R.
Non-aqueous fill electrolytes for capacitors.
U. S. 3,065,389 (C. 317-230), Nov. 20, 1962, Appl. Nov. 23, 1959; 4 pp. C. A. 58, 4171 (1963).
Propylene carbonate has a dielectric constant of 61 at 40°; it is a good solvent for inorganic compounds; has a low pour point (-80°); and has a high boiling point (242°).

Muenster, W. and Dreher, E.
Ger. 1,169,459 (Cl. C07d), May 6, 1964, Appl. June 9, 1960; 3 pp. C. A. 61, 4218 (1964). C. A. 55, P393 (1960). C. A. 51, P7408 (1957). C. A. 49, P1785 (1955). C. A. 44, P8947 (1950).
Preparation of propylene carbonate.

Najer, H., Chabrier, P., and Guidicelli, R.
Cyclic organic carbonates and their derivatives. I. Preparation of carbonates of 1, 2-propanediol, 1, 2-butanediol, and their action on amines; 1-methyl-2-hydroxyethyl and 1-methyl-2-hydroxypropyl carbonates.
Bull. soc. chim. France 1954, 1142-8. C. A. 49, 12303 (1955).
Preparation.

Najer, H., Chabrier, P., and Guidicelli, R.
Reactions of 1, 2-propylene carbonate and 2, 3-butylene car-

bonate with aliphatic amines.
Compt. rend. 238, 690-2 (1954). C. A. 49, 3129 (1955).

Olefin carbonates.
Brit. 760,966, Nov. 7, 1956. C. A. 51, 11380 (1957).
Preparation of propylene carbonates.

Linear condensation polyesters.
Brit. 769,700, March 31, 1957. C. A. 51, 12552 (1957).
Condensation of propylene carbonate by heat.

Organopolysiloxane elastomes.
Brit. 847,556, Sept. 7, 1960. C. A. 55, 5008 (1961).
Propylene carbonate.

Cyclic carbonates of α, β-diols.
Fr. 1,139,206, June 26, 1957. C. A. 53, 21671 (1959).
Preparation of propylene carbonate.

Peppel, W. J.
Preparation and properties of the alkylene carbonates.
Ind. Eng. Chem. 50, 767-70 (1958). C. A. 52, 16192-3 (1958).
Preparation of propylene carbonate from propylene oxide.

Saadi, A. H. and Lee, W. H.
Physicochemical studies of some cyclic carbonates. IV. A re-determination of the rates of alkaline hydrolysis of ethylene and propylene carbonates.
J. Chem. Soc., Phys. Org. 1966 (1), 1-4. C. A. 64, 6426 (1966).
C. A. 55, 15090 (1961).
By means of high frequency conductance measurements at 15, 25, and 35 °C.

Sönnerskog, S.
Spinning of polyacrylonitrile.
Swed. 164,017, July 15, 1958. C. A. 53, 7616 (1959).
Claims that propylene carbonate is miscible with water in any ratio.

Steward, R. P. and Vieira, E. C.
Dielectric constants of ethylene carbonates and solutions of ethylene carbonates in water, methanol, benzene, and propylene carbonate.
J. Phys. Chem. 62, 127-8 (1958). C. A. 52, 7798 (1958).

Watanebe, M. and Fuoss, R. M.
Quaternization kinetics. IV. Pyridine and 4-picoline in ethylene carbonate and 4-picoline in mixtures of propylene carbonate and diphenyl ether.
J. Am. Chem. Soc. 78, 527-9 (1956). C. A. 50, 7554 (1956).
C. A. 50, 4604 (1956).

Wu, Y. C. and Friedman.
Heats of solution of some trifluoroacetates, tetraphenylborates,

iodides, and perchlorates in water and in propylene carbonate and the related enthalpies of solution of the alkali metal ions in propylene carbonate.
J. Phys. Chem. 70 (2), 501-9 (1966) (in English). C. A. 64, 10476 (1966).

Yasui, E. and Shibata, T.
Alkylene carbonates.
Japan 23,175 ('63), Oct. 31, Appl. June 2, 1960; 2 pp. C. A. 60, 2767 (1964).
Preparation of propylene carbonate.