

A Lewis Acid Catalysed Diels–Alder Reaction with Inverse Electron Demand; an Alternative Synthesis of α -Damascone

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Summary α -Damascone has been synthesised from isoprene by acetylation, acid catalysed Diels–Alder reaction of the resulting 4-methylhexa-3,5-dien-2-one with isobutylene, and final aldol condensation with acetaldehyde.

LEWIS ACID catalysis of Diels–Alder reactions with inverse electron demand has been reported¹ only in the rather special case of tetraphenylcyclopentadienone with ethylene. We describe the catalysed Diels–Alder reaction between 4-methylhexa-3,5-dien-2-one² (**1**) and 2-methylprop-1-ene (isobutylene) to give the adduct (**2**). The adduct (**2**) was subsequently converted into α -damascone (**3**), a natural product³ with important fragrance and flavour properties.

Dienone (**1**) was conveniently prepared by acylation⁴ of isoprene with acetyl chloride and stannic chloride catalyst at -60° . 6-Chloro-4-methylhex-4-en-2-one, obtained as the only acylation product,[†] was dehydrochlorinated with diethylaniline to give dienone (**1**) as a mixture of *cis*- and *trans*-isomers (20:80) in *ca.* 30% yield based on acetyl chloride.

2-Methylprop-1-ene was passed through a solution of dienone (**1**) (1.0 mol) and aluminium chloride (0.9 mol) in methylene chloride at room temperature. In 4 h 90% of the dienone (**1**) had reacted and, after column chromatography, addition products were obtained in 60% yield based on (**1**). Products (**2**), (**4**)–(**7**) were separated in the ratios 20:55:15:6:4 respectively.[‡] The structure of vinyl ether (**4**) was confirmed by Büchi and Pickenhagen who recently reported⁵ that it was also the major product from cyclisation of *cis*- and *trans*-4,8-dimethylnona-3,7-dien-2-one in sulphuric acid. [We had found that with boron trifluoride in benzene the main product from this dienone was (**2**).]

† Applications of this stereospecific reaction will be published later.

‡ Pure *trans*-dienone (**1**) isomerised under the reaction conditions to give a mixture of *cis*- and *trans*-isomers (20:80).

¹ C. F. H. Allen, R. W. Ryan, and J. A. VanAllan, *J. Org. Chem.*, 1962, **27**, 778.

² C. Crisan and H. Normant, *Bull. Soc. chim. France*, 1957, 1451.

³ G. Ohloff, V. Rautenstrauch, and K. H. Shulte-Elte, *Helv. Chim. Acta*, 1973, **56**, 1503.

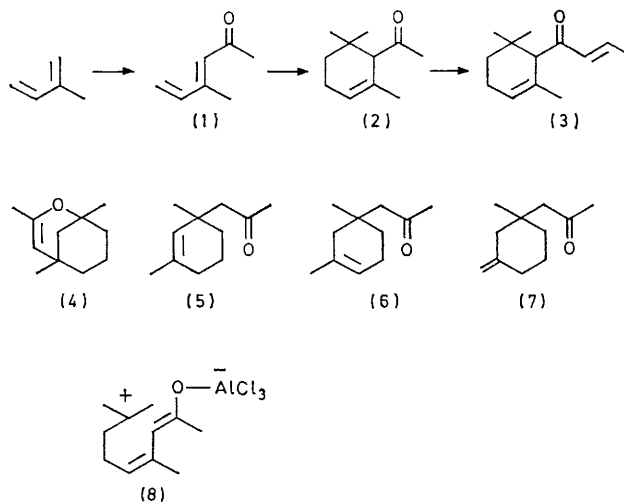
⁴ T. S. Cantrell and B. L. Strasser, *J. Org. Chem.*, 1971, **36**, 674; D. J. J. de Villiers, C. F. Garbers, and R. N. Laurie, *Phytochemistry*, 1971, **10**, 1359.

⁵ G. Büchi and W. Pickenhagen, *J. Org. Chem.*, 1973, **38**, 894.

⁶ A. T. Nielsen, C. Gibbons, and C. A. Zimmerman, *J. Amer. Chem. Soc.*, 1951, **73**, 4696.

⁷ Cf. K. S. Ayyar, R. C. Cookson, and D. A. Kagi, *J.C.S. Chem. Comm.*, 1973, 161.

The products can be explained through the zwitterion intermediate (**8**) which either closes to form adduct (**2**) or (more favourably) loses a proton and cyclises to give (**4**)–(**7**). The possibility of formation of (**2**) by a one-step mechanism cannot be excluded at present.



Adduct (**2**) was treated with *N*-methylanilinomagnesium bromide⁶ and then condensed with acetaldehyde. Elimination of water from the intermediate aldol with sodium acetate in acetic anhydride gave α -damascone in good yield.⁷

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