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# A NEW METHOD OF OLEFIN SYNTHESIS. COUPLING OF LITHIUM DIALKYLCUPRATES WITH ENOL TRIFLATES[1]

by

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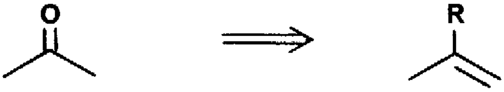
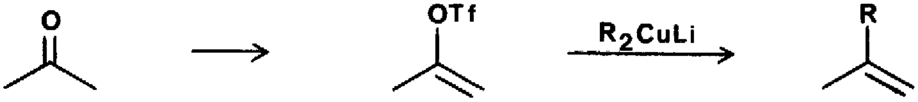
Abstract. Enol trifluoromethansulfonates react with lithium dialkylcuprates to give the coupling products in high yields. The reaction is stereoselective and is successful with a wide variety of organocuprates, including methyl, butyl, phenyl, vinyl, and cyclopropyl reagents.

The regioselective transformation of a ketone into an alkyl-substituted olefin represents an unsolved problem in the methodology of organic synthesis.



Classical methods for effecting this conversion involve addition of a Grignard or organolithium reagent to the ketone, followed by dehydration. Unfortunately, the dehydration step is rarely regiospecific; a mixture of olefin isomers is normally produced. A critical breakthrough occurred several years ago with the report by Blaszczak[2] that enol diphenylphosphates, prepared regiospecifically by enolate trapping, undergo a coupling reaction with di-*n*-butylcuprate. The net result is regiospecific replacement of enolate oxygen by an alkyl group. Unfortunately, the reaction does not work well with other organocuprates such as lithium dimethylcuprate. More recently, Oshima[3] has demonstrated that enol diphenylphosphates also couple with trialkylalanes in the presence of $Pd(PPh_3)_4$.

We wish to report what we believe to be a general solution to the problem. We have found that *enol trifluoromethansulfonates*[4] (enol triflates) undergo regio- and stereoselective coupling in high yield with a wide variety of organocuprate reagents.[5] Some of our results are presented in the Table.



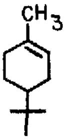
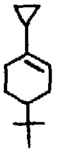
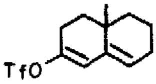
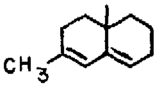
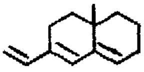
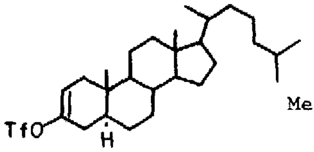
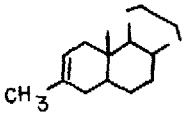
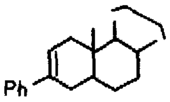
| Reaction No. | Enol Triflate | Organocuprate | Product | Yield (%) |
|---|---|---|---|---|
| 1 |  | $Me_2CuLi$ |  | 75 |
| 2 | " | $Bu_2CuLi$ |  | 100 |
| 3 | " | $Ph_2CuLi$ |  | 75 |
| 4 | " | $(CH_2{=}CH)_2CuMgBr$ |  | 62 |
| 5 | " | (▷)$_2$CuMgBr |  | 68 |
| 6 |  | $Me_2CuLi$ |  | 76 |
| 7 | " | $(CH_2{=}CH)_2CuMgBr$ |  | 71 |
| 8 |  | $Me_2CuLi$ |  | 82 |
| 9 | " | $Ph_2CuLi$ |  | 100 |

Table. Reactions of Enol Triflates with Organocuprates

As the data in the Table indicate, a wide variety of different organocuprate reagents couple with enol triflates. Methyl, butyl, phenyl, vinyl, and cyclopropyl cuprates all give good yields of the desired products. The vinyl coupling may well be particularly useful since one can imagine the formation of a variety of functionalized Diels-Alder dienes through use of functionalized vinyl cuprates.[6] Mono-enol triflates and di-enol triflates (reactions 6 and 7) appear to couple equally well, indicating that polyolefins are accessible by this coupling method.

We have also demonstrated that the coupling reaction occurs with high stereoselectivity about the double bond. Treatment of pure (*Z*)-5-trifluoromethansulfonyloxy-5-decene[7] with lithium dimethylcuprate gave (*E*)-5-methyl-5-decene with none of the (*Z*)-isomer detected by GC/MS Similar treatment of the pure (*E*)-5-trifluoromethansulfonyloxy-5-decene[7] gave (*Z*)-5-methyl-5-decene contaminated with a small amount (approx. 10%) of the (*E*)-isomer. It therefore appears that double bond geometry is largely maintained during the coupling reaction with only a small amount of isomerization occurring.

(*Z*) (*E*)

+ 10% (*E*)

(*E*) (*Z*)

In a representative procedure, a solution of lithium dimethylcuprate was prepared by adding 5.5 ml (10.8 mmole) of 2.0 *M* methyllithium in hexane to a stirred slurry of CuI (1.43 gm, 7.5 mmole) in 15 ml of THF at 0°. 1-Trifluoromethansulfonyloxy-4-*t*-butylcyclohexene (0.625 gm, 2.2 mmole) in 5 ml of THF was added, and the reaction mixture was stirred 12 hr at -15°. The reaction mixture was then diluted with hexane, filtered through a pad of Florisil, and concentrated on the rotary evaporator. Chromatography of the residue on silica gel provided pure 4-*t*-butyl-1-methylcyclohexene (250 mg, 75%); NMR ($CDCl_3$) $\delta$ 5.38 (m, 1H), 1.87 (m, 4H), 1.63 (s, 3H), 1.25 (m, 3H), 0.84 (s, 9H). Further identification was provided by comparison of the product with an authentic sample.

We feel that this new method of olefin synthesis offers much promise, and we are continuing our work to delineate the scope of the reaction.

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## Notes and References

1. This work was carried out at the University of California, Santa Cruz, California 95064.
2. L. Blaszczak, J. Winkler, and S. O'Kuhn, *Tetrahedron Lett.*, 4405 (1976).
3. K. Takai, K. Oshima, and H. Nozaki, *Tetrahedron Lett.*, *21*, 2531 (1980).
4. The cyclic enol triflates used in this work were prepared from the corresponding ketones by the general procedure of Stang, using 2,6-di-*t*-butylpyridine and triflic anhydride in dichloromethane solution: P. J. Stang and T. E. Fisk, *Synthesis*, 438 (1979); P. J. Stang and W. Trepton, *Synthesis*, 283 (1980). See also J. R. Hassdenteufel and M. Hanack, *Tetrahedron Lett.*, *21*, 503 (1980).

   Enol triflates are quite stable and easily handled. We experienced no difficulties in storing the enol triflate from 4-*t*-butylcyclohexanone for several months, and we were able to purify enol triflates chromatographically (both column and GLC) without incident.
5. For a review of organocuprate coupling reactions, see G. H. Posner, *Org. Reactions*, *22*, 253 (1975).
6. For syntheses of bis(α-ethoxyvinyl)cuprate and bis(α-trimethylsilylvinyl)cuprate, see: R. K. Boeckman and K. J. Bruza, *J. Org. Chem.*, *44*, 4781 (1979).
7. Prepared by addition of trifluoromethansulfonic acid to 5-decyne, followed by chromatographic separation of (*E*) and (*Z*) isomers on silica gel. See: R. H. Summerville, C. A. Senkler, P. v. R. Schleyer, T. E. Dueber, and P. J. Stang, *J. Amer. Chem. Soc.*, *96*, 1100 (1974).

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