

論文の内容の要旨

論文題目 : Development of Radical-Based Methods for Introduction of Highly Oxygenated Carboskeletons

(ラジカル反応を利用した高酸化度炭素骨格導入法の開発)

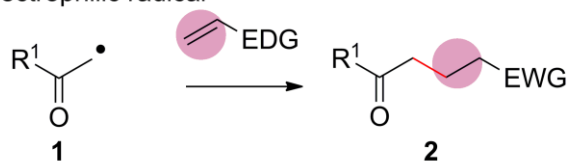
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1. Introduction

Among various chemical reactions, carbon-carbon (C–C) bond forming reaction plays a central role in chemical syntheses because of its high utility in construction of molecular carbon frameworks. In particular, the study of C–C bond formations by a radical addition to C–C π -bonds is the one of the most attractive research fields, because radical species has both a high reactivity and compatibility of various functional groups, which enables effective C–C bond formation reactions. Based on the characteristics of radical species, nucleophilicity and electrophilicity, development of new radical-based methods for introduction of highly oxygenated units was planned (Scheme 1). Accordingly, the reaction of the α -carbonyl radical with an electron-rich olefin and the reaction of the α -oxy radical with an electron-deficient olefin were developed.

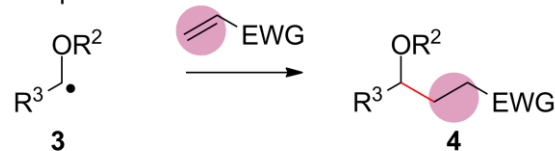
Scheme 1. Reactivity of nucleophilic radical and electrophilic radical

(1) Electrophilic radical



α -carbonyl radical

(2) Nucleophilic radical

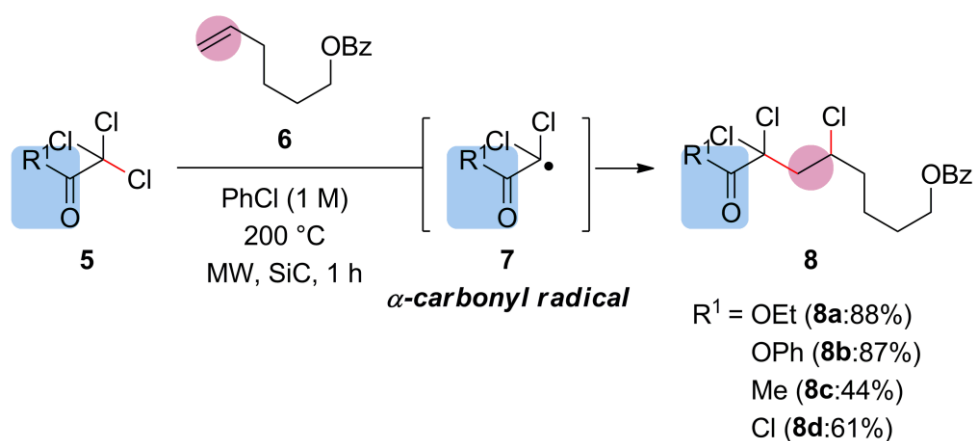


α -oxy radical

2. Introduction of Carbonyl Unit

A new method for introduction of the carbonyl unit via the α -carbonyl radical was developed (Scheme 2). Carbonyl group is the most important functional group in the synthetic organic chemistry, because it shows various reactivities and its transformation often plays a key role in construction of carboskeletons. Therefore, development of an effective method for introduction of a carbonyl group is desired. In this reaction, α -carbonyl radical **7** was generated without any radical initiators or metal catalysts. Trichloroacetyl compounds **5** functioned as a radical precursor and produced α -carbonyl radical **7** by being heated using microwave in the presence of the heating element (SiC). This method realized introduction of ester, ketone, acyl chloride to electron-rich olefin **6**.

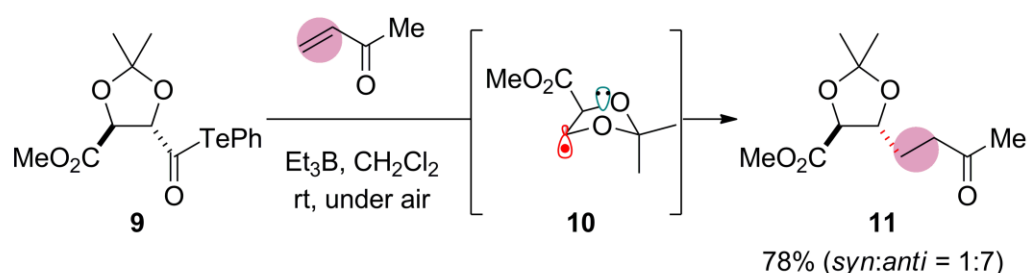
Scheme 2. Introduction of carbonyl unit via α -carbonyl radical



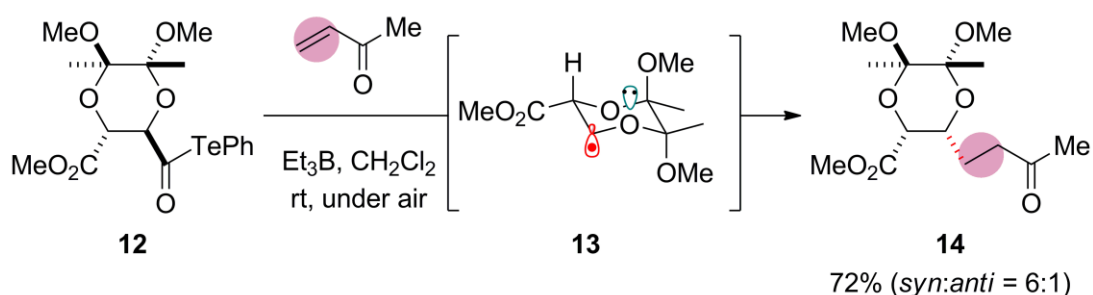
3. Introduction of Diol Unit

Development of the new method for introduction of diol unit to electron-deficient olefins via α -oxy radical was achieved (Scheme 3). The new method for introduction of the diol unit would contribute to convergent syntheses of polyol compounds. After unsuccessful attempts, it was revealed that the treatment of α -oxy acyl telluride **9** with triethylborane under air produced α -oxy radical **10** probably due to decarbonylation from the acyl radical facilitated by the adjacent oxygen atom. The reaction of acetonide-protected α -oxy acyl telluride **9** and methyl vinyl ketone mainly gave *anti*-diol **11**, while the reaction of bisacetal-protected α -oxy acyl telluride **12** with methyl vinyl ketone gave *syn*-diol **14** as the major product. These stereoselectivities were derived from the reaction of axial σ -radicals **10** and **13**, which were more stabilized than equatorial σ -radicals, because the lone pair of the oxygen atom at the α -position interact with the σ^* orbital of the radical. Stereoselective introduction of the 1,2-diol unit was realized by taking advantage of characteristics of the lone pair of the oxygen atom.

Scheme 3. Introduction of 1,2-diol unit
(1) *Anti*-selective introduction of 1,2-diol

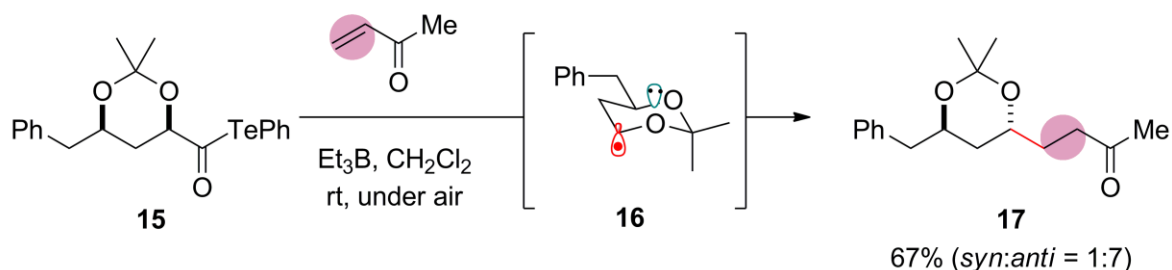


(2) *Syn*-selective introduction of 1,2-diol



In addition to the 1,2-diol unit, introduction of the 1,3-diol unit was achieved using acetonide-protected α -oxy acyl telluride **15** (Scheme 4). In the same way, *anti*-diol **17** was obtained mainly in this reaction, through the reaction of axial σ -radical **16**. *Anti*-selective introduction of the 1,3-diol unit to the electron-deficient olefin was succeeded.

Scheme 4. Introduction of 1,3-diol unit



4. Conclusion

New radical-based methods for introduction of highly oxygenated units were developed. Introduction of the carbonyl unit to an electron-rich olefin via the α -carbonyl radical and introduction of the diol unit to an electron-deficient olefin via the α -oxy radical were realized. The former reaction enabled generation of the α -carbonyl radical without any radical initiators and metal catalysts. By heating trichloroacetyl compounds using microwave in the presence of the heating element, the α -carbonyl radical was generated. In the study of the latter reaction, α -oxy acyl tellurides were revealed to function as the precursor of the α -oxy radical. In addition, stereoselective introduction of the diol unit was succeeded by taking advantage of the effect of the lone pair of the adjacent oxygen atom. This reaction would contribute to effective convergent syntheses of complex natural products such as polyol compounds.