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Simple and regioselective azidoiodination of alkenes using Oxone®

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Abstract—An efficient method for azidoiodination of alkenes using NaN_3/KI/Oxone® combination is described.

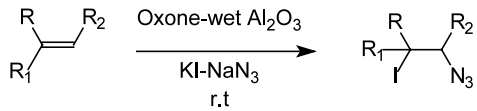
β-Azido iodo compounds have many applications in organic synthesis, particularly as precursors of vinyl azides,[1] amines[2] and aziridines,[3] therefore there is a considerable interest in developing new simple methodologies for their preparation.

β-Azido iodo compounds have usually been prepared by iodoazidation of alkenes using sodium azide generated by reaction of iodine with silver azide[4] and from sodium azide and iodine chloride in polar solvents.[5] Although no problems have been reported, iodine azide is potentially explosive.

Recently Kirschning,[6] Nair[7] and Barluenga[8] have reported three different methods for azidoiodination of alkenes using $PhI(OAc)_2/Et_4NI/TMSN_3$, CAN/NaI/NaN_3 and IPy_2BF_4/Me_3SiN_3 reagent combination, respectively. Kirsching also reported the use of polymer-bound iodine azide.[9]

Oxone® (potassium hydrogen persulfate) has been largely used for the oxidation of several functional groups such as alkenes,[10] amines,[11] imines,[12] sulfides,[13] selenides,[14] acetals,[15] and carbonyl regeneration from thioacetals,[16] oximes,[17] and nitroalkanes.[18] Moreover Oxone® can be used for the oxidation of halide in the oxidation of α,β-enones,[19] bromination of pyrimidines,[20] halogenation of toluene,[10] preparation of *gem*-halonitro derivatives,[21] and halodecarboxylation of α,β-unsaturated acids.[22]

We wish to report that Oxone® in the presence of KI and NaN_3 can be used for selective conversion of alkenes into azido iodo derivatives in good yield and mild reaction conditions.



When alkenes are treated with KI, NaN_3 and Oxone® supported on wet alumina[13] in chloroform, at room temperature β-azido iodo derivatives are produced in good yields. (Table 1)

Without Al_2O_3 no reaction products were observed. Probably Al_2O_3 acts both as a support (to allow inorganic salts to interact with organic compounds) and as a basic reagent to avoid azide decomposition in the presence of an acidic medium).

The reactions showed to be regioselective and the regiochemistry was determined by ^1H and ^{13}C NMR spectra.[23]

It is interesting to note that the regiochemistry of the addition is anti-Markovnikov. This result could be explained by a radical course of the reaction favored by the low polarity of the solvent.[24] The regiochemistry of the addition with different halides and different reaction conditions are under investigation.

In summary the described method is a very good yielding procedure and represents a regioselective, simple and safe synthesis of β-azido iodides.

Typical procedure: Oxone® (5 equiv.) was added to a stirring suspension of wet Al_2O_3 (20 g) in $CHCl_3$ (50

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ml). KI (5 equiv.) was added and the resulting deep purple suspension was stirred for 10 min. After this period solid NaN_3 (1.5 equiv.) and alkene in 5 ml of $CHCl_3$ were added dropwise. After 2 h the mixture was filtered under vacuum and the solution washed with saturated $NaHSO_3$ and brine. The organic layer was dried over Na_2SO_4 and concentrated. The crude product was purified by SiO_2 gel column chromatography.

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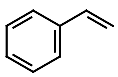
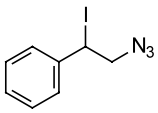
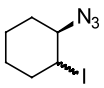
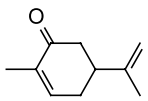
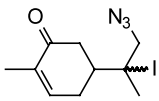
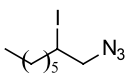
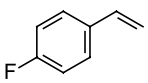
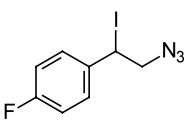
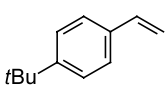
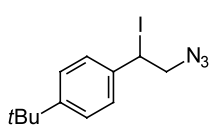
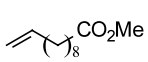
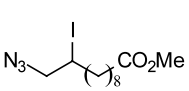
Table 1.

Substrate	Product	Yield (%)[a]
		92[7]
		84[6b]
		83[6c]
		89[7]
		64[25]
		80[26]
		82[27]

[a] Isolated yield.
[b] 1:5 *cis*/*trans* mixture.
[c] 1:1 mixture of diasteroisomers.

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23. In the ^1H NMR spectra proton signals for CH-I systems are always deshielded respect to the CH-N3 ones. In ^{13}C NMR spectra carbon signals of C-N3 systems are always deshielded respect to C-I ones.
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25. IR (neat) 2096 cm^{-1}; ^1H NMR (200 MHz $CDCl_3$) δ 7.46 (dd, $J=5.16$, 8.6 Hz, 2H), 7.08 (t, $J=8.6$ Hz, 2H), 5.18 (t, $J=7.4$ Hz, 1H), 3.96 (d, $J=7.4$ Hz, 2H); ^{13}C NMR (200 MHz $CDCl_3$) δ 27.11, 59.26, 116.47 ($J=44$ Hz), 129.89, 136.69, 162.88 ($J=494$ Hz).

26. IR (neat) 2102 cm^{-1}; ^1H NMR (200 MHz $CDCl_3$) δ 7.42 (d, $J=8.2$ Hz, 2H), 7.29 (d, $J=8.2$ Hz, 2H), 5.21 (t, $J=7.9$ Hz, 1H), 3.98 (d, $J=7.9$ Hz, 2H), 1.35 (s, 9H). ^{13}C NMR (200 MHz $CDCl_3$) δ 146.81, 133.87, 127.22, 126.31, 58.86, 34.72, 31.22, 28.38.

27. IR (neat) 2101, 1736 cm^{-1}; ^1H NMR (200 MHz $CDCl_3$) δ 4.11 (m, 1H), 3.84–3.61 (m, 2H), 3.71 (s, 3H), 2.35 (t, $J=7.4$ Hz, 2H), 2.2–1.2 (m, 14H); ^{13}C NMR (200 MHz $CDCl_3$) δ 174.2, 58.98, 51.45, 37.07, 34.40, 29.12, 28.69, 24.88.