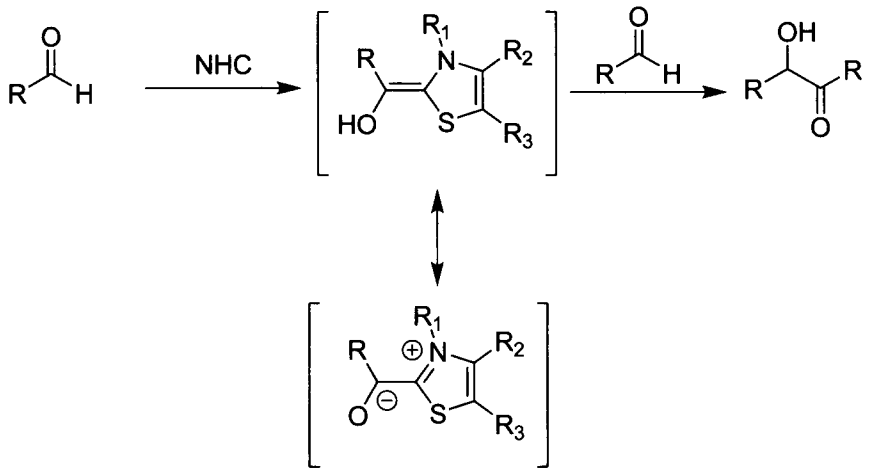
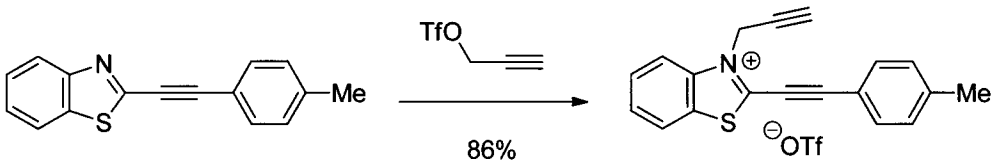


With Breslow subsequently citing the nucleophilic carbene to be responsible for catalysis in the process that utilizes a thiamine related NHC, this "umpoulong" chemistry has evolved into distinct area of research called NHC catalysis, and it has found many applications in the recent past. A detailed discussion on this topic is, however, beyond the scope of this book and has been reviewed elsewhere.[54]

Tosylates as well as alkyl halides can also cause *N*-alkylation of thiazoles and involve an S_N2 quarternization reaction. The thiazolium salt formation concept has been well utilized in medicinal chemistry. For example, Kerwin and co-workers at the University of Texas at Austin have reported the role of 2-alkynylbenzothiazolium component in DNA cleavage.[55] They prepared a series of "moderately potent" *N*-propargyl-2-alkylbenzothiazolium aza-enediynes DNA cleavage agents, an example of which is shown below. Propargyl triflate was employed as the alkylating agent.



benzothiazolium aza-enediyne

7.2.4 N-*Oxidation*

Thiazole *N*-oxides may result from the direct oxidation of thiazoles with hydrogen peroxide, tungstic acid, or peracetic acid.[56]