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Visible-light-promoted synthesis of benzothiazoles from 2-aminothiophenols and aldehydes

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ABSTRACT

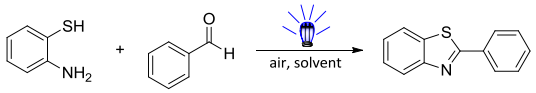
A visible-light-promoted synthesis of benzothiazoles from 2-aminothiophenols and aldehydes has been developed. A wide range of aromatic, heteroaromatic and aliphatic aldehydes were successfully applied. The benzothiazole products were prepared in good yields. The reaction was carried out in the absence of transition-metal catalysts and extra additives. A radical reaction pathway was proposed.

Benzothiazoles are an important class of heterocyclic compounds. They possess various attracting biological and pharmacological properties[1], such as antimicrobial[2], antitumor[3], anticonvulsant[4] and antidiabetic[5] activities. A number of synthetic methods of benzothiazoles have been developed.[6] Among them, the condensation of 2-aminothiophenols with aldehydes is the most commonly used method. Generally, metal catalysts[7], Brønsted acid catalysts[8], and oxidants[9] are required to promote the reaction. Aminoxyl radical/oxygen[10] and activated-carbon/oxygen system[11] were also efficient for the condensation of 2-aminothiophenols and aldehydes under high temperature. Chen and co-workers found that Montmorillonite K-10 can catalyze the transformation with continuous bubbling of air.[12] Microwave is also used to accelerate the formation of benzothiazoles.[13] Recently, Han and co-workers reported an efficient synthesis of 2-arylbenzothiazoles under DMSO/air conditions, however aliphatic aldehydes are not compatible in the reaction.[14]

In recent years, visible-light promoted transformations have received great attentions.[15] The methods are cleaner, safer and more cost-effective. It was known that diphenyl disulfides can be homolytically cleaved to phenylthiyl radicals under photoirradiation.[16] Recently, we found that visible-light can promote the formation of benzothiophenes from diphenyl disulfides and alkynes. The generation of phenylthiyl radicals via visible light-promoted homolysis of diphenyl disulfides is suggested as the crucial initiation step.[17] In 2010, Yoon and co-workers reported that visible-light directly promotes the formation of diphenyl disulfides from thiophenols in the absence of extra catalysts or additives.[18] We speculate that the reaction of 2-aminothiophenols and aldehydes under visible-light irradiation can provide benzothiazoles via in situ formation and homolysis of diphenyl disulfide intermediates. Herein we report the experiment results along with this idea.

To test our hypothesis, a solution of 2-aminothiophenol and benzaldehyde in toluene was irradiated with a 12W blue LED for 6 h under an air atmosphere. To our delight, the benzothiazole **3a** was obtained in a 67% yield. The reaction conditions were further examined and the results are summarized in Table 1. Among the tested reaction solvents, ethyl acetate afforded the best yield (Table 1, entry 3). The lights of other wavelengths (254 nm, 365 nm and 530 nm) were also evaluated, but lower yields were obtained (Table 1, entries 10-12). Lower yields were observed under argon or oxygen atmosphere (Table 1, entries 13-14). The result implicated that the presence of oxygen is crucial for the reaction, but the concentration of oxygen must be controlled at a suitable scope to avoid the inhibition of the radical process. A small amount of the product was obtained when the reaction was performed in the dark (Table 1, entry 15).

Table 1. Screening of reaction conditions.[a]



1a 2a 3a

Entry	Solvent	Light source	Yield (%)[b]
1	Toluene	450 nm	67
2	MeCN	450 nm	41

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