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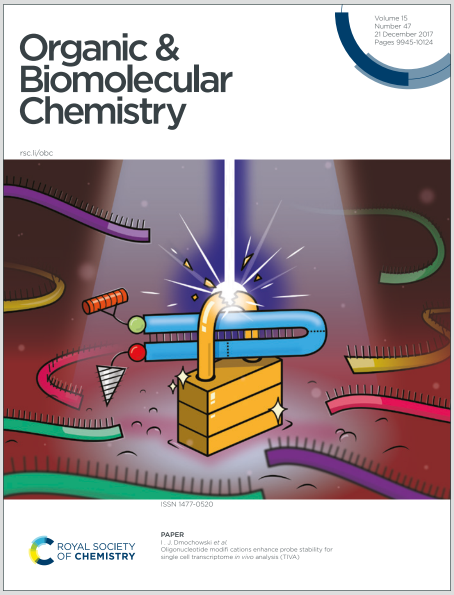

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FULL PAPER

Photocatalytic Dual Decarboxylative Alkenylation Mediated by Triphenylphosphine and Sodium Iodide

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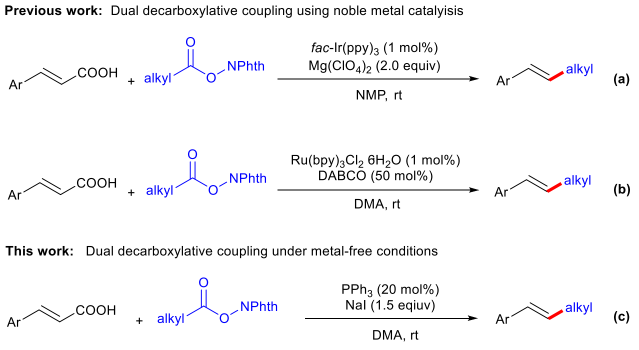
An efficient photocatalytic dual decarboxylative alkenylation of α,β-unsaturated carboxylic acids and alkyl *N*-hydroxyphthalimide (NHP) esters mediated by triphenylphosphine and sodium iodide has been developed. This protocol proceeds under 456-nanometer irradiation by visible blue light in the absence of transition metals or organic dye based photoredox catalysts. The reaction is successfully applied to a wide range of redox-active esters derived from aliphatic carboxylic acids (1°, 2° and 3°) and α-amino acids, enabling transformations of diverse α,β-unsaturated carboxylic acids to α,β-alkylated styrenes with high efficiency and excellent selectivity under mild conditions.

Carboxylic acids and their derivatives are a highly important class of platform molecules which have broad applications in biological and chemical synthesis because they are abundant, low cost, easy to store, and simple to handle.[1] One of the most functional transformations of carboxylic acids and their derivatives is decarboxylative cross-coupling, in which undergoes C-C bond cleavage to liberate CO_2 along with the construction of new C-C or C-heteroatom bond.[2-4] Generally, the decarboxylative cross-coupling process are achieved by transition metal-catalyzed extrusion of CO_2 to form nucleophilic organometallic intermediates. [5-7] Despite these achievements obtained in this area, the current methods require metal catalysis or high temperature. The development of a mild and environmentally-benign route to form this process is highly desired.

In recent years, visible-light-induced radical decarboxylative functionalization of carboxylic acids and their derivatives has emerged as a powerful method for the construction of C-C bond owning to their sustainability, practicality, and environmental friendliness.[8-10] The radical intermediates formed from carboxylic acids can directly participate in cross-coupling under photocatalytic conditions, among them, *N*-hydroxyphthalimide (NHP) esters were demonstrated to be very efficient alkyl source in C(sp^3)-C bond formation.[11,12] In 2017, Duan and co-workers[12a] reported a visible-light-mediated decarboxylative coupling between alkyl NHP esters and α,β-unsaturated carboxylic acids in the presence of *fac*-Ir(ppy)$_3$ and Mg(ClO_4)$_2$ (scheme 1a). In the same year, Xu, Zhang and co-workers[12b] described a similar visible-light-mediated dual decarboxylative reaction using Ru(bpy)$_3$Cl$_2$ as the photocatalyst and DABCO as the base for this transformation (scheme 1b). Although these two methods provide an efficient way to construction of α,β-alkylated styrenes, they require noble metal catalysis. Recently, Shang, Fu and co-workers[12c] developed a new photocatalytic decarboxylative alkenylation reactions of *N*-(acyloxy)phthalimide derived from α-amino and α-hydroxy acids with 1,1-diarylethene, and with cinnamic acid derivatives. The advantage of this reaction was using sodium iodide and triphenylphosphine instead of a traditional dye- or metal as redox catalysts for the synthesis of allylic amine or allylic ether derivatives, but a wide range of alkyl NHP esters did not involved. Therefore, we envisaged that using triphenylphosphine and sodium iodide to achieve decarboxylative alkenylation of α,β-unsaturated carboxylic acids with alkyl *N*-hydroxyphthalimide esters, which applied to a wide range of redox-active esters derived from aliphatic carboxylic acids (1°, 2° and 3°) and α-amino acids.



Scheme 1 Photocatalytic dual decarboxylative alkenylation.

Herein, we report a new, metal-free photocatalytic dual decarboxylative alkenylation between α,β-unsaturated carboxylic acids and alkyl NHP esters in combination of

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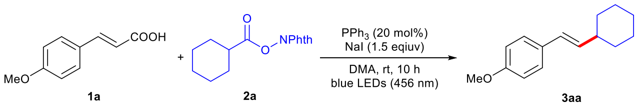
triphenylphosphine and sodium iodide (scheme 1c). It should be noted that a wide range of redox-active esters derived from aliphatic carboxylic acids (1°, 2° and 3°) as well as α-amino acids were found to be compatible. This method offers an efficient way to access α,β-alkylated styrenes with highly regio- and stereo-specificity.

The optimized reaction conditions for dual decarboxylative alkenylation using 4-methoxycinnamic acid **1a** and *N*-acyloxyphthalimide **2a** as the model reaction partners (Table 1). To our delight, the desired decarboxylative coupling product **3aa** was isolated in 90% yield under blue LED irradiation of 20 mol% PPh_3 and 1.5 equiv of NaI in DMA at room temperature for 10 h (entry 1). Other iodides, including LiI, KI and *n*-Bu_4NI were examined: each of which exhibited good catalytic activity but was less efficient than NaI (entries 2-4). Other halides such as NaF, NaCl and NaBr were entirely ineffective (entry 5). Next, we screened a series of phosphines with different electronic and steric properties, the result showed that PPh_3 was the most efficient catalyst for stabilizing the iodine radical as a R_3P-I· species (entries 6-8). Among the solvents examined, DMA was the best option compared with other solvents such as DMSO, DMF, 1,4-dioxane or MeCN (entries 9-12). All three components phosphine, sodium iodide and irradiation were essential for the reaction (entries 13-15). Gratifyingly, the reaction (entry 16) scale up to 1 g of acid **1a** was successful to construct **3aa** in 85% yield for 36 h, (more details see the SI).

Table 1 Screening of optimal reaction conditions [a]

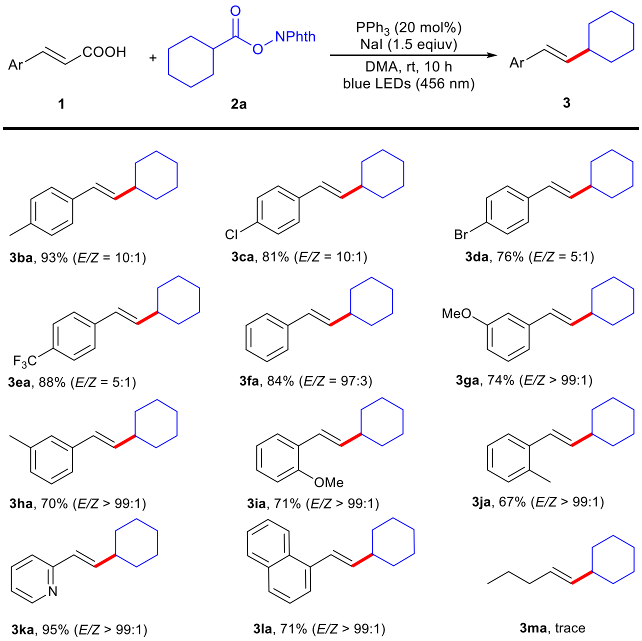


Entry	Variation from the optimal conditions	Yield [%]
1	none	90
2	LiI instead of NaI	40
3	KI instead of NaI	57
4	*n*-Bu_4NI instead of NaI	60
5	NaF, NaCl, NaBr instead of NaI	<5%
6	$P(4\text{-}MeC_6H_4)_3$ instead of PPh_3	81
7	$P(4\text{-}FC_6F_4)_3$ instead of PPh_3	84
8	PCy_3 instead of PPh_3	33
9	DMSO instead of DMA	62
10	DMF instead of DMA	60
11	1,4-dioxane instead of DMA	43
12	MeCN instead of DMA	35
13	without NaI	0
14	without PPh_3	0
15	without blue LEDs	0
16[b]	none	85

[a] Reaction conditions: **1a** (0.2 mmol), **2a** (0.3 mmol), NaI (1.5 equiv), PPh_3 (20 mol%), DMA (2 mL), room temperature, argon, and 10 h. *E/Z* was determined by ^{1}HNMR analysis of the crude mixture. [b] **1a** (1 g) and 36 h.

With the optimized reaction conditions in hand, we exploited the substrate scope of α,β-unsaturated carboxylic acids **1** in the coupling with alkyl NHP esters **2a**. As shown in Table 2, a wide range of cinnamic acids **1b-1e** with both electron-donating and electron-withdrawing substituents at the *para*-position of the phenyl ring all reacted smoothly with alkyl NHP esters **2a** to give the corresponding styrenes **3ba-3ea** in 76-93% yields. The cinnamic acid **1f** with no group on the phenyl ring was well tolerated. Furthermore, *ortho*-substituted and *meta*-substituted cinnamic acids **1g-1j** were also suitable substrates in this transformation, but these showed lower reactivity than *para*-substituted cinnamic acids. To our delight, the electron-withdrawing substrate such as 3-(pyridin-2-yl)acrylic acid **1k** gave **3ka** in 95% yield. 3-(Naphthalen-2-yl)acrylic acid **1l** was also an effective substrate in this protocol, and the desired product **3la** was isolated in 71% yield. Unfortunately, 2-hexenoic acid **1m** was not suitable for this reaction, possibly due to the lower stability of the alkyl radical compared with the benzylic radical.

Table 2. Variations of α,β-unsaturated carboxylic acids (**1**) [a]



3ba, 93% (*E/Z* = 10:1)
3ca, 81% (*E/Z* = 10:1)
3da, 76% (*E/Z* = 5:1)
3ea, 88% (*E/Z* = 5:1)
3fa, 84% (*E/Z* = 97:3)
3ga, 74% (*E/Z* > 99:1)
3ha, 70% (*E/Z* > 99:1)
3ia, 71% (*E/Z* > 99:1)
3ja, 67% (*E/Z* > 99:1)
3ka, 95% (*E/Z* > 99:1)
3la, 71% (*E/Z* > 99:1)
3ma, trace

[a] Reaction conditions: **1a** (0.2 mmol), **2a** (0.3 mmol), NaI (1.5 equiv), PPh_3 (20 mol%), DMA (2 mL), room temperature, argon, and 10 h. *E/Z* was determined by ^{1}HNMR analysis of the crude mixture.

Subsequently, we examined the scope of alkyl NHP esters in this decarboxylative alkenylation reaction. As outlined in Table 3, A variety of functionalized alkyl NHP esters **2b-j** comprising 1°, 2°, and 3° alkyl groups were all suitable substrates and provided **3ab-3aj** in moderate to good yields. The 1° alkyl functional groups, such as aryl **2b**, terminal alkene **2c**, terminal alkyne **2d**, led to **3ab-3ad** in 73-82% yield. The 2° alkyl groups containing linear alkyl **2e**, cycloalkyl **2f** and heteroatoms on the aliphatic ring **2g** also worked well to give the desired products **3ae-3ag** in good yields. 1-Phenylcyclopropyl or adamantyl-possessing NHP esters **2h-2i** were delivered in moderate yields, but 3° bridge ring-containing NHP ester **2j** furnished **3aj** in high

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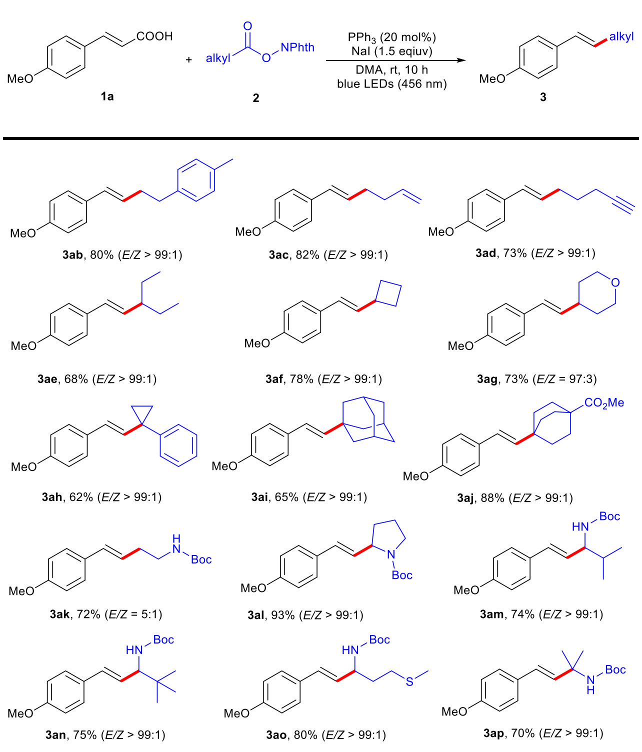
yield, probably due to the electron-withdrawing ester group. Alkyl NHP esters **2k-2p** derived from various natural and unnatural amino acids were reactive to give substituted allylic amine product **3ak-3ap**. Cinnamic acids could be transformed into their amine derivatives in one step, demonstrating the potential of this method for rapid, post-synthetic natural products or drug modification.

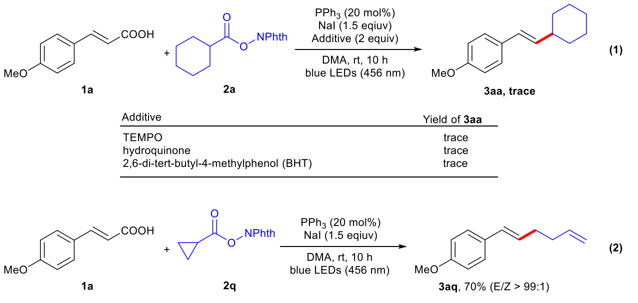
Table 3. Variations of the alkyl NHP esters (**2**) [a]



[a] Reaction conditions: **1a** (0.2 mmol), **2a** (0.3 mmol), NaI (1.5 equiv), PPh$_3$ (20 mol%), DMA (2 mL), room temperature, argon, and 10 h. *E/Z* was determined by ^{1}HNMR analysis of the crude mixture.

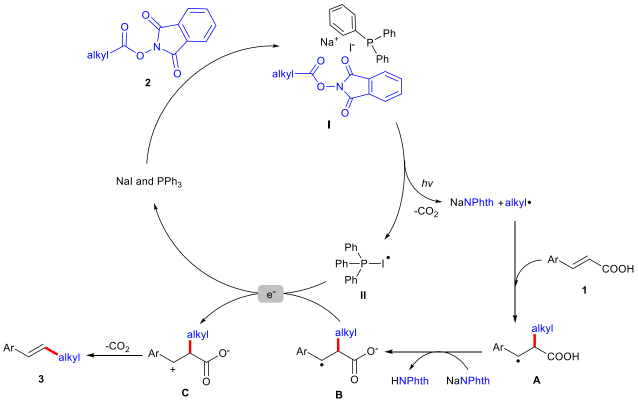
In order to gain insight into the reaction mechanism, the radical inhibitor TEMPO, hydroquinone and BHT, were added to the present reaction (Scheme 2), and the formation of product **3aa** was totally suppressed. These results suggest that an alkyl radical intermediate might be involved in this transformation. In addition, treatment of cyclopropyl NHP ester **2q** with **2a** under the optimized reaction conditions furnished the ring-opening product **3aq** in 70% yield, it also demonstrated that the alkyl radical was generated from the NHP ester.

Consequently, a possible mechanism for the dual decarboxylative alkylation protocol is proposed (Scheme 3).[13] Initially, the triphenylphosphine, sodium iodide and alkyl NHP esters **2** assemble to form the chromophore **I** *via* coulombic interaction. Under the bule-LED irradiation, the chromophore **I** induce electron transfer from iodide to alkyl NHP esters **2** to generate NaNPhth and the alkyl radical through extrusion of CO$_2$, and PPh$_3$ stabilize iodine radicals to generate Ph$_3$P-I· species **II**. Then addition of the alkyl radical across the C=C bond of α,β-unsaturated carboxylic acids **1** selectively occurs to form benzylic radical intermediate **A.** Deprotonation of the intermediate **A** with NaNPhth gives HNPhth and the radical intermediate **B**, which direct oxidized by Ph$_3$P-I· species **II** to produce the intermediate **C**, finally the intermediate **C** could release CO$_2$ to deliver the desired product **3**.



Additive	Yield of 3aa
TEMPO	trace
hydroquinone	trace
2,6-di-tert-butyl-4-methylphenol (BHT)	trace

Scheme 2 Control experiments



Scheme 3 Possible mechanism

In summary, we have developed a new visible-light-induced dual decarboxylative alkenylation of α,β-unsaturated carboxylic acids with alkyl *N*-hydroxyphthalimide esters through in combination of triphenylphosphine and sodium iodide. This reaction provided a facile and efficient way for the preparation of α,β-alkylated styrenes. Moreover, the reaction features mild conditions, good functional group tolerance and excellent stereoselectivity.

Conflicts of interest

There are no conflicts to declare.

Acknowledgment

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Notes and references

1. (a) Y. Wei, P. Hu, M. Zhang, W. Su, *Chem. Rev.*, 2017, **117**, 8864; (b) J. Xuan, Z.-G. Zhang, W.-J. Xiao, *Angew. Chem. Int. Ed.*, 2015, **127**, 15854; (c) Q. Wang, X.-T. Qi, L.-Q. Lu, T.-R. Li, Z.-G. Yuan, K. Zhang,

B.-J. Li, Y. Lan, W.-J. Xiao, *Angew. Chem. Int. Ed*., 2016, **128**, 2890; (d) X. Tan, Z. Liu, H. Shen, P. Zhang, Z. Zhang, C. Li, *J. Am. Chem. Soc*., 2017, **139**, 12430; (e) J. Cornella, I. Larrosa, *Synthesis*, 2012, **44**, 653; (f) J.-D. Weaver, A. Recio, A.-J. Grenning, J. Tunge, *Chem. Rev*., 2011, **111**, 1846. (g) T.-R. Li, M. L. Maliszewski, W.-J. Xiao, J. Tunge, A. *Org. Lett*., 2018, **20**, 1730. (h) C. Wan, R.-J. Song, J.-H. Li, *Org. Lett*., 2019, **21**, 2800; (i) R. SHANG, L. LIU, *Sci. China Chem*., 2011, **54**, 1670.

2. (a) H.-T. Song, W. Ding, Q.-Q. Zhou, J. Liu, L.-Q. Lu, W.-J. Xiao, *J. Org. Chem*., 2016, **81**, 7250; (b) X. Tan, T. Song, Z. Wang, H. Chen, L. Cui, C. Li, *Org. Lett*., 2017, **19**, 1634; (c) L. Cui, H. Chen, C. Liu, C. Li, *Org. Lett*. 2016, **18**, 2188; (d) J. Kan, S. Huang, J. Lin, M. Zhang, W. Su, *Angew. Chem. Int. Ed*., 2015, **54**, 2199; (e) C. Liu, X. Wang, Z. Li, L. Cui, C. Li, *J. Am. Chem. Soc*., 2015, **137**, 9820; (f) C.-J. Li, *Acc. Chem. Res*., 2009, **42**, 335; (g) Y. Wei, L.-Q. Lu, T.-R. Li, B. Feng, Q. Wang, W.-J. Xiao, H. Alper, *Angew. Chem. Int. Ed*., 2016, **128**, 2240.
3. (a) T.-W. Lyons, M.-S.Sanford, *Chem. Rev*., 2010, **110**, 1147; (b) N. Rodríguez, L. Goossen, *J. Chem. Soc. Rev*., 2011, **40**, 5030; (c) C.-S. Yeung, V.-M. Dong, *Chem. Rev*., 2011, **111**, 1215; (d) H. Wang, L. N. Guo, S. Wang, X.-H. Duan, *Org. Lett*., 2015, **17**, 3054; (e) L. Chen, L. Ju, K.-A. Bustin, J.-M. Hoover, *Chem. Commun*., 2015, **51**, 15059; (f) T. Patra, S. Nandi, S.-K. Sahoo, D. Maiti, *Chem. Commun*., 2016, **52**, 1432; (g) D.-A. Loginov, A.-O. Belova, A.-V. Vologzhanina, A.-R. Kudinov, *J. Organomet. Chem*., 2015, **793**, 232. (h) Z. Fu, S. Huang, J. Kan, W. Su, M. Hong, *Dalton Trans*., 2010, **39**, 11317.
4. (a) W.-M. Cheng, R. Shang, Y. Fu, *Nat. Commun*., 2018, **9**, 5215; (b) S. Sharma, I.-A. Khan, A.-K. Saxena, *Adv. Synth. Catal*., 2013, **355**, 673; (c) B. Majhi, D. Kundu, T. Ghosh, B.-C. Ranu, *Adv. Synth. Catal*., 2016, **358**, 283; (d) B. Zhao, R. Shang, W-M. Cheng, Y. Fu, *Org. Chem. Front*., 2018, **5**, 1782; (e) H.-X. Zou, Y. Li, Y. Yang, J.-H. Li, J. Xiang, *Adv. Synth. Catal*., 2018, **360**, 1439.
5. (a) G.-Z. Wang, R. Shang, Y. Fu, *Org. Lett*., 2018, **20**, 888; (b). J.-F. Zhao, X.-H. Duan, Y.-R. Gu, P. Gao, L.-N. Guo, *Org. Lett*., 2018, **20**, 4614; (c) Bin. Zhao, Y. Fu, R. Shang, *Org. Lett*., 2019, **21**, 9521; (d). R. Shang, Z. Huang, X. Xiao, X. Lu, Y. Fu, L. Liu, *Adv. Synth. Catal*., 2012, **354**, 2465; (e). X. Lu, X.-X. Wang, T.-J. Gong, J.-J. Pi, S.-J. He, Y. Fu, *Chem. Sci*., 2019, **10**, 809; (f). T.-R. Li, F. Tan, L.-Q. Lu, Y. Wei, Y.-N. Wang, Y.-Y. Liu, Q.-Q. Yang, J.-R. Chen, D.-Q. Shi, W-J. Xiao, *Nat. Commun*., 2014, **20**, 5550; (g) W.-I. Dzik, P.-P. Lange, L. Gooßen, *J. Chem. Sci*., 2012, **3**, 2671; (h) J. Miao, H. Ge, *Synlett*., 2014, **25**, 911; (i) R. Shang, D.-S. Ji, L. Chu, Y. Fu, L. Liu, *Angew. Chem. Int. Ed*., 2011, **50**, 4470.
6. (a) H. Wang, C.-F. Liu, Z. Song, M. Yuan, Y. A. Ho, O. Gutierrez, M. J. Koh, *ACS Catal*., 2020, **10**, 4451; (b) R. Lavernhe, E. J. Alexy, H. Zhang, B. M. Stoltz, *Org. Lett*., 2020, **22**, 4272; (c) J. Zhang, J.-Y. Wang, M.-H. Huang, W.-J. Hao, X.-C. Tu, S.-J. Tu, B. Jiang, *J. Org. Chem*., 2020, **85**, 7036; (d) B. Song, P. Xie, Y. Li, J. Hao, L. Wang, X. Chen, Z. Xu, H. Quan, L. Lou, Y. Xia, K. N. Houk, W. Yang, *J. Am. Chem. Soc*., 2020, **142**, 9982; (e) E. Kim, C. Y. Lee, S.-G. Kim, *Adv. Synth. Catal*., 2020, **362**, 1; (f) Q.-Z. Li, Y. Liu, M.-Z. Li, X. Zhang, T. Qia, J.-L. Li, Org. Biomol. *Chem*., 2020, **18**, 3638; (g) A. M. Diehl, G. Manolikakes, *ChemCatChem*, 2020, **12**, 1; (h) X. Zhang, X. Feng, H. Zhang, Y. Yamamotoa, M. Bao, *Green Chem*., 2019, **21**, 5565; (i) Z. Xiao, L. Wang, J. Wei, C. Ran, S. H. Liang, J. Shang, G.-Y. Chen, C. Zheng, *Chem. Commun*., 2020, **56**, 4164.
7. (a) H. Uno, N. Punna, E. Tokunaga, M. Shiro, N. Shibata, *Angew. Chem. Int. Ed*., 2020, **59**, 8187; (b) Y. Zuo, X. He, Q. Tang, W. Hu, T. Zhou, Y. Shang, *Org. Lett*., 2020, **22**, 3890; (c) Y. Liu, L. Xue, B. Shi, F. Bu, D. Wang, L. Lu, R. Shi, A. Lei, *Chem. Commun*., 2019, **55**, 14922; (d) P. Bao, N. Meng, Y. Lv, H. Yue, J.-S. Li, W. Wei, *Org. Chem. Front*., 2019, **6**, 3983; (e) D. Kong, P. J. Moon, O. Bsharat, R. J. Lundgren, *Angew. Chem. Int. Ed*., 2020, **59**, 1313; (f) R. Lavernhe, E. J. Alexy, H. Zhang, B. M. Stoltz, *Adv. Synth. Catal*., 2020, **362**, 344; (g) X. Shao, Y. Zheng, L. Tian, I. Martín-Torres, A. M. Echavarren, Y. Wang, *Org. Lett*., 2019, **21**, 9262; (h) X. Li, Q. Zhang, W. Zhang, Y. Wang, Y. Pan, *J. Org. Chem*. 2019, **84**, 14360.
8. (a) Y. Zhao, J.-R. Chen, W.-J. Xiao, *Org. Lett*., 2018, **20**, 224; (b) H. Wang, L.-N. Guo, X.-H. Duan, *Adv. Synth. Catal*., 2013, **355**, 2222; (c) J. Lin, Z. Li, J. Kan, S. Huang, W. Su, Y. Li, *Nat. Commun*., 2017, **8**, 14353; (d) J. He, G. Chen, B. Zhang, Y. Li, J.-R. Chen, W.-J. Xiao, F. Liu, C. Li, *Chem*., 2020, **6**, 1; (e) R. Garza-Sanchez, A. Tlahuext-Aca, G. Tavakoli, F. Glorius, *ACS Catal*., 2017, **7**, 4057. (f) X. Yong, Y.-F. Han, Y. Li, R.-J. Song, J.-H. Li, *Chem. Commun*., 2018, **54**, 12816; (g) X.-H. Ouyang, J. Cheng, J.-H. Li, *Chem. Commun*., 2018, **54**, 8745; (h) Christina G. Na, Davide Ravelli, Erik J. Alexanian, *J. Am. Chem. Soc*., 2019, **132**, 14391.
9. (a) P.-J. Xia, Z.-P. Ye, Y.-Z. Hu, J.-A. Xiao, K. Chen, H.-Y. Xiang, X.-Q. Chen, H. Yang, *Org. Lett*., 2020, **22**, 1742; (b) X.-X. Meng, Q.-Q. Kang, J.-Y. Zhang, Q. Li, W.-T. Wei ,W,-M, He, *Green Chem*., 2020, **22**, 1388; (c) X. Wang, Y. Kuang, S. Ye, J. Wu, *Chem. Commun*., 2019, **55**, 14962; (d) K. Zhou, J.-B. Liu, W. Xie, S. Ye, J. Wu, *Chem. Commun*., 2020, **56**, 2554; (e) X. Gong, M. Yang, J.-B. Liu, F.-S. He, J. Wu; *Org. Chem. Front*., 2020, **7**, 938; (f) X. Gong, M. Yang, J.-B. Liu, F.-S. He, X. Fan, J. Wu, *Green Chem*., 2020, **22**, 1906; (g) Q. Guo, X. Ren, Z. Lu, *Org. Lett*., 2019, **21**, 880; (h) B. Yang, Z. Lu, *Chem. Commun*., 2017, **53**, 12634.
10. (a) V. T. Nguyen, V. D. Nguyen, G. C. Haug, N. T. H. Vuong, H. T. Dang, H. D. Arman, O. V. Larionov, *Angew. Chem. Int. Ed*., 2020, **59**, 7921; (b) Q.-Y. Han, K.-L. Tan, H.-N. Wang, C.-P. Zhang, *Org. Lett*., 2019, **21**, 10013 ; *(c)* M.-J. Jiao, D. Liu, X.-Q Hu P.-F. Xu, *Org. Chem. Front*., 2019, **6**, 3834; (d) Y. Lv, P. Bao, H. Yue, J.-S. Li, W. Wei, *Green Chem*., 2019, **21**, 6051; (e) J.-J. Ji, Z.-Q. Zhu, L.-J. Xiao, D. Guo, X. Zhu, J. Tang, J. Wu, Z.-B. Xie, Z.-G. Le, *Org. Chem. Front*., 2019, **6**, 3693; (f) S. Khan, M. K. Zaman, R. Li, Z. Sun, *J. Org. Chem*., 2020, **85**, 5019.
11. (a) Y. Zhao, J.-R. Chen, W.-J. Xiao, *Org. Lett*., 2018, **20**, 224; (b) J. He, G. Chen, B. Zhang, Y. Li, J.-R. Chen, W.-J. Xiao, F. Liu, C. Li, *Chem*, 2020, **6**, 1; (c) A. Tlahuext-Aca, R. A. Garza-Sanchez, M. Schäfer, F. Glorius, *Org. Lett*., 2018, **20**, 1546; (d) X. Wang, Y.-F. Han, X.-H. Ouyang, R.-J. Song, J.-H. Li, *Chem. Commun*., 2019, **55**, 14637; (e) X.-H. Ouyang, Y. Li, R.-J. Song, J.-H. Li, *Org. Lett*., 2018, **20**, 6659. (f) Q.-Q. Kang, W. Wu, Q. Li W.-T. Wei, *Green Chem*., 2020, **22**, 3060; (g) W.-M. Cheng, R. Shang, Y. Fu, *ACS Catal*., 2017, **7**, 907; (h) W.-M. Cheng, R. Shang, M.-C. Fu, Y. Fu, *Chem. Eur. J*., 2017, **23**, 2537.
12. (a) J.-J. Zhang, J.-C. Yang, L.-N. Guo, X.-H. Duan, *Chem. Eur. J*., 2017, **23**, 10259; (b) K. Xu, Z. Tan, H. Zhang, J. Liu, S. Zhang, Z. Wang, *Chem. Commun*., 2017, **53**, 10719; (c) Y.-T. Wang, M.-C. Fu, B. Zhao, R. Shang, Y. Fu, *Chem. Commun*., 2020, **56**, 2495.
13. (a) M.-C. Fu, R. Shang, B. Zhao, B. Wang, Y. Fu, *Science*, 2019, **363**, 1429. (b) A. Noble and V. K. Aggarwa, *Sci. China*: *Chem*., 2019, **62**, 1083.

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Photocatalytic Dual Decarboxylative Alkenylation Mediated by Triphenylphosphine and Sodium Iodide

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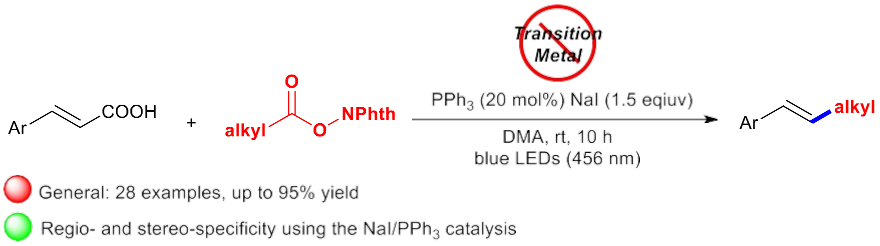

A new transition-metal-free photoredox decarboxylative alkylation of α,β-unsaturated carboxylic acids and alkyl

N-hydroxyphthalimide (NHP) esters by NaI/PPh$_3$ catalysis has been developed.