

Copper-catalysed Reaction of Arylacetylenes with *C,N*-Diarylnitrones

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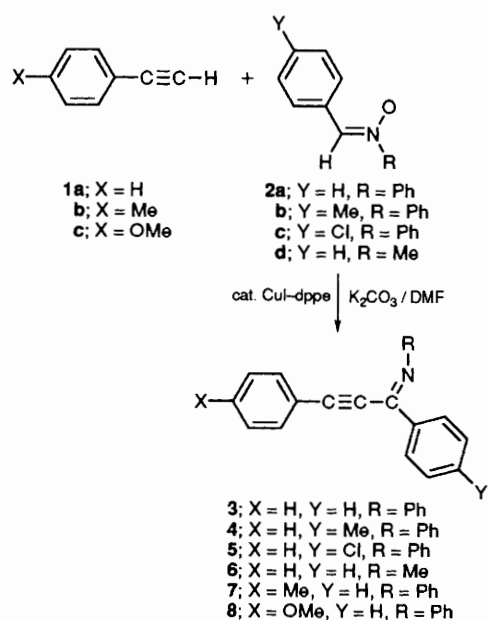
Reaction of arylacetylenes with *C,N*-diarylnitrones is effectively catalysed by copper(I) iodide-dppe [1,2-bis(diphenylphosphino)ethane] in the presence of potassium carbonate to give the corresponding 1-azabut-1-en-3-yne (iminopropyne) derivatives in good yield.

Alkynes activated by electron-withdrawing groups undergo [3 + 2] cycloaddition reactions with nitrones to give isoxazoline derivatives.¹⁻³ While simple terminal alkynes cannot react with nitrones, reaction of copper(I) acetylides with them interestingly affords azetidin-2-one (β -lactam) derivatives.^{4,5}

On the other hand, we have recently reported that coupling reaction of terminal alkynes with aryl and vinyl iodides

efficiently proceeds in the presence of copper(I) iodide and triphenylphosphine using potassium carbonate as base.⁶ In the course of the study, we found that arylalkynes **1a-c** could react with *C,N*-diarylnitrones **2a-c** and *N*-benzylidenemethylamine *N*-oxide **2d** to give the corresponding 1-azabut-1-en-3-yne compounds **3-8** in good yield when the reaction was carried out in *N,N*-dimethyl formamide (DMF) by using a catalyst system of CuI-dppe [1,2-bis(diphenylphosphino)ethane]-K₂CO₃ in the presence of water (Scheme 1 and Table 1). This clearly contrasts with the above mentioned reaction using copper(I) acetylides.

Analysis of the reaction mixture of **1a** with **2a** revealed formation of small amounts of (*E*)-*N*,3,4-triphenylazetidin-2-one **9**, *N*-benzylideneaniline **10**, and phenylacetic acid **11** as



Scheme 1

Table 1 Copper-catalysed reactions of arylacetylenes with nitrones^a

Alkyne	Nitron	<i>t</i> /h	Yield (%) ^b
1a	2a	4	3, 74
1a^c	2a	6	3, 70
1a^d	2a	24	3, 54
1a	2b	5	4, 79
1a	2c	5	5, 80
1a	2d	24	6, 77
1b	2a	6	7, 74
1c	2a	3	8, 72

^a Reaction conditions: [**1**]:[**2**]:[CuI]:[dppe]:[K₂CO₃]:[H₂O] = 2:2:0.2:0.2:2.2:4 (in mmol), DMF (8 ml), 80 °C, under N₂.

^b Isolated yield. All the products gave satisfactory spectral and elemental analysis data. M.p. (°C): **3**, 58–59 (lit.⁸ 60), **4**, 75–76, **5**, 111–113. Other compounds were obtained as oils. ^c CuI (0.1 mmol).

^d CuI (0.02 mmol).

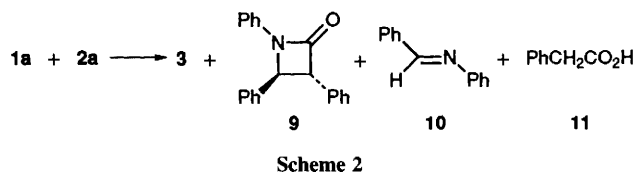


Table 2 Effect of ligand on reaction of 1a with 2a

Ligand	t/h	Yield (%) ^b			
		3	9	10	11
None	10	40	18	25	— ^c
dppe	4	74	3	7	9
dppp	4	68	7	11	— ^c
PPh ₃	3	53	19	27	— ^c
PBu ₃ ⁿ	5	13	36	44	33
bpy ^d	5	15	6	38	— ^c
phen ^e	3	Trace	28	51	40

^a Reaction conditions: [1]:[2]:[CuI]:[K₂CO₃]:[H₂O] = 1:1:0.1:1.1:2 (in mmol), DMF (5 ml), 80 °C, under N₂. ^b Determined by GLC analysis. ^c Not determined. ^d bpy = 2,2'-Bipyridine. ^e phen = 1,10-Phenanthroline.

minor products (Scheme 2 and Table 2). The reaction did not take place in the absence of either K₂CO₃ or CuI, suggesting that copper(i) phenylacetylide coordinated by the ligand added is involved as the key intermediate. The reaction was rather slow without water. It was also observed that the product composition was marked function of the ligand employed. The reaction using dppp [1,3-bis(diphenylphosphino)propane] and triphenylphosphine also gave the azaenyne 3 as the major product, whilst with tri-*n*-butylphosphine, a considerable amount of the lactam 9 was produced. In the case of 1,10-phenanthroline, only a trace amount of 3 was formed, affording 10 and 11 favourably. The reaction also occurred without addition of the ligands, but the rate was considerably reduced, giving 3, 9 and 10 in comparable amounts. These results suggest that the reaction proceeds in three fashions

which involve (a) nucleophilic attack of the terminal carbon of the copper acetylide intermediate on the electrophilic carbon of 2, (b) 1,3-dipolar cycloaddition of 2 to the acetylide,^{4,5} and (c) oxygen-atom transfer from 2 to the acetylide, leading to 3, 9, and the mixture of 10 and 11, respectively. The reaction of 1-heptyne with 2a using CuI-dppe gave a mixture of (*E*)-*N*,4-diphenyl-3-pentylazetid-2-one (28%), 10 (59%), and heptanoic acid (50%), no azaenyne product being detected. This may imply that the precedence of the three reaction paths is also determined by the nature of terminal alkynes as well as that of the ligands.

While relevant methods for preparation of 2,4-diaryl-1-azabut-2-en-3-yne employing the corresponding imidoyl chlorides and terminal alkynes have been reported,⁷⁻⁹ the present route seems to be advantageous in some respects; the reaction can be easily carried out using reagents which are less expensive and easily handled.

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