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A SELECTIVE UNSYMMETRICAL ULLMANN-TYPE REACTION

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It has recently been demonstrated that 2-nitrobiphenyls are formed in fair yield when 2-nitrobenzoic acids are boiled in quinoline with copper(I)oxide and iodobenzene derivatives (1). Practically no symmetrical biphenyls are formed in this reaction. The results indicate that copper-catalysed decarboxylation and Ullmann coupling may proceed *via* a common intermediate. This intermediate may be an aryl copper. Such an intermediate has recently been demonstrated in the coupling of *p*-iodotoluene with copper in quinoline solution to give 4,4'- dimethylbiphenyl (2). The intermediate in the copper-catalysed decarboxylation of 2-nitrobenzoic acid and in Ullmann coupling of 2-halogenonitrobenzenes is presumably favoured by the nitro group in the *ortho*-position.

We have found that a similar reactive intermediate may apparently be generated very easily from 1,3-dinitrobenzenes and may then react selectively with iodoarenes. Thus, when equivalent amounts of 1,3-dinitrobenzene, copper(I) oxide and an iodobenzene derivative are boiled in excess quinoline (≥ 4 moles per mole of dinitrobenzene) water is given off, copper(I)iodide is formed and 2,6-dinitrobiphenyls are formed in fair yields. The reaction has been used for the preparation of the following compounds: 2,6-dinitrobiphenyl (41 % yield after 2 h boiling), 4-methoxy-2′,6′-dinitrobiphenyl (69 %, 2.5 h), 3,4-methoxy- 2′,6′-dinitrobiphenyl (58 %, 2 h), 2,4-dimethoxy- 2′,6′-dinitrobiphenyl (62 %, 2 h). Similar results were obtained when 2,6-dinitrobenzoic acid was used instead of 1,3-dinitrobenzene. The reaction may be used for the preparation of terphenyls also, though the yields are lower. In the reaction of 1,3,5-trinitrobenzene and 1-iodo-4-methoxybenzene with copper(I)oxide in quinoline 4,4"-dimethoxy-2′,4′,6′-trinitro-m-terphenyl (7 %) is obtained in addition to the main product, 4-metoxy-2′,4′,6′-trinitrobiphenyl (69 %) (5 h at 180°). Reaction of 1,3-dinitrobenzene with 1,4-di-iodo-2,5-dimethoxybenzene gives 2′,5′-dimetoxy-2,2", 6,6"-tetranitro-p-terphenyl (12 % after 5 h boiling). As indicated previously (1), even nitrobenzene slowly undergoes a similar reaction to give small amounts of 2-methoxy- 2′-nitrobiphenyl after prolonged boiling with copper(I)oxide and 1-iodo-2-methoxybenzene in quinoline.

Preparatively the reaction is simple, the reactants are boiled for 1-5 h, the copper(I)oxide dissolves and water is given off. On cooling a yellow quinoline complex of copper(I) iodide crystallises and may be precipated with ether and filtered off. The quinoline is removed from the filtrate by extraction with dilute acid and biphenyls and terphenyls may be then isolated by distillation, chromatography or simple recrystallisation. Triarylamines and dehalogenation products are encountered by-products.

The reaction may be summarised by the following equation:

$$\text{Ar-H} + 1/2\ \text{Cu}_2\text{O} + \text{Ar}'\text{-I} \xrightarrow[\text{quinoline}]{} \text{Ar-Ar}' + \text{CuI} + 1/2\ \text{H}_2\text{O}$$

The reaction is obviously closely related to the secondary coupling which is often encountered as a side reaction in Ullmann couplings and is especially marked for _m_-dinitro compounds (3):

$$\text{Ar-H} + 2\ \text{Ar}'\text{-I} + 2\ \text{Cu} \xrightarrow{\qquad} \text{Ar-Ar}' + \text{Ar}'\text{-H} + 2\ \text{CuI}$$

Forrest obtained ca 10 % of 2,6-dinitrobiphenyl when the reaction of iodobenzene with copper was conducted in the presence of 1,3-dinitrobenzene (3). Similar secondary coupling, though to a smaller extent, has been observed for halogen compounds, for example the reaction of 2-chloroiodobenzene with copper gave a dichloro-iodobiphenyl and a trichloroterphenyl as by-products (4). If aryl copper compounds occur as intermediates in these Ullmann reactions the secondary coupling could be interpreted in terms of a hydrogen-metal interchange and parallel the so-called reductive dehalogenation (5) which is another side reaction in Ullmann couplings implied by the formation of Ar--H in the formula above. The present reaction should then be interpreted to proceed _via_ metalation by copper(I)oxide.

The special reactivity of 1,3-dinitrobenzenes in these reactions is similar to the reactivity of 2,6-dinitrohalogenobenzenes (6) and suggests a stabilisation of the intermediate by the two nitro groups in the _ortho_ positions. The formation of the intermediate directly from 1,3-dinitrobenzene may at first seem surprising. However, 1,3-dinitrobenzene is known to be rapidly deuterated in the 2-position in D_2O-_N_-dimethylformamide solution. The mechanism in this deuteration is not known, but it has been suggested to proceed via anions (7). The biaryl synthesis presented here may be considered analogous to the preparation of diaryl ethers from phenols and halogenobenzenes with copper(I)oxide in basic solvents (8). The present work concerns only 1,3-dinitrobenzenes but the reaction seems to be more general. It is hoped to publish further details shortly (cf. 9).

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