Tetrahedron Letters No.7, pp. 679-682, 1966. Pergamon Press Ltd.
Printed in Great Britain.

REACTION OF 2-THIENYL COPPER WITH IODOBENZENE

Martin Nilsson

Division of Organic Chemistry, Royal Institute of Technology,
Stockholm 70, Sweden

(Received 18 December 1965)

There are many indications for the occurrence of organocopper compounds in the Ullmann biaryl synthesis. Very recently evidence has been presented for the formation of an aryl copper and its dimerisation, with elimination of metallic copper, in the Ullmann coupling of non-activated iodoarenes conducted in quinoline solution (1). Aryl copper compounds afford biaryls even on decomposition in air (2). A recent statement, concerning unpublished work indicates that heating of aryl copper compounds in inert solvents is a practical way for the preparation of symmetrical biaryls (3).

Ullmann biaryl syntheses involving activated halides (e.g. 2-bromonitrobenzene and methyl 2-bromobenzoate) presumably proceed by another mechanism in which a reactive intermediate derived from the activated halide and copper seems to react with another molecule of halogenoarene to give the unsymmetrical biaryl (1,3, 4,5).

Alternative methods for the preparation of unsymmetrical biaryls have recently been developed: decarboxylation of 2-nitrobenzoic acids in quinoline in the presence of copper(I)oxide and iodobenzene derivatives gives 2-nitrobiphenyls (6), boiling of 1,3-dinitrobenzenes in quinoline with copper(I)oxide and iodobenzene derivatives similarly affords 2,6-dinitrobiphenyls (7). The intermediates in these reactions seem to be the same as those in Ullmann couplings of 2-nitro- and 2,6-dinitrohalogenobenzenes. The favourable effect of quinoline seems to be the same as that encountered in the reaction of non-activated halides and may be due to complexing of intermediate aryl copper compounds (1).

To establish the connection between the two types of Ullmann biaryl syntheses it was desirable to study aryl copper compounds which correspond to the activated halides. Aryl copper compounds have been prepared from Grignard reagents by treatment with copper(I)iodide in ether (2), a method not suitable for nitro compounds or esters. However, some heterocyclic halides seem to be very reactive in the Ullmann reaction, namely 2-halogenothiophenes and -pyridines (4). The present communication describes preliminary results of the preparation and reactions of 2-thienyl copper.

The Grignard reagent from 2-iodothiophene reacted readily with copper(I)iodide in ether to give a straw-coloured precipitate, presumably 2-thienyl copper. This precipitate was very sensitive to air and on decomposition in air gave 2,2′-bithienyl (thin-layer chromatography). With iodobenzene it gave a strong red colour but otherwise no appreciable reaction at room temperature. When boiled with an excess iodobenzene it gave complicated mixtures from which small amounts of 2,2′-bithienyl could be isolated. On addition of an excess quinoline to the 2-thienyl copper, a yellow precipitate was obtained, which was only sparingly soluble in ether and was somewhat more stable in air than the original compound.

On addition of iodobenzene to the quinoline-thienyl copper mixture no colour change occurred and no appreciable reaction took place. When the mixture was heated a marked reaction occurred at ca. 160° and was completed by boiling for 30 min. The cooled reaction mixture was diluted with ether and filtered to remove the copper(I)-iodide-quinoline complex. The solution was extracted with dilute acid to remove quinoline, dried and evaporated to give a low-melting product, which was distilled (b.p. 120°/15 mm) to give a colourless solid. Recrystallisation from methanol gave a 50 % yield of 2-phenylthiophene m.p. 33-35°, identified by its infrared (8) and ultraviolet spectra, which differ greatly from those of 2,2′-bithienyl. The 2-phenylthiophene, on boiling with iodobenzene and copper(I)oxide in quinoline afforded 2,5-diphenylthiophene, m.p. 152-154° (ca. 20 % yield). This reaction is analogous to those reported for 1,3-dinitrobenzenes (7) and shows further the reactivity of the α-position of thiophenes, which is evident from secondary coupling with the formation of "α-polythienyls" encountered in the reaction of 2-iodothiophene with copper (9,10).

The present results show that 2-thienyl copper may be used for preparation of 2-arylthiophenes and shows a further modification of the Ullmann reaction for the preparation of unsymmetrical biaryls:

$$\text{Ar-Cu} + \text{Ar}'\text{-I} \xrightarrow[\text{quinoline}]{} \text{Ar-Ar}' + \text{CuI}$$

This reaction is obviosly closely related to the large class of copper-promoted aromatic substitutions (3, 11) and may be a step on one of the main reaction paths of the Ullmann biaryl synthesis. Naturally the present results afford no conclusive proof for the occurrence of aryl copper compounds in the ordinary Ullmann reaction of activated and non-activated halides conducted without a solvent. However, the present results as well as other evidence (1,6,7) seem to indicate that even ordinary Ullmann couplings should be conducted in solvents like quinoline.

It is hoped to communicate further details and the rigorous characterisation of 2-thienyl copper in the near future.

Acknowledgements:

This work has been supported by the Swedish Technical Research Council. Mr T. Andersson gave skilful assistance, Mr K.H. Baggaley checked the English.

REFERENCES

1. A.H. Lewin and T. Cohen, Tetrahedron Letters 4531 (1965).
2. H. Gilman and J.M. Straley, Rec. trav.chim. **55**,821 (1936).
3. R.G.R. Bacon and H.A.O. Hill, Quart.Rev (London) **19**,95 (1965).
4. P.E. Fanta, Chem.Rev. **64**,613 (1964).
5. J. Forrest, J.Chem.Soc. 594 (1960).
6. M. Nilsson, Acta Chem.Scand. In press.
7. C. Björklund and M. Nilsson, Tetrahedron letters, Ms submitted.
8. J.S. Sörensen and N.A. Sörensen Acta Chem.Scand. **12**,771 (1958).
9. W. Steinkopt, R. Leitsman and H.H. Hofmann, Ann. **546**,18 (1941).
10. J.W. Sease and C. Zechmeister, J. Am. Chem. Soc. **69**,270 (1947).
11. M. Nilsson, Acta Chem.Scand. **12**,537 (1958).