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Electrosynthesis of 3-Thienylzinc Bromide from 3-Bromothiophene via a Nickel Catalysis.

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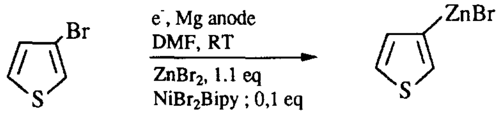
Abstract : 3-Thienylzinc bromide is prepared under mild conditions by electroreduction of a DMF solution of 3-bromothiophene, zinc bromide, and a catalytic amount of nickel-bipyridine complex, using a magnesium rod as sacrificial anode. The resulting organometallic is then coupled with aryl halides using a palladium catalysis. © 1997 Published by Elsevier Science Ltd. All rights reserved.

A recent review[1] has described the use of 3-substituted thiophenes in the synthesis of various interesting pharmaceutical, agrochemical, and cosmetical products. They can be obtained by coupling between 3-thienyl organometallics and different electrophiles. However, these organometallics are very difficult to obtain from available 3-halothiophenes. Thus 3-bromothiophene reacts with Rieke manganese[2] but not with Rieke zinc or magnesium[3]. 3-Lithiothiophene is obtainable from 3-bromothiophene by classical metal-halogen exchange in ethers at -70°C[4] or in a 10/1 mixture of hexane/THF at -40°C[5]. The lithiothiophene is relatively stable even at room temperature in the latter solvent. It can be used to prepare other organometallics by tranmetallation or can be converted into 3-iodothiophene which in turn reacts with Rieke magnesium or zinc metals[3].

In this paper, we report the first one-pot preparation of 3-thienylzinc bromide from 3-bromothiophene by a very simple electrochemical method. We have already reported on the electrochemical preparation of arylzincs from aryl halides using nickel catalysis and a sacrificial anode of zinc[6]. In order to make the method suitable for the preparation of 3-thienylzinc bromide, we have had to use $NiBr_2Bipy$ instead of $Ni(BF_4)_2Bipy_3$ + 2 Bipy, magnesium instead of zinc as the sacrificial anode[7], and $ZnBr_2$ as precursor of Zn(II) species (eq 1). In this procedure, the use of a supporting electrolyte, (*e.g.* NBu_4BF_4) is not necessary because $ZnBr_2$ is sufficiently dissociated to ensure a good ionic conductivity of DMF as solvent.



(1)

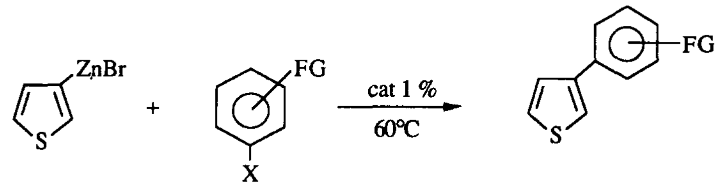
The procedure is as follows : in an undivided electrolysis cell flushed with argon and fitted with a magnesium rod as anode and a nickel foam as cathode, were introduced 40 ml of solvent (DMF), 3-Bromothiophene (7.5 mmoles), $ZnBr_2$ (8 mmoles) and $NiBr_2Bipy$ (0.75 mmoles) as catalyst. A constant current intensity of 0.2 A was applied at room temperature until a charge of 2F per mole of halide was passed. The yield of 3-thienyl zinc bromide was *ca* 80 % as determined by GC analysis after treatment with I_2. Similar results were obtained with 3-chlorothiophene. The formation of 3-thienylzinc bromide may appear questionable inasmuch as the formation of the organomagnesium derivative could be anticipated when a Mg anode is used. However, in the absence of zinc salt no organometallic was detected ; in addition, would the

Mg derivative form, it would readily react with DMF.

Electroanalytical studies have been conducted to elucidate the mechanism of the electrochemical procedure of formation of organozinc from aromatic or heteroaromatic halides. Since 3-bromothiophene undergoes a very rapid oxidative addition of electrogenerated zerovalent nickel, we think that the organozinc is formed by transmetallation between the thienyl nickel intermediate and $ZnBr_2$.

Electrogenerated 3-thienylzinc bromide can be coupled with aromatic halides in the same medium using classical catalysis by $PdCl_2(PPh_3)_2$ or $Pd(PPh_3)_4$. Surprisingly, and contrary to the results obtained by Rieke and coll.(3), the nickel catalyst which is still in the reaction medium and can be electrochemically reduced to Ni(0) does not promote the coupling. The results are reported in table 1.

Table 1. Pd-Catalyzed Coupling of 3-Thienylzinc Bromide with Aryl Halides.



ArX	Catalyst	Coupling product Yield^a %
PhI	$Pd(PPh_3)_2Cl_2$	72
PhI	$Pd(PPh_3)_4$	81
p-NC-Ph-Br	"	47
o-CH_3OOC-Ph-Br	"	40
p-CH_3O-Ph-Br	"	0

a) Isolated yields based on 3-bromothiophene. All products gave satisfactory ^1H NMR, ^{13}C NMR and MS data.

The procedure for the coupling is as follows : 1 % of Pd catalyst and 1 equivalent of aryl halide were added to the reaction mixture and the solution was heated at 60° C for 1 or 2 hours. The coupling occured in high yield with idobenzene, indicating a high efficiency in the formation of the 3-thienylzinc bromide. With aryl bromides, an electron-withdrawing group is necessary for the coupling to occur while no coupling was observed in the case of electron-releasing substituent.

In conclusion, it is now possible to prepare 3-thienylzinc bromide in a single operation from 3-bromothiophene by a very simple and efficient electrochemical method.

References and Notes

1. Schulz, E.; Fahmi, K.and Lemaire, M. *Acros Organics Acta* **1995**, *1*, 10-17.
2. Kim, S.H.; Hanson, M.V. and Rieke, R.D. *Tetrahedron Lett.* **1996**, *37*, 2197-2200.
3. Wu, X. and Rieke, R.D. *J. Org. Chem.* **1995**, *60*, 6658-6659.
4. Gronowitz, S. *Arkiv Kemi* **1958**, *12*, 533-545.
5. Wu, X.; Chen, T.A.; Zhu, L. and Rieke R.D. *Tetrahedron Lett.* **1994**, *35*, 3673-3674.
6. Sibille, S.; Ratovelomanana, V. and Périchon, J. *J. Chem. Soc., Chem. Commun.* **1992**, 283-284.
7. Zinc was first used as the anodic material, but this led to low faradic and chemical yields, probably because Zn^{2+} ions generated from the anode are reduced at a potential close to that of the nickel catalyst.

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