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Abstract: Oxidative homo coupling of various arylmagnesium bromides in the presence of $ZnBr_2$ gave the corresponding symmetrical biaryls in moderate to good yields at room temperature. An efficient method under mild conditions without the use of reoxidant is described.

Keywords: Aryl magnesium bromide, biaryls, homo coupling, zinc bromide

INTRODUCTION

Biaryls have gained importance in organic synthesis because of their versatile applications in pharmaceuticals, polymers, and optically active ligands.^[1] The synthesis of biaryls via coupling reactions has been the subject of numerous past and current investigations,^[2] and these reactions are often prepared from aryl halides by the classical Ullmann-type reaction.^[3,4] Oxidative homo coupling of aryl-metal reagents is one of the most efficient synthetic methods for the construction of symmetrical biaryls^[5] and is mainly based on Co(II),^[6] Cu(II),^[7] Ti(IV),^[8] TiCl,^[9] or V(V)^[10] as oxidants and catalytic use of these metals in combination with reoxidants such as molecular oxygen or dibromoethane.^[11–13] In addition, recent research interests have been limited to Pd- or Cu-catalyzed reactions of organoboron,^[11] silicon,^[12] and tin reagents.^[13] Each method has its own

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drawbacks in terms of conversion, selectivity, and isolation procedures. Therefore, development of an efficient and economically viable method for the synthesis of symmetrical biaryls is of interest.

RESULTS AND DISCUSSION

In continuation of our efforts,^[14,15] we have developed a feasible method of synthesis for symmetrical biaryls and studied various oxidants such as ZnCl₂, Zn(OAc)₂, and ZnBr₂ independently as catalysts and in combination with reoxidants such as dibromoethane for oxidative homocoupling of aryl magnesium bromides. Results of the oxidative homo coupling reaction of phenyl magnesium bromide with different catalysts with and without reoxidants to obtain biaryls are summarized in Table 1.

ZnBr₂ is an efficient catalyst in the absence of reoxidant for the homo coupling reaction. ZnBr₂ undergoes reduction followed by oxidation to catalyze the reaction. It is known^[6,16] that the metal halides on reaction with aryl magnesium bromides undergo reduction to a lower oxidation state and subsequently oxidize in a chain reaction. Thus, in general metal halides are claimed as oxidation–reduction catalysts and provide oxidative homo coupling of aryl magnesium bromides to form biaryls. The mechanism of reaction is formulated below in cyclic form (Scheme 1).

The reaction is further studied with various aryl magnesium bromides to see the versatility of the reaction. Substituents such as electron donors or electron acceptors on the phenyl ring had no influence on the rate of reaction and yield of products. However, sterically hindered or ortho-substituted aryl magnesium bromides had longer reaction times and gave the corresponding biaryls in moderate to good yields. Reactions were carried out in diethylether or tetrahydrofuran (THF) at room temperature under mild conditions with neat workup procedure. In a typical reaction, aryl magnesium bromide is prepared using aryl bromide and magnesium metal in diethyl ether/THF, and the generated aryl magnesium bromide in situ is catalyzed with 5 mol% ZnBr₂. Biaryls are obtained with a yield as high as 98%. The

Entry	Catalyst	Reoxidant	Time (h)	Yield (%)
1	ZnBr ₂	1,2-Dibromethane	1	80
2	$ZnBr_2$	_	1	98
3	$Zn(OAc)_2$	1,2-Dibromethane	6	
4	$Zn(OAc)_2$		6	
5	ZnCl ₂	1,2-Dibromethane	2	55
6	$ZnCl_2$		2	70

Table 1. Studies on roles of various oxidants

Homo Coupling of Aryl Magnesium Bromides



sequence of reaction is drawn in Scheme 2, and results are summarized in Table 2.

CONCLUSION

In conclusion, we have found that the $ZnBr_2$ -induced homo coupling reaction of aryl magnesium bromides proceeds efficiently in ether/THF under mild conditions at room temperature. This procedure is applicable to a variety of substituted aryl magnesium bromides.

EXPERIMENTAL

General Procedure for ZnBr₂-Catalyzed Homo Coupling Reaction of Aryl Magnesium Bromides

Magnesium turnings (2.5 mmol) and diethyl ether (3 mL) were placed in a flask under an N_2 atmosphere; substituted bromo benzene (2.9 mmol) in



Scheme 2.

Entry	Substrate	Time (h)	Product	Yield $(\%)^a$
1	MgBr	1		98
2		2		94
3	MgBr OMe	4	MeO OMe	80
4	MeOMgBr	2	MeO-	95
5	MgBr	3		78
6		6		68
7	F	3	F	88
8 ^{<i>b</i>}	MgBr	5		80
9 ^{<i>b</i>}	MgBr	4		85
10	CI	2	сі	82

Table 2. Preparation of symmetrical biaryls by oxidative homocoupling reaction

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(continued)

Homo Coupling of Aryl Magnesium Bromides



Table 2. Continued

^aYields of isolated products.

^bReactions were carried out in THF.

diethyl ether (3 mL) was slowly added over a period of 30 min at $0-10^{\circ}$ C and stirred for 0.5 h at room temperature. The Grignard reagent thus formed was added to a mixture of 5 mol% ZnBr₂ (0.125 mmol) in diethyl ether (5 mL) and stirred for 1–6 h at room temperature. The progress of the reaction was monitored by TLC at regular intervals. The reaction mixture was diluted with water and extracted with ethyl acetate (2 × 10 mL). The ethyl acetate extract was dried over sodium sulphate and concentrated in vacuo. Purification was carried out by column chromatography using 60 to 120-mesh silica-gel and gave the corresponding biphenyl.

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