

Synthesis of *o*-Arylenedizinc Compounds from 1-Iodo-2-trifluoromethylsulfonyloxybenzenes and Zinc Powder and Their Synthetic Application

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Abstract

1-Iodo-2-trifluoromethylsulfonyloxybenzenes readily reacted with Zn powder to yield *o*-arylenedizinc compounds, efficient synthetic equivalents of *o*-arylene dianions in Pd(0)-catalyzed cross-coupling reactions, wherein the novel insertion of Zn powder into the C-O bond of aryl triflates took place. © 1998 Elsevier Science Ltd. All rights reserved.

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o-Phenylenedimetals **1** (R=H) possess formal negative charges on the adjacent carbons of the benzene ring, posing as useful building blocks of the *o*-phenylene segment **2** (R=H) when synthesizing 1,2-disubstituted benzenes. However, their synthetic application has been scarcely evaluated, presumably due to the lack of reactive, readily available, and/or easily handling ones [1,2]. In the course of our study on the synthesis and synthetic application of arylzinc compounds [3,4], we had found that the *o*-phenylenedizinc compound **1a** is readily produced by the reaction of Zn powder with *o*-diiodobenzene and just fulfills the above requirements as the synthetic reagent affording **2** (R=H) [1]. Thereupon, we were interested in synthesizing similar compounds from the derivatives of *o*-iodophenols in place of *o*-diiodobenzene in view of the flexibility in obtaining the starting materials (*vide infra*). In this paper, we wish to report the first synthesis of *o*-arylenedizinc compounds from 1-iodo-2-trifluoromethylsulfonyloxybenzenes **3** via the novel insertion of Zn powder into the C-O bond.

Initially, the reactivity of Zn powder to a variety of esters like *o*-iodophenyl triflate, methylsulfonate, 4-tolylsulfonate, or acetate was examined in 1,1,3,3-tetramethylurea (TMU) at 90 °C. The oxidative addition of Zn powder into the C-I bond readily took place with every ester, but only with triflate did the reaction also cleanly take place at the C-O bond to give **1b** in

Scheme 1

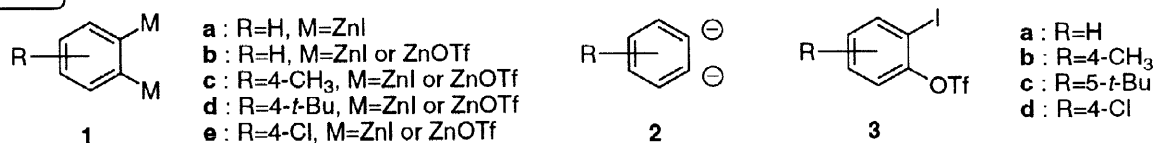
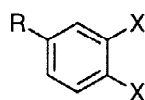


Table 1. Synthesis of **1** from **3**^a

Entry	Conditions	Product (Yield / %)
1	1. 3a , TMU, 4 in TMU, RT, 0.5 h 2. 60 °C, 3 h	1b (84)
2	3b , N,N'-Dimethylpropyleneurea (DMPU), 90 °C, 24 h	1c (75)
3	3c , TMU, 90 °C, 24 h	1d (52)
4	1. 3d , TMU, 4 in TMU, RT, 0.5 h 2. 90 °C, 5 h	1e (67)

^a Molar ratio: **3** / Zn / Me₃SiCl / **4** = 1 / 4 / 0.04 / 0.05 (if used). One ml of solvent was used for 0.8 mmole of aryl triflate.

Scheme 2 Cross-Coupling Products of **1** with X⁺

5 : R, X ; Yield / %
a : H, C₆H₅ ; 92
b : H, 4-C₂H₅O₂CC₆H₄ ; 93
c : H, C₆H₅CO ; 72
d : H, 4-NCC₆H₄CO ; 89
e : CH₃, 4-C₂H₅O₂CC₆H₄ ; 71
f : CH₃, 4-NCC₆H₄CO ; 76
g : Cl, 4-ClC₆H₄CO ; 75

Molar ratio: **1** / ArI or ArCOCl / Pd(PPh₃)₄ = 1 / 2.2 / 0.04, 40 °C, 6 h.

a yield of 58% after stirring for 6h.¹ Here, it is noteworthy that 1) the unprecedented reaction of Zn powder with aryl triflates [5,6] is possible only if an iodine is situated at the *o*-position; neither the C-O bond in *o*-phenylene ditriflate, *o*-cyanophenyl triflate, phenyl triflate, nor *p*-iodophenyl triflate reacted with Zn powder under the examined conditions, although the last triflate afforded an arylzinc compound (*p*-trifluoromethylsulfonyloxyphenylzinc iodide) in a yield of 83% [7]. 2) The addition of a dehydrating agent improved the yield of **1b**, which may be concerned with the reduced reactivity of aryl triflates themselves; in the presence of molecular sieves 4A (120 mg per 1 mmole of aryl triflate), **1b** was obtained in a yield of 77% after 8h stirring at 80 °C. Since organozinc compounds are very sensitive to water, their addition (for example, the addition of a TMU solution of *o*-chlorophenylzinc iodide **4**, prepared separately) also afforded the preferred result as shown in Table 1 (entry 1). This methodology of vicinal dizincation was then applied to substituted ones, resulting in the production of the corresponding *o*-arylenedizinc compounds in good yields (entries 2~4).¹ The TMU or DMPU solution of **1**, thus obtained, was stable at ambient temperature under nitrogen for months and played the role of the stock solution of the synthetic equivalents of *o*-arylene dianions **2** in Pd(0)-catalyzed cross-coupling with aryl iodides or acyl chlorides as electrophiles (scheme 2).² Since *o*-arylenedizinc compounds are readily obtained from 1-iodo-2-trifluoromethylsulfonyloxybenzenes, which in turn are available from phenols by conventional *o*-iodination followed by triflation procedures [8,9], a new, general, efficient, and facile synthetic route from phenols to 1,2-disubstituted benzenes has been established.

References

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¹ Yields of arylzincs were determined by the iodolysis of reaction aliquots followed by GLC analysis of formed aryl iodides.

² **5b**: Mp 98-99 °C; IR (CDCl₃) 1707 cm⁻¹; ¹H-NMR (CDCl₃) δ=1.37 (t, 6H), 4.35 (q, 4H), 7.1-7.9 (m, 12H). Found; C, 76.66; H, 5.76%. Calcd for C₂₄H₂₂O₄; C, 77.0; H, 5.9%. **5d**: Mp 177-178 °C. Lit. [1] 175-177 °C. **5e**: Mp 106-108 °C; IR (CDCl₃) 1708 cm⁻¹; ¹H-NMR (CDCl₃) δ=1.37 (t, 3H), 2.44 (s, 3H), 4.35 (q, 4H), 7.1-7.9 (m, 11H). Found; C, 77.32; H, 6.41%. Calcd for C₂₅H₂₄O₄; C, 77.3; H, 6.2%. **5f**: Mp 138-139 °C; IR (CDCl₃) 1662, 2228 cm⁻¹; ¹H-NMR (CDCl₃) δ=2.50 (s, 3H), 7.3-7.9 (m, 11H). Found; C, 78.67; H, 4.28; N, 7.91%. Calcd for C₂₃H₁₄N₂O₂; C, 78.8; H, 4.0; N, 8.0%. **5g**: Mp 113-115 °C; IR (CDCl₃) 1670 cm⁻¹; ¹H-NMR (CDCl₃) δ=7.3-7.7 (m, 11H). Found; C, 61.41; H, 3.02%. Calcd for C₂₀H₁₁Cl₃O₂; C, 61.7; H, 2.9%.