Formation of 1-Sulfonyl-3-sulfinyl Pyrrole in the Reaction of Pyrrole with Phenylsulfonyl Chloride

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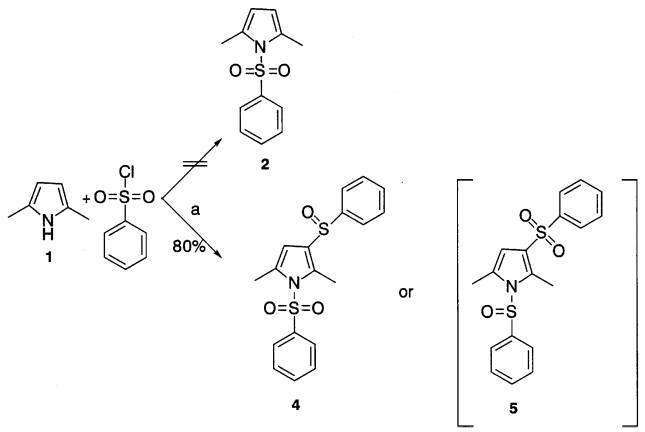
Electrophilic substitution in pyrrole occurs predominantly at the C_2-position.[1-3] Thus, the investigation of efficient methods for preparing C_3-substituted pyrroles is one of the important goals in pyrrole chemistry because of their frequent uses for obtaining various biological active compounds like porphyrins. For the substitution on β-(C_3) position, Friedel-Crafts acylation or alkylation on pyrrole bearing electron-withdrawing substituent at C_2[1-8] or N_1[9,10] has been widely investigated.

Friedel-Crafts acylations on N-phenylsulfonylpyrrole having masked acyl group[11] at C_3-position in order to obtain 2,4-diacylpyrroles also have been studied extensively, but arylsulfonylation on 2,5-disubstituted pyrrole has not been reported yet. We have been investigating to prepare new pyrroles having symmetric and unsymmetric substituents on 3,4-position by manipulating 2,5-dimethylpyrrole with phenylsulfonyl chloride, but 1,3-disulfopyrrole was obtained unexpectedly.

Direct Friedel-Crafts acylation on 2,5-dimethylpyrrole also gives 3,4-symmetric acyl compounds, but normally the yield is very low (<5%) when no electron withdrawing groups are on the substituted pyrroles.[12] So we tried to introduce phenylsulfonyl group on N_1-position using phenylsulfonyl chloride as usual. Expecting 1-phenylsulfonyl-2,5-dimethylpyrrole, 2,5-dimethylpyrrole **1** was reacted with phenylsulfonyl chloride, tetrabutylammonium hydrogensulfate as a phase transfer catalyst, and 50% sodium hydroxide solution in dichloromethane as described in the literature procedure.[10] However, 1,3-disubstituted product **4** was obtained unexpectedly instead of N_1-phenylsulfonyl pyrrole **2** (Scheme 1). The product, however was confirmed to lack one oxygen by Mass spectrum, that can not tell which sulfur loses one oxygen. Another possible compound **5** could be obtained, but the structure was confirmed as 1-phenylsulfonyl-3-phenylsulfinyl-2,5-dimethylpyrrole[13] **4** by X-ray crystallography (Figure 1).



Scheme 1. (a) n-Bu_4NHSO_4, 50% NaOH, CH_2Cl_2, 0 °C to 40 °C, 20 h.

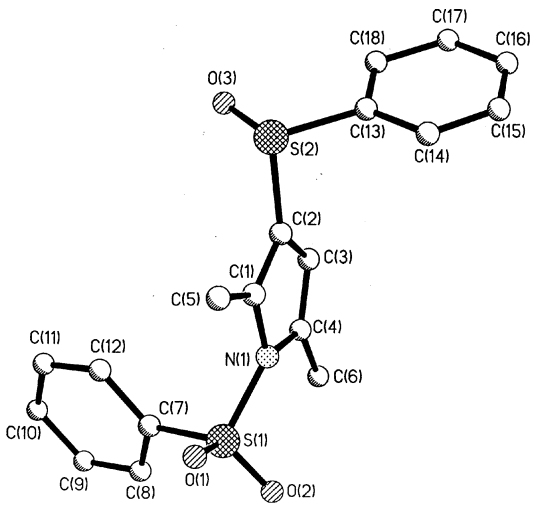


Figure 1. X-ray structure of 1-phenylsulfonyl-3-phenylsulfinyl-2,5-dimethylpyrrole **4**.

Formation of disubstituted pyrrole, can not be avoided in any reaction conditions. It might be due to relatively stronger electron donating power of 2,5-dimethylpyrrole than normal pyrrole, and spontaneously gives an extra substitution. Because the mono-sulfonated compound **2**, 1-phenylsulfonyl-2,5-dimethylpyrrole, can not be obtained in this reaction condition, it is not clear whether the phenylsulfonyl group on C_1-position migrates to C_3-position or the second molecule of phenylsulfonyl chloride attacks the C_3-position directly.

In order to confirm disubstituted pyrrole, the compound **4** was further oxidized with OXONE® and tetrabutylammonium hydrogensulfate in dichloromethane at room temperature for overnight to give 1,3-diphenylsulfonyl-2,5-dimethylpyrrole **3** quantitatively[14] (Scheme 2), which showed very stable in standing at normal condition. The crystal structure of this product also can be determined by X-ray crystallography (Figure 2). These sulfo-compounds can be used as important intermediates for preparation of symmetric and

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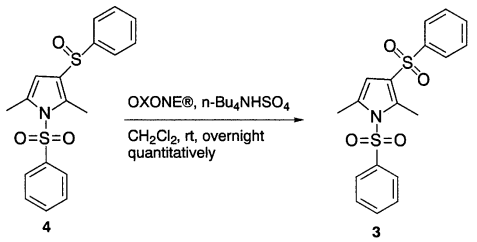

Scheme 2

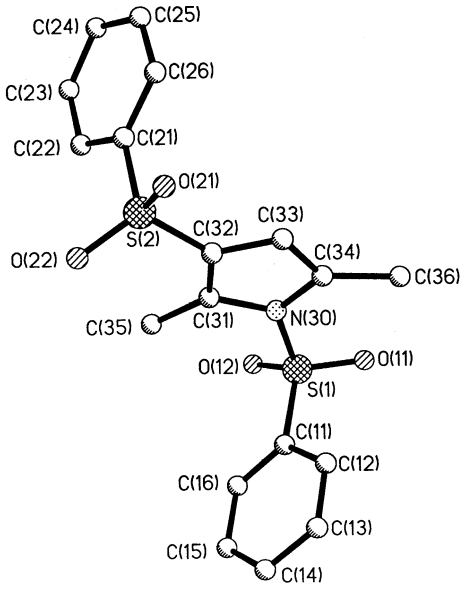

Figure 2. X-ray structure of 1,3-diphenylsulfonyl-2,5-dimethylpyrrole **3**.

unsymmetric pyrroles as well as for the synthesis of substituted peripheral porphyrins.

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Supporting Information Available. Tables of crystallographic details, atomic coordinates, bond lengths and angles, anisotropic displacement parameters, hydrogen coordinates,, and isotropic displacement parameters (7 pages). The supporting materials will be given upon your reguest to the correspondence author.

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13. Melting points are uncorrected and were measured on a Fisher/Johns microscopic hot stage apparatus. Mass spectra were obtained on a Shimadzu GC MS-QD 5050A mass spectrometer using a direct insertion probe (EI). All the X-ray data were collected on a Siemens P4 X-ray Diffractometer equipped with a Mo X-ray tube and a graphite crystal monochromator. ^{1}H NMR spectra were obtained using a Varian EM360 spectrometer, and chemical shifts are reported relative to TMS at 0.00. IR spectra were obtained using a Bio-Rad Win IR spectrometer. Compound **4** (Yield; 60%): ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.71-7.39 (10H, m, aromatic), 5.78 (1H, s, -CH), 2.68 (3H, s, -CH_3), 2.27 (3H, s, -CH_3); Mass, m/e (rel intensity) 342 (100), 359 (4); IR (KBr, cm^{-1}), 1369.9 (s), 1186.0 (s) , 1043.69 (s); mp 129-130 °C.
14. Compound **3** (Yield; qunatitatively): ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.88-7.48 (10H, m, aromatic), 6.29 (1H, s, -CH), 2.65 (3H, s, -CH_3), 2.38 (3H, s, -CH_3). Mass, m/e (rel intensity) 234 (100), 375 (70); IR (KBr, cm ^{1}), 1373.0 (s), 1309.8 (s), 1190.2 (s), 1157.0 (s); mp 107-108.4 °C.