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Preliminary communication

ORGANOMETALLIC COMPOUNDS

XX*. STEREOCHEMISTRY IN THE OXIDATIVE CYCLIZATION OF 1,1′-BIS(1-HYDROXYALKYL)FERROCENE WITH OXYGEN

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Summary

Oxidative cyclization of 1-(1-hydroxy-1-phenylethyl)-1′-(1′-hydroxy-1′-phenylpropyl)ferrocene with molecular oxygen and acid proceeded stereoselectively. Some reactions to confirm the configuration of the products are described.

It has been found that reaction of (1-hydroxyalkyl)ferrocene derivatives with molecular oxygen in the presence of acidic catalysts afforded 1,2-dioxane derivatives (peroxides) of ferrocene and their derivatives [1-4]. Further investigations [5] suggest that the oxidative reaction proceeded by a mechanism different from that of usual reactions of dienophiles with singlet-state oxygen producing peroxides [6]. We now describe that the oxidative cyclization of 1-(1-hydroxy-1-phenylethyl)-1′-(1′-hydroxy-1′-phenylpropyl)-ferrocene (I) with molecular oxygen and acid gave stereoselective reaction products.

Treatment of the diol I (350 mg) with oxygen gas and 6 *N* HCl afforded several (2-methyl)-[4]ferrocenophanes, benzoylferrocene (6 mg) and other unknown products (20 mg). The reaction products were separated into an insoluble crystalline compound (II, 135 mg), in ethyl acetate and a soluble fraction. The latter was column-chromatographed on alumina to be separated into IIIa (3 mg), IV (10 mg), Va (20 mg), Vb (13 mg) and other compounds (Scheme 1).

The peroxide II had a composition of $C_{27}H_{24}O_2$ Fe (M^+, 436.1107), and a methyl signal at δ 0.94 d**. In order to confirm the structure of those products some reactions were carried out (Scheme 2). Rearrangement of II

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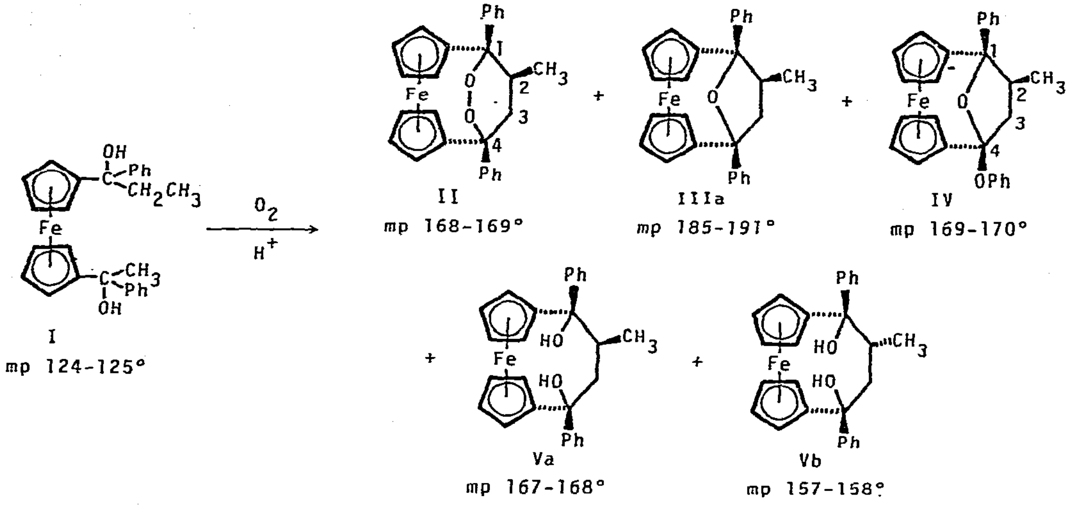
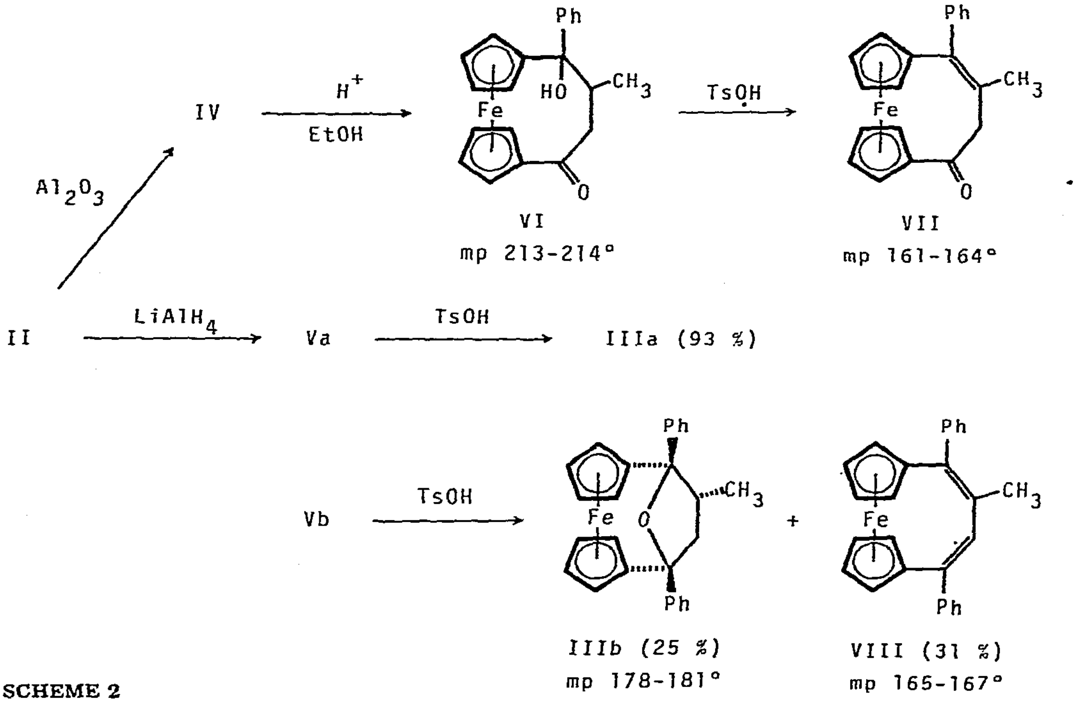
[*] For part XIX see ref. 4.
[**] The molecular weights of all other compounds in this paper also were confirmed by high-resolution mass spectrometry. PMR spectra were measured at 100 MHz in $CDCl_3$.



SCHEME 1



SCHEME 2

with Al_2O_3 afforded the ketal IV (ν(C—O—C) 1060—960 cm^{-1}, δ 0.53 (3H, d, Me)). IV was treated with EtOH—aq.HCl and then with TsOH to give the enone VII (ν(C=O) 1655 cm^{-1}, ν(C=C) 1625 cm^{-1}), in which both signals of methyl (δ 1.95) and methylene protons (δ 3.52) appeared as singlets. The formation of the enone VII indicates that the precursor IV was the 2-methyl but not the 3-methyl isomer.

Both diols Va and Vb have the same configuration as the peroxide II with respect to the 1- and 4-carbons on the bridge, because their IR spectra in highly diluted solutions (CCl_4, 3.8×10^{-4} mol/l) showed strong intramolecular hydrogen bonding bands at 3412 and 3395 cm^{-1}, respectively. Reduction of II gave the diol Va (δ 1.03 (3H, d, Me)), which was converted with TsOH into the tetrahydrofuran IIIa (ν(C-O-C) 1040-980 cm^{-1}, δ 0.63 (3H, d, Me)). On the other hand, dehydration of the other bridging diol Vb (δ 0.73 (3H, d, Me)) under the same conditions as the above reaction Va gave the tetrahydrofuran IIIb (ν(C-O-C) 1040-980 cm^{-1}, δ 1.20 (3H, d, Me)), unisolated in the oxidation reaction of I, together with the bridging butadiene VIII (δ 1.70 (3H, s, Me), δ 5.85 (1H, s, olefinic methine)). When the configuration of the tetrahydrofuran is examined with a molecular model, diamagnetic anisotropy of a benzene ring for the methyl group at the 2-position in the *cis*-configuration derivative is much more effective than for that in the *trans* isomer. The tetrahydrofuran IIIa in which the methyl protons appeared at an unusually high field (δ 0.63) was assigned to the *cis* isomer. In the dehydration of Va the butadiene VIII was not found, but only IIIa was afforded in a 93 % yield, as described above. This suggests a blocking effect of the *cis*-methyl group for attack of the reagent to the OH group at the 1-position; the reaction behaviour also supports the *cis* configuration of IIIa. Subsequently, it was confirmed that II, Va and IV also are in the *cis* form.

The results indicate that the cyclization of I with molecular oxygen proceeded stereoselectively; each total yield of *cis* and *trans* configuration products was ca. 49 % and 4 %, respectively.

Further experiments are in progress to investigate the mechanism of oxidative stereoselective cyclization.

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