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The Reaction of Activated Nitrones to C—C-Double Bonds of Organic *Lewis* Acids. Organic *Lewis* Acids 37[1]

Short Communication

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The reaction of activated nitrones with the C—C double bond of organic electrically neutral *Lewis* acids is described. The addition products rearrange forming indolenine derivatives.

(Keywords: Indolenine; Nitrone; Organic Lewis Acids)

Die Reaktion aktivierter Nitrone mit C—C-*Doppelbindungen organischer Lewis-Säuren. Organische Lewis-Säuren, 37. Mitt. (Kurze Mitteilung)*

Die Reaktion aktivierter Nitrone an die C—C-Doppelbindung organischer elektrisch neutraler *Lewis*-Säuren wird beschrieben. Die primär gebildeten Additionsprodukte zerfallen unter der Bildung von Indoleninderivaten.

The *Knoevenagel* condensation of aromatic aldehydes with activated methylene groups yields products which contain a polar C—C double bond. Such compounds undergo neutralisation reactions and act therefore as electrically neutral organic *Lewis* acids. In order to study the reactivity of organic *Lewis* acids, 1,3- as well as 1,4-cycloadditions to the electrophilic C—C double bonds of arylidene *Meldrum*'s acids and arylidene *N*,*N'*-dimethylbarbituric acids have been performed[2]. The 1,3-dipolar addition of diazomethan leads at room temperature to cyclopropanes[2–4], and olefines[2,4]; the direct addition products, pyrazolines, are not stable at temperatures higher than —40 °C[5]. The addition

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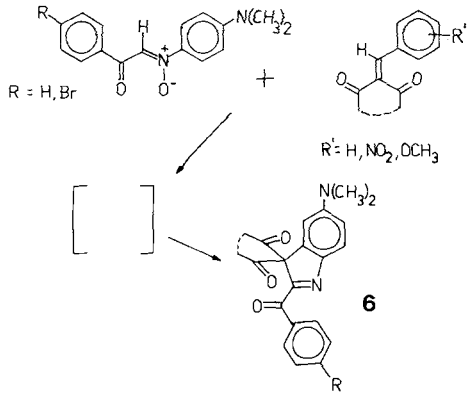
of nitrones to organic *Lewis* acids takes place only at higher temperatures followed by decomposition of the adducts. *C*-Benzoyl-*N*-phenylnitrones are much more reactive[6–10] (the rate constant is 3200 times faster[7]) than *C*,*N*-diphenylnitrone.

We used *C*-benzoyl-*N*-(dimethylamino-)phenyl-nitrone (**1**) and *C*-(4-bromobenzoyl-)*N*-(dimethylamino)-phenylnitrone (**2**) for the addition to organic *Lewis* acids. These nitrones should be reactive in view of additions to strong polar electrophilic double bonds. The reaction of **1**



and **2** proceeds with the arylidene derivatives of *Meldrum*'s acid (2,2-dimethyl-1,3-dioxane-4,6-dion) (**3**), dimethylbarbituric acid (*N*,*N*'-dimethyl-2,4,6-pyrimidine-trione) (**4**), 1,3-indandione (**5**) at room temperature to form products which are independent on the aryl residue. The directly built intermediates, possibly cycloadditions products, could not be isolated. In Table 1 the main products of the reaction of various *Lewis* acids with nitrones of type **1** and **2** are given.

The reactivity of organic *Lewis* acids towards addition reactions to activated nitrones increases with increasing acidity. Benzylidenedimethylbarbituric acid, per example, reacts completely within 5 minutes at 0 °C, whereas 4-methoxibenzylidene-1,3-indandione reacts only within a few hours.

A possible mechanism for the formation of the indolenine derivatives (**6**) would be the rearrangement of a cycloadduct, followed by decomposition of the isoxazolidines. An intramolecular electrophilic attack, followed by oxidation leads to the stable products **6**. A precise analysis of the exact reaction mechanism together with kinetic investigations is still in work.

Table 1. *Reaction products of the addition of organic Lewis acids to activated nitrones*

Lewis acid	nitrone	m.p. (°C)
3	**1**	208–210 (decomp.)
3	**2**	209–211 (decomp.)
4	**1**	284–286
4	**2**	311–312
5	**2**	201–204

Compounds of type **6** fluorescence, they are highly colored and show a remarkable change of the UV-VIS-spectrum in dependence on the solvent. NMR-, MS-, IR- and UV-VIS-spectra as well as elemental analysis are in good agreement with the given structures.

Experimental

Melting points are uncorrected. ^{1}H-NMR-spectra were measured in $CDCl_3$ as solvent using an XL 100 spectrometer (100 MHz, Varian) and a WM 250 spectrometer (250 MHz, Bruker). IR-spectra were taken on a Perkin-Elmer IR-spectrometer 377 in CCl_4 solution (5%) or as KBr disc. UV-VIS-spectra were recorded on a Perkin-Elmer 330 spectrophotometer and the fluorescence spectra were recorded on a Spex Fluorolog. As solvents ethanol, chloroform, acetone and cyclohexane (Uvasole, Merck) were used. Column chromatography was performed with silicagel 60 (Merck) with chloroform and chloroform-ethanol-mixtures as eluents.

Compounds: Nitrones of type **1** and **2** were prepared according to Refs.[6,11]. **1**: Fp.: 109°–111 °C (Lit.: mp.: 110 °C); **2**: mp.: 131°–133 °C from ethanol ($C_{16}H_{15}N_2O_2$, C 55.83, H 4.32, N 8.07, Br 23.05; Found: C 55.26, H 4.40, N 8.07, Br 23.41).

The *Lewis* acids were prepared following procedures described in literature: **3**[12,13], **4**[14], **5**[15].

General procedure for the addition: A mixture to 1 mmol *Lewis* acid and 1 mmol nitrone was stirred in a small amount of chloroform or ethanol at 0 °C between 5 min and 6 h until the reaction was finished (the progress of reaction was monitored by thin-layer chromatography). Column chromatography with chloroform and chloroform:ethanol (4:1) gave products, which were recrystallised in benzene/cyclohexane; the reaction products with **4** were sublimed at 0.1 Torr.

Reaction product of **3** with **1**: ^{1}H-NMR (δ, $CDCl_3$): 8.46 (2 H, m), 7.62 (1 H, m), 7.51 (2 H, m) (aromatic protons of the benzoylring); 7.76 (1 H, d, $J = 9.2$ Hz), 6.76 (1 H, dd, $J_1 = 9.2$ Hz, $J_2 = 2.5$ Hz), 6.67 (1 H, d, $J = 2.5$ Hz) (aromatic protons of the dimethylamino substituted ring); 3.06 (6 H, s) [—$N(CH_3)_2$ protons]; 2.25 (3 H, s) and 2.00 (3 H, s) (protons of the CH_3-groups of the *Meldrum's* acid ring).

MS: M^+ (*m*/e 392), M^+-102 (*m*/e 290) ($C_4H_6O_3$), fragmentation of the *Meldrum*'s acid ring.

IR: $\nu_{C=O}$ 1 695 cm^{-1}, 1 730 cm^{-1}.

UV-VIS: acetone $\lambda_{max} = 478$ nm ($\varepsilon = 19\,900$), cyclohexane 438 nm, ethanol 476 nm, chloroform 483 nm.

Fluorescence sp.: $\lambda_{max} = 614$ nm.

Reaction product of **4** with **1**: ^{1}H-NMR (δ, $CDCl_3$): 8.46 (2 H, m), 7.62 (1 H, m), 7.50 (2 H, m) (aromatic protons of the benzoyl ring); 7.76 (1 H, d, $J = 9.2$ Hz), 6.75 (1 H, dd, $J_1 = 9.2$ Hz, $J_2 = 2.6$ Hz), 6.51 (1 H, d, $J = 2.6$ Hz) (aromatic protons of the dimethylamino substituted ring); 3.44 (6 H, s) (N—CH_3 protons of the barbituric acid ring); 3.05 (6 H, s) (protons of the $N(CH_3)_2$ group].

MS: M^+ (*m*/e 404), M^+-114 (*m*/e 290) ($C_4H_6O_2N_2$), fragmentation of the barbituric acid ring.

IR: $\nu_{C=O}$ 1 690 cm^{-1}.

UV-VIS: acetone $\lambda_{max} = 470$ nm ($\varepsilon = 21\,300$), cyclohexane 452 nm, ethanol 475 nm, chloroform 479 nm.

Fluorescence sp.: acetone $\lambda_{max} = 603$ nm.

Reaction product of **3** with **2**: ^{1}H-NMR (δ, $CDCl_3$), 8.38 (2 H, d, $J = 8.3$ Hz), 7.65 (2 H, d, $J = 8.3$ Hz) (aromatic protons of the 4-bromobenzoylring); 7.75 (1 H, d, $J = 9,1$ Hz), 6.75 (1 H, dd, $J_1 = 9.1$ Hz, $J_2 = 2.6$ Hz), 6.67 (1 H, d, $J = 2.6$ Hz) (aromatic protons of the dimethylamino substituted ring); 3.08 (6 H, s) (protons of the dimethylamino-group); 2.22 (3 H, s) and 2.00 (3 H, s) (protons of the CH_3-groups of *Meldrum*'s acid ring).

MS: M^+ (*m*/e 470, 472), M^+-102 ($C_4H_6O_3$) (*m*/e 368, 370); fragmentation of the *Meldrum*'s acid ring.

UV-VIS: acetone $\lambda_{max} = 489$ nm ($\varepsilon = 22\,570$).

Fluorescence sp.: $\lambda_{max} = 628$ nm.

Reaction product of **4** with **2**: ^{1}H-NMR ($CDCl_3$): 8.36 (2 H, d, $J = 8.6$ Hz), 7.65 (2 H, d, $J = 8.6$ Hz) (aromatic protons of the 4-bromobenzoylring); 7.76 (1 H, d, $J = 9.4$ Hz), 6.75 (1 H, dd, $J_1 = 9.4$ Hz, $J_2 = 2.9$ Hz), 6.51 (1 H, d, $J = 2.9$ Hz) (aromatic protons of the dimethylamino substituted ring); 3.42 (6 H, s) (protons of the N—CH_3-groups of the barbituric acid ring); 3.05 (6 H, s) (protons of the dimethylamino group).

MS: M^+ (*m*/e 484, 482), M^+-114 (*m*/e 370, 368) ($C_4H_6O_2N_2$), fragmentation of the barbituric acid ring.

UV-VIS: acetone: $\lambda_{max} = 488$ nm ($\varepsilon = 20\,900$).

Fluorescence sp.: $\lambda_{max} = 629$ nm.

Reaction product of **5** with **2**: ^{1}H-NMR (δ, $CDCl_3$) 8.30 (2 H, d, $J = 8.7$ Hz), 7,62 (2 H, d, $J = 8.7$ Hz) (aromatic protons of the 4-bromobenzoylring); 8.17 (2 H, m), 7.97 (2 H, m) (aromatic protons of the indandione ring); 7.79 (1 H, d, $J = 9.1$ Hz), 6.77 (1 H, dd, $J_1 = 9.1$ Hz, $J_2 = 2.4$ Hz), 6.27 (1 H, d, $J = 2.4$ Hz) (aromatic protons of the dimethylamino substituted ring); 2.97 (6 H, s) (protons of the dimethylamino group).

MS: M^+ (*m*/e 474, 472), M^+-104 (C_7H_4O) (*m*/e 370, 368), fragmentation of the indandione ring.

UV-VIS: acetone $\lambda_{max} = 485$ nm ($\varepsilon = 19\,700$).

Fluorescence sp.: acetone $\lambda_{max} = 632$ nm.

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