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CONNECTING HINDERED AMINES WITH AMINOXYL RADICALS. I. ONE-STEP SYNTHESIS OF SPIN-LABELLED ESTERS

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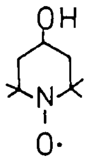
This paper introduces a one-step procedure of general use for obtaining spin-labeled esters. The method implies base-catalyzed transesterification of methyl esters of fatty acids, aromatic acids, hydroxyaromatic acids, unsaturated acids, etc. with paramagnetic alcohols (e.g. **1–3**)[1-3] resulting in a vast array of new and known aminoxyl esters.



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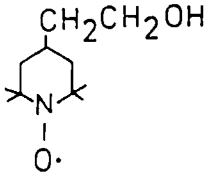

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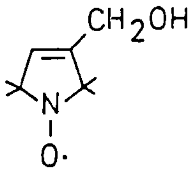

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KEY WORDS: Hindered amines, aminoxyl radicals, esters, ESR, spin-labelling

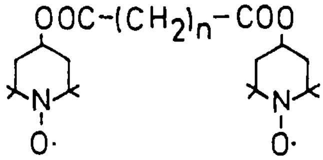
INTRODUCTION

Up to now the most applied technique for preparing such esters was condensation of aminoxyl alcohols with acid chlorides or, rather infrequently, of labeled acid chlorides with alcohols or phenols.[1] In the first case, as highlighted by Rozantsev, an excess of amine must be used to remove the hydrogen chloride formed in the reaction; to avoid accompanying resinification low temperature is recommended leading to increased reaction times.[1,4] Further limitation of the method is the difficult preparation of some acid chlorides, e.g. of hydroxy- or aminoaromatic acids.

RESULTS AND DISCUSSION

According to our procedure stoichiometric amounts of a methyl ester of an organic acid and a spin-labeled alcohol are reacted for 2–3 hours in refluxing toluene with removal of the reaction methanol by azeotropic distillation. The catalyst, sodium methoxide, is addmitted prior to the reactants as a 8% methanolic solution and is turned into a fine catalyst suspension by distillation of the azeotrope methanol-toluene. After the reaction the catalyst is washed away from the mixture with water. For syntheses with water-soluble **1** or **2** this aqueous solution also contains small amounts of unreacted labeled alcohol (corresponding to the equilibrium) which can be recovered quantitatively on saturation with inorganic bases, followed by extraction with an appropriate solvent (ethyl acetate, ethyl ether). In contrast to acid chlorides the methyl esters used as starting materials are stable to moisture andintiem are generally commerical. Purification of the crude aminoxyl ester can be readily performed by recrystallization since traces of organic base no longer contaminate the material.

Transesterification with 2,2,6,6-tetramethyl-4-piperidinol of a large variety of methyl esters is used on industrial scale in the preparation of piperidinic esters belonging to the newest and superior class of light stabilizers for polymers, the hindered amines (HALS). Applying the same method to stable aminoxyl radicals seemed worth while since paramagnetic esters result from HALS by conventional hydrogen peroxide oxidation (e.g. **4**, $n = 8$ from **5** (Tinuvin 770))[5] and



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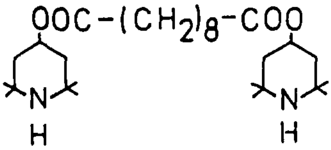

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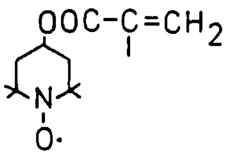

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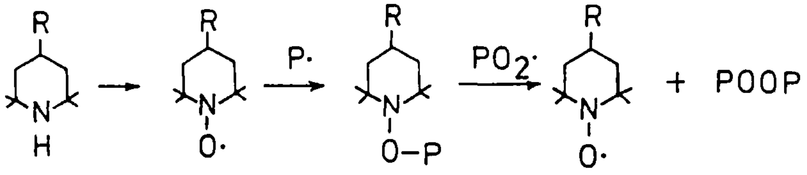
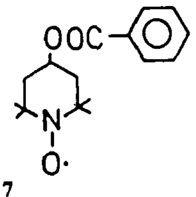
are besides excellent light stabilizers themselves.[6] Furthermore during photooxidation of polymers stabilized with HALS the corresponding aminoxyl radicals are formed in a first stage; these aminoxyls,



which can not disproportionate because of α, α' substitution, act as key intermediates by a chain-breaking mechanism trapping reactive alklyl radicals (P·) and being regenreated in the process.[7]

Esters of alcohol **1** such as 4-methacryloyloxy- (**6**), 4-benzoyloxy- (**7**), 4-palmitoyloxy-, 4-stearoyloxy-2,2,6,6-tetramethylpiperidin-1-oxyl, *bis*(2,2,6,6-tetramethylipieridin-1-oxyl)adipate and -sebacate (**4**), here synthesized by the one-step procedure, correspond to well



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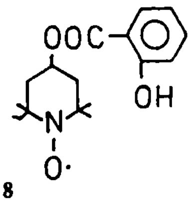

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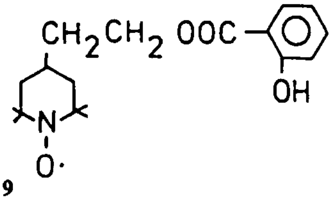

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TABLE 1
Syntheses of aminoxyl esters

	Molar ratios (based on starting ester)						Literature[a]		
Compd.	**1** or **2**	cat.	Color	M.p. °C	Purification	Yield %	Ref.	M.p. °C	Yield %
6	1.03	-.30	pink-orange	-86–88	Recryst. (hexane)	67.0	8	88.7[b]	51.5[c]
7	1.05	0.30	pink	103–105	Recryst. (2:1 MeOH–H_2O)	85.1	1	105	90.0[d]
4,*N* = 8[e]	2.06	0.36	pink	98–101	Recryst. (hexane)	56.1	1,9	101[b]	51.0[c]
8	1.23	1.39	pale–pink	104–106	Recryst. (2:1 MeOH-H_2O)	62.8	–	–	–
9	1.00	1.4	red	oil	Chromatography (CCl_4)	70.2	–	–	–

[a] Syntheses with acid chlorides; [b] Purification by column chormatography, sublimation and recrystallization from hexane; [c] After chromatography; [d] After recrystallization from MeOH; [e] 25% of introduced **1** is recovered from the water extracts.

TABLE 2
Spectra of aminoxyl esters

	IR		^{1}H-NMR ($CDCl_3$; δ (ppm)			
			Piperidinic ring protons			Other protons
Compd.	(CCl_4;	cm^{-1})	CH_3	CH_2	H_{tert}	
6	1190 1630 1710	($\nu_{C\text{-}O\text{-}C}$) ($\nu_{C=C}$) ($\nu_{C=O}$)	1.20(s) 1.29(s)	1.28(m) 1.95(m)	5.28(m)	1.94 (d, $C(CH_3) = CH_2$) 5.56(m); 6.10(m) olefinic
8	1670 3200	($\nu_{C=O}$) (ν_{OH})	1.15(s) 1.27(s)	2.0(d)	5.40(m)	6.38(d(d), $1H_{arom}$ adj. OH) 6.32 and 6.91 (t, $2H_{arom}$) 7.28d(d), $1H_{arom}$ adj. COO–)
9$_b$	–″–					

[a] After phenylhydrazine reduction; [b] ESR (benzene): $a_N = 15.4G$, $g = 2.0062$

known UV stabilizers some of which are industrial products. This procedure enables chemists involved in studying the effectiveness and mechanism of stabilization by different HALS esters to easily prepare the respective aminoxyl radical from commercically available reagents **1** and methyl ester. Illustrative syntheses are presented in the tables.

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References

1. Rozantsev, E.G. *Free Nitroxyl Radicals*, Plenum Press, New York, (1970).

2. a) Rozantsev, E.G. Grigoryan, G.L. and Ivanov, V.P. *Izv. Akad. Nauk SSSR, Ser. Khim.*, **1970**. 2840; b) Usovskaya, V.S. Sharapov, I.M. Nikitskaya, E.S. Levkoeva, E.I. Mashkovskii M.K. and Yakhontov, L.N. French Pat. Appl. 2043474 (Mar. 26, 1971), *Chem Abstr.* **76**, 14364 c (1972).
3. Hideg, K., Hankovszky, H.O., Lex, L. and Kulcsár, Gy.*Synthesis* **1980**, 911.
4. Karrer, F.E., *Makromol. Chem.* **181**, 595, (1980).
5. Hodgeman, D.K.C., *J. Polym. Sci., Polym. Chem. Ed.*, **19**, 807, (1981).
6. Toda, T., Kurumada, T. and Murayama, K. *ACS Symposium Series* **280**, 37, (1985).
7. a) Brownlie, I.T. and Ingold, K.U. *Can. J. Chem.*, **45**, 2427, (1967); b) Allen, N.S., *Chem. Soc. Rev.*, **15**, 373 (1986); Andrei, C. Drăgutan, I. and Balaban, A.T. *Hindered Amine Light Stabilizers for Polymers* (Rom.), Ed. Academiei R.S. România, Bucharest, in press.
8. Rozantsev, E.G. and Suskina, V.I. *Izv. Akad. Nauk SSSR, Ser. Khim.*, **1968**, 2106.
9. Rozantsev, E.G, Golubev, V.A., Neiman, M.B. and Kokhanov, Yu.V. *Izv. Akad. Nauk SSSR, Ser. Khim.*, **1965**, 572.

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