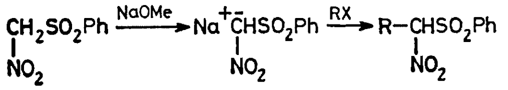
C-Alkylation Reactions of Phenylsulphonylnitromethane. A Convenient New α-Nitro-sulphone Synthesis

By PETER A WADE,* SCOTT D MORROW, STEVEN A HARDINGER, MALLORY S SAFT, and HARRY R HINNEY
(*Department of Chemistry, Drexel University, Philadelphia, Pennsylvania*, 19104)

Summary Phenylsulphonylnitromethane (**1**) is *C*-alkylated by benzylic halides and primary alkyl iodides affording α-nitro-sulphones in 43—75% yield, α-nitro-sulphones (83—90% yield) are also obtained from the corresponding *C*-alkylation of allylic acetates in the presence of catalytic $Pd(PPh_3)_4$

CARBANIONS derived from nitro-compounds (nitronates) have proven versatile intermediates in a variety of processes[1] including Michael addition, radical anion, aromatic nucleophilic substitution, and nitroaldol reactions However, the synthetic utility of nitronates towards alkylation by typical alkyl halides and related compounds is frustrated by a strong preference for oxygen–carbon rather than carbon–carbon bond formation [2]

Phenylsulphonylnitromethane (**1**) contains a bulky arenesulphonyl substituent adjacent to the incipient carbanion centre, presumably steering alkylation towards oxygen Furthermore, other arenesulphonylnitroalkane derivatives ($ArSO_2CHRNO_2$) are known to *O*-alkylate when treated with diazomethane [3] These facts, coupled with a discouraging report[4] from the early literature concerning *p*-toluenesulphonylnitromethane, do not recommend compound (**1**) as an attractive candidate for *C*-alkylation Nevertheless, we now report two useful *C*-alkylation processes for (**1**)

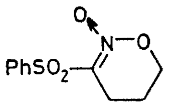


$$\underset{NO_2}{CH_2SO_2Ph} \xrightarrow{NaOMe} Na^+\underset{NO_2}{\bar{C}HSO_2Ph} \xrightarrow{RX} \underset{NO_2}{R-CHSO_2Ph} \qquad (1)$$

(1) **(2)—(12)**

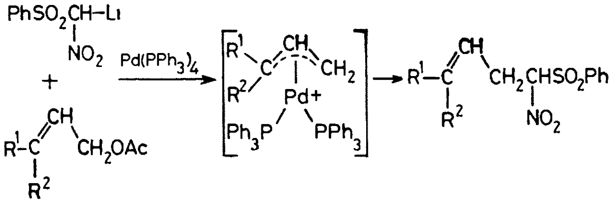
(**2**) R = Me
(**3**) R = Bu
(**4**) R = Heptyl
(**5**) R = 3-Chloropropyl
(**6**) R = $PhCH_2$
(**7**) R = $O_2NC_6H_4CH_2$-*p*
(**8**) R = $MeC_6H_4CH_2$ *o*
(**9**) R = $PhCH{=}CHCH_2$
(**10**) R = $Me[CH_2]_6CH{=}CHCH_2$
(**11**)**a**, R = (*E*)-$Me_2C{=}CH[CH_2]_2CMe{=}CHCH_2$ **b**, R = (*Z*)-$Me_2C{=}CH[CH_2]_2CMe{=}CHCH_2$
(**12**) R = $Me_2C{=}CH[CH_2]_2$ $C(Me)(CH{=}CH_2)$

When the sodium salt of (**1**) was treated with methyl iodide, primary alkyl iodides, or benzylic bromides and iodides, fair-to-good yields of the *C*-alkylates were obtained (equation 1) This reaction provides a convenient synthesis of the α-nitro-sulphones (**2**)—(**8**),[5] especially since salts of (**1**) do not need to be stored under an inert atmosphere (Table) Dialkylation is not a serious problem except when intramolecular possibilities arise [*e g* , compound (**13**) is formed along with (**5**)]



(13)

A particularly effective alkylation occurs when allylic acetates are treated with salts of (**1**) in the presence of tetrakis(triphenylphosphine)palladium It is thought that an intermediate π-allylpalladium complex is attacked by the nucleophile[6] (equation 2) to give the α-nitro-sulphones (**9**)—(**12**) as products (Table) These reactions are regioselective with only neryl acetate yielding detectable amounts of two regioisomers



(2)

The regioselectivity observed for geranyl and neryl acetates is similar to that observed by Trost and Verhoeven with the anion of methyl phenylsulphonylacetate [7] This is in agreement with steric control of attack as postulated by Trost The stereospecificity is also similar to that observed for methyl phenylsulphonylacetate Thus, salts of (**1**) must be rapidly trapping the intermediate π-allylpalladium complexes derived from geranyl and neryl acetate before loss of

Table. α-Nitro-sulphones produced by alkylation of (**1**)[a]

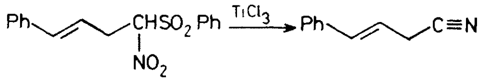
Substrate	Temp./°C	Time/h	Solvent[b]	Product	Yield/%[c]
MeI	22	4	HMPA	(**2**)	72
	67	7	MeOH	(**2**)	68[d]
BuI	22	14	HMPA	(**3**)	54
					40[d]
Heptyl iodide	22	14	HMPA	(**4**)	59
$ClCH_2CH_2CH_2I$	22	14	HMPA	(**5**)	43[e]
$PhCH_2I/Br$	22	24	Me_2SO	(**6**)	73/68
$O_2NC_6H_4CH_2Br$-*p*	22	24	Me_2SO	(**7**)	75
$MeC_6H_4CH_2I/Br$-*o*	22	24	Me_2SO	(**8**)	71/64
$PhCH{=}CHCH_2OAc$[f]	67	2	THF	(**9**)	90
$Me[CH_2]_6CH{=}CHCH_2OAc$[f]	67	2	THF	(**10**)	89
(*E*)-$Me_2C{=}CH[CH_2]_2CMe{=}CHCH_2OAc$[f]	67	5	THF	(**11a**)	83[g]
(*Z*)-$Me_2C{=}CH[CH_2]_2CMe{=}CHCH_2OAc$[f]	67	5	THF	(**11b**), (**12**) (88 : 12)	84[g]

[a] $NaCH(NO_2)SO_2Ph$ was used as nucleophile unless otherwise stated. [b] HMPA = hexamethylphosphoric triamide; THF = tetrahydrofuran. [c] Yields refer to pure isolated products. Structures were assigned on the basis of spectral data and elemental analyses. [d] An excess of alkyl iodide was employed. [e] A 9% yield of the nitronic ester (**13**) was isolated. [f] $LiCH(NO_2)SO_2Ph$ was used as nucleophile. [g] The (*E*)-, (*Z*)-, and terminal isomers (**11a**), (**11b**), and (**12**) were readily distinguished by v.p.c. analysis on a 5′ 15% OV-101 (Chromosorb G-HP support) column at 220 °C. The ^1H n.m.r. spectra at 360 MHz differ for the (*E*)-isomer [δ 1·65, 1·60 and 1·56 (all Me)] and the (*Z*)-isomer [δ 1·69 (2 Me) and 1·59 (Me)].

stereochemical integrity about the double bond can occur. This is despite the weak nature of the nucleophile (pK_a 5·7[8]).

An excess of nucleophile has been employed in most of our studies. Differences in kinetic acidity were used to separate the regenerated compound (**1**) from the products. The majority of the α-nitro-sulphone products [(**2**)—(**9**); not (**10**)—(**12**)] are soluble in 5% aqueous sodium hydroxide as is (**1**). However, (**1**) transfers within 30 s from methylene chloride solution into aqueous base ('fast' acid) while all the other α-nitro-sulphones are less rapidly transferred ('slow' acids). Iterative extraction procedures were thus used to separate (**1**) from the products formed.

Whilst investigating the chemistry of α-nitro-sulphones we found an unusual reduction with titanium(III) chloride. Normally this reagent converts nitro-compounds into carbonyl compounds, although other reactions have been observed.[9] The α-nitro-sulphone (**9**), however, upon treatment with unbuffered 20% aqueous $TiCl_3$ afforded 4-phenylbut-3-enenitrile in 70% yield (equation 3). Presumably this reaction involves the corresponding α-oximino-sulphone as an intermediate.[10]



(3)

We thank the donors of the Petroleum Research Fund, administered by the American Chemical Society, for generous support.

(*Received*, 13*th November* 1979; *Com.* 1187.)

---

[1] For reviews see: R. G. Coombes in 'Comprehensive Organic Chemistry,' ed. I. O. Sutherland, Pergamon, New York, Vol. 2, 1979, p. 305; O. von Schickh, G. Apel, H. G. Padeken, H. H. Schwartz, and A. Segnitz in Houben-Weyl-Müller, 'Methoden der Organische Chemie,' Verlag, Stuttgart, Vol. 10, 1971, p. 1; S. I. Ioffe, L. M. Leont'eva, and V. A. Tartakovskii, *Russ. Chem. Rev.*, 1977, **46**, 872; 'The Chemistry of the Nitro and Nitroso Group,' ed. H. Feuer, Wiley Interscience, New York, Pts 1 and 2, 1970.

[2] While simple nitronates typically give *O*-alkylation, αα-dianions of nitro-compounds readily *C*-alkylate: D. Seebach, R. Henning, F. Lehr, and J. Gonnerman, *Tetrahedron Letters* 1977, **1161** and references cited therein.

[3] J. J. Zeilstra and J. B. F. N. Engberts, *J. Am. Chem. Soc.*, 1975, **97**, 7091. See also P. A. Wade and H. R. Hinney, *ibid.*, 1979, **101**, 1319.

[4] R. L. Shriner and S. O. Greenlee, *J. Org. Chem.*, 1939, **4**, 242.

[5] For alternative approaches to the synthesis of α-nitro-sulphones, see J. J. Zeilstra and J. B. F. N. Engberts, *Rec. Trav. Chim. Pays-Bas*, 1974, **93**, 11 and references cited therein.

[6] The intermediacy of π-allylpalladium complexes in nucleophilic substitution reactions is well documented: for a review see B. M. Trost, *Tetrahedron*, 1977, **33**, 2615; B. M. Trost, L. Weber, P. E. Strege, T. J. Fullerton, and T. J. Dietsche, *J. Am. Chem. Soc.*, 1978, **100**, 3416.

[7] B. M. Trost and T. R. Verhoeven. *J. Org. Chem.* 1976, **41**, 3215.

[8] F. G. Bordwell and J. E. Bartmess, *J. Org. Chem.*, 1976, **43**, 3101.

[9] For a review, see J. E. McMurry, *Acc. Chem. Res.*, 1974, **7**, 281.

[10] The Lewis acid catalysed formation of benzonitrile from an α-oximino-sulphone has been reported: J. J. Zeilstra and J. B. F. N. Engberts, *Synthesis*, 1974, 49.

Printed by Heffers Printers Ltd Cambridge England