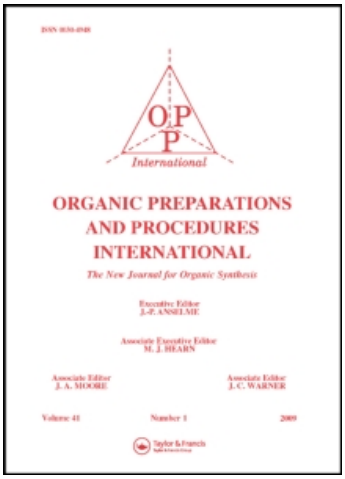


Organic Preparations and Procedures International

Publication details, including instructions for authors and subscription information:
http://www.informaworld.com/smpp/title~content=t902189982

$S_{RN}1$ REACTIONS IN LIQUID AMMONIA AT ROOM TEMPERATURE

P. G. Manzo[a]; S. M. Palacios[a]; R. A. Alonso[a]; R. A. Rossi[a]
[a] Departamento de Química Orgánica Facultad de Ciencias Químicas, EQUIMAP, Universidad Nacional de Córdoba, Córdoba, ARGENTINA

To cite this Article Manzo, P. G. , Palacios, S. M. , Alonso, R. A. and Rossi, R. A.(1995) '$S_{RN}1$ REACTIONS IN LIQUID AMMONIA AT ROOM TEMPERATURE', Organic Preparations and Procedures International, 27: 6, 660 — 663
To link to this Article: DOI: 10.1080/00304949509458526
URL: http://dx.doi.org/10.1080/00304949509458526

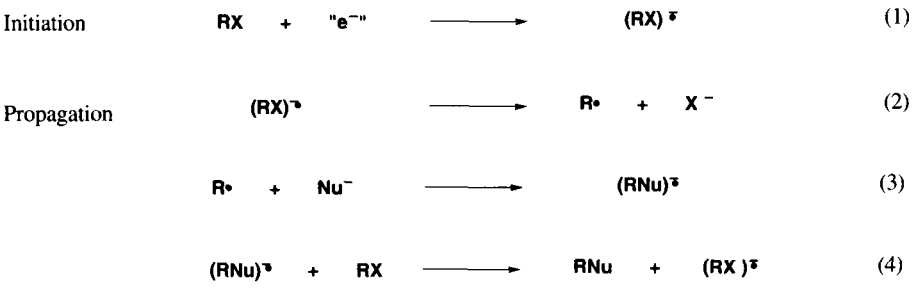
$S_{RN}1$ REACTIONS IN LIQUID AMMONIA AT ROOM TEMPERATURE

Submitted by P. G. Manzo, S. M. Palacios, R. A. Alonso* and R. A. Rossi*
(07/25/95)

CEQUIMAP and Departamento de Química Orgánica
Facultad de Ciencias Químicas, Universidad Nacional de Córdoba
Est. 16, CC 61, 5016 Córdoba, ARGENTINA

The $S_{RN}1$ method has proved to be suitable to promote nucleophilic substitution of unactivated aromatic substrates to form C-C, C-P, C-S, C-Se, C-Sn and C-N bonds.[1] It is a chain process[1] (Scheme I) that requires an initiation step (Eq. 1). In a few systems, spontaneous electron transfer (ET) from the nucleophile to the substrate has been observed.[2] When it is not a spontaneous reaction, it can be induced by light,[3] by solvated electrons in liquid ammonia,[4] by cathodically generated electrons,[5] or by certain inorganic salts.[6]

Scheme I

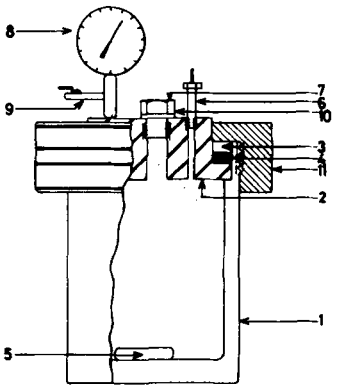


Among the solvents more often used in $S_{RN}1$ reactions are acetonitrile, dimethyl sulfoxide and liquid ammonia,[7] the latter being the most frequently utilized because it is a good solvent for nucleophilic anions and a poor hydrogen donor.[8] Secondary radical reactions (such as hydrogen abstraction) which decrease the selectivity and yield of substitution product are avoided in ammonia; in addition, it is also easily eliminated from the reaction medium. However, due to its boiling point, the reactions must be carried out at -33° at atmospheric pressure. Light is the most common initiator, but this type of process is most effective only in dilute solutions. We have been searching for new procedures to perform $S_{RN}1$ reactions on a preparative scale, which would avoid the disadvantages of ammonia at -33°, and light initiation. Recently we reported that $S_{RN}1$ reactions of aromatic halides in liquid ammonia (-33°) with diphenyl-phosphide ions[9] (Ph_2P^-) and carbanions[10] are initiated by sodium amalgam [Na(Hg)] as controlled source of electrons. We also found that ultrasound mediates these reactions using liquid ammonia as solvent at room temperature.[11] It therefore follows that in order to keep ammonia as liquid at 25°, a pressurized reactor was needed. We report here the design and use of a new reactor for $S_{RN}1$ reactions using liquid ammonia as solvent at room temperature (~25°) under pressure conditions (9 Kg/cm^2), which allows sonication or sodium amalgam to initiate these $S_{RN}1$ reactions. It is not known whether or not ammonia cavitates under these conditions.

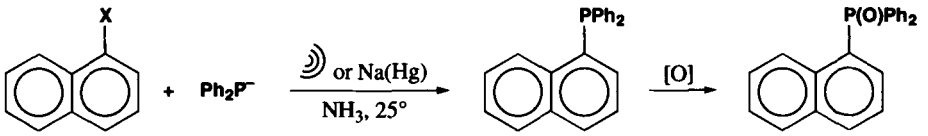
The reactor consists of a stainless steel cylinder (**1**) (5 mm wall thickness) with a reactor head assembly (**2**) and a screw-topped cap (**11**), as shown in the Figure. The reactor head assembly is provided with an inlet for introducing the reagents, an outlet valve (**9**), pressure gauge (**8**) and a safety valve (**6**). The inlet is closed during the reaction with a cap screw (**7**) adjusted with a teflon gasket (**10**). An O ring (**4**) and a compression ring (**3**) are used for best fitting of the screw-topped cap (**11**).

Examples of the use of the reactor for the synthesis of 1-naphthyldiphenylphosphine oxide by $S_{RN}1$ reactions in liquid ammonia at room temperature initiated by sonication, or by reaction with [Na(Hg)] are reported.

1 Reactor cylinder
2 Reactor head assembly
3 Compression ring
4 O ring
5 Magnetic stirrer
6 Safety valve
7 Inlet screw cap
8 Pressure-meter
9 Gas outlet valve
10 Teflon Gasket
11 Drop band with screw



Stainless Steel Reactor



EXPERIMENTAL SECTION

^{1}H NMR spectra were recorded on a Bruker 200 MHz FT-nuclear magnetic spectrometer. Mass spectral measurements were obtained with a Finnigan Model 3300 FT-100 mass spectrometer. Gas chromatographic analyses were performed on a Konik instrument with a flame ionization detector using a column packed with 3% SE30 on chromosorb P. The reagents are all commercially available and were used as received. Na(Hg) amalgam (3% w/w) was prepared and its concentration determined as reported.[12]

Reaction of 1-Bromonaphthalene with Ph_2P^- Ions in Liquid Ammonia (Sonication).- This reaction is representative. The reactor was placed in a cold bath (a container with ethanol and Dry Ice) and 200 mL of freshly distilled dry ammonia were transferred, under inert atmosphere, through an inlet tube, while the outlet valve was connected to an U-type tube filled with mercury and kept open to

avoid raising the pressure. Triphenylphosphine (5.25 g, 20 mmol) and Na metal (0.92 g, 0.04 g-atm) were added and allowed to react (magnetic stirring) for 60 min and then *t*-BuOH (1.88 mL, 20 mmol) was added followed by 0.62 g (3 mmol) of 1-bromonaphthalene. The inlet tube was removed and replaced by the screw cap. The gas outlet valve was closed and the reactor was allowed to reach room temperature. The magnetic stirrer was removed and the reactor was placed (avoiding contact with the bottom of the bath) in the Ney ultrasonic cleaner series 300, filled with 3.6 liters of water, 115 watts and 100 KHz of frequency[13] and the power turned on for 90 min. The outlet was opened gently to allow ammonia to escape until atmospheric pressure was reached. Ammonium nitrate (1.6 g, 20 mmol) was added through the inlet to neutralize the anions and the solvent was allowed to evaporate to dryness. The residue was partitioned between water and CH_2Cl_2 and the organic layer was treated with 30 mL of 40% H_2O_2 to give 1-naphthyldiphenylphosphine oxide (87%) and naphthalene (10%), by GLC (quantitative analysis). The solvent was evaporated, and the residue was chromatographed on 80 g silica gel (70-230 mesh) [petroleum ether (bp 60-80°):diethyl ether 9:1, and then diethyl ether], to give 593 mg (60% yield) of pure 1-naphthyldiphenylphosphine oxide, mp 177-179°, lit.[14] 178-179°. ^{1}H NMR: δ 7.4 (16 H,m), 8.4 (1 H, m). MS, *m/z* (relative intensity) 329 (8), 328 (100), 202 (9).

Reaction of 1-Chloronaphthalene with Ph_2P^- Ions in Liquid Ammonia [Na(Hg)].- The procedure was as above. To 200 mL of freshly distilled dry ammonia, triphenylphosphine (2.1 g, 8 mmol) and Na (0.37 g, 0.016 g-atm) were added, under inert atmosphere. The mixture was stirred for 60 min, and *t*-BuOH (0.75 mL, 8 mmol) was then added. 1-Chloronaphthalene (0.65 g, 4 mmol) and Na(Hg) (3%, 3.89 g) were added and the inlet was closed with the screw cap and the reactor was allowed to reach room temperature with stirring for 120 min. The work-up was as above. The solvent was evaporated, and the residue was chromatographed on silica gel (as before) to give 846 mg (66% yield) of pure 1-naphthyldiphenylphosphine oxideas a colorless solid, mp. 177-179°, lit.[14] 174-179°.

REFERENCES

1. For reviews, see: a) R. A. Rossi, A. B. Pierini and A. B. Peñéñory, *"The Chemistry of Functional Groups: The Chemistry of Halides, Pseudo-halides and Azides"*, S. Patai and Z. Rappoport, Eds.; Wiley, Vol. 2, **1995**; b) R. A. Rossi and R. H. de Rossi, *"Aromatic Substitution by the $S_{RN}l$ Mechanism"*; ACS Monograph 178; ACS, Washington, DC, **1983**; c) R. K. Norris, *"Comprehensive Organic Synthesis"*, B. M. Trost, Ed., **1991**, Vol. 4, Pergamon Press, 451.

2. a) J. K. Kim and J. F. Bunnett, *J. Am. Chem. Soc.*, **92**, 7463 (1970); b) R. G. Scamehorn and J. F. Bunnett, *J. Org. Chem.*, **42**, 1449 (1977).

3. a) R. A. Rossi and J. F. Bunnett, *ibid.*, **38**, 1407 (1973); b) S. Hoz and J. F. Bunnett, *J. Am. Chem. Soc.*, **99**, 4690 (1977); c) M. A. Fox, J. Jounathan and G. E. Fryxell, *J. Org. Chem.*, **48**, 3109 (1983).

4. a) J. K. Kim and J. F. Bunnett, *J. Am. Chem. Soc.*, **92**, 7464 (1970); b) R. A. Rossi and J. F. Bunnett, *ibid.*, **96**, 112 (1974).

5. J. M. Savéant, *Adv. Phys. Org. Chem.*, **26**, 1 (1990), and references cited therein.

6. Fe^{+2} catalysis: a) C. Galli and J. F. Bunnett, *J. Am. Chem. Soc.*, **49**, 3041 (1984); b) C. Galli and P. Gentili, *J. Chem. Soc. Perkin Trans. 2*, 1135 (1993); c) M. v. Leeuwen and A. Mckillop, *J. Chem. Soc., Perkin Trans. 1*, 2433 (1993). SmI_2 catalysis: M. A. Nazareno and R. A. Rossi, *Tetrahedron Lett.*, **35**, 5185 (1994).

7. J. F. Bunnett, R. G. Scamehorn and R. P. Traber, *J. Org. Chem.*, **41**, 3677 (1976).

8. C. Amatore, J. Pinson, J. M. Savéant and A. Thiebault, *J. Am. Chem. Soc.*, **104**, 817 (1982).

9. E. Austin, R. A. Alonso and R. A. Rossi, *J. Org. Chem.*, **56**, 4486 (1991).

10. E. Austin, R. A. Alonso and R. A. Rossi, *Tetrahedron*, **49**, 4495 (1993).

11. P. G. Manzo, S. M. Palacios and R. A. Alonso, *Tetrahedron Lett.*, **35**, 677 (1994).

12. E. Austin, R. A. Alonso and R. A. Rossi, *J. Chem. Res.*, 190 (**1990**).

13. To optimize the effectiveness of sonication the following experiment was carried out. The reactor cylinder was filled with water and introduced in the water bath of the ultrasound cleaner and its position adjusted until the waves of the cylinder of water were maximized. This position was used when the $S_{RN}1$ reactions were carried out.

14. D. G. Gillespie, B. J. Walker, D. Stevens and C. A. Mc Auliffe, *J. Chem. Soc. Perkin Trans. 1*, 967 (1983).

****

FACILE SYNTHESIS OF 3-CHLOROCOUMARINS

Submitted by (10/06/94)

Raghao S. Mali* and Jyoti V. Deshpande

Garware Research Centre, Department of Chemistry
University of Poona, Pune 411 007, INDIA

3-Substituted coumarins constitute an important class of coumarins. Apart from their natural occurrence,[1] several 3-substituted coumarins are known to possess anthelmintic, hypnotic and insecticidal properties.[2] 3-Halocoumarins[3] (**1**) also possess insecticidal and fungicidal properties and are useful intermediates for the synthesis of various compounds[3] such as **2** and some furocoumarins[4] and isocoumestans.[5] Several methods have been reported for the synthesis of 3-chlorocoumarins e. g. the chlorination[3] of coumarins, the von Pechmann condensation[6] of ethyl 2-chloroacetoacetate with