SYNLETT Spotlight 238

Disulfur Dichloride (S₂Cl₂)

Compiled by Bárbara Vasconcellos da Silva

This feature focuses on a reagent chosen by a postgraduate, highlighting the uses and preparation of the reagent in current research

Bárbara Vasconcellos da Silva was born in Rio de Janeiro, Brazil in 1981. She received her Chemistry degree from Universidade Federal do Rio de Janeiro in 2007 and she is currently working toward her Ph.D. in organic synthesis under the supervision of Dr. Angelo da Cunha Pinto at the same university. Her research interests focus on the synthesis of isatins and oxindole derivatives.

Centro de Tecnologia, Bloco A, Instituto de Química, Universidade Federal do Rio de Janeiro, 21941-590 Rio de Janeiro, Brazil
E-mail: barbara.iq@gmail.com

Introduction

Disulfur dichloride (S₂Cl₂), also known as sulfur chloride (S₂Cl₂), is widely used in organic synthesis as a sulfurizing and chlorinating agent. Sulfide compounds are found in many natural products and may have useful biological properties.¹ This reagent has been explored for the preparation of heteroaryl disulfides,² symmetric aryl di-, tri-, and tetrasulfides,^{2,3} episulfides⁴ and benzopolysulfides.^{5,6} Moreover, S₂Cl₂ is a suitable substrate for the synthesis of dialkoxy disulfide,⁷ or for the Herz reaction.⁸ It decomposes into SO₂, HCl, and S₈ when exposed to wet air due to reaction with water.

S₂Cl₂ is a smelly, clear, yellowish-red, oily liquid. It should be used with care and proper precautions must be taken because it is toxic, corrosive, and harmful to the environment.

Preparation

S₂Cl₂ is synthesized by partial chlorination of elemental sulfur⁹ and is also commercially available.

Scheme 1

Abstracts

(A) Korn and Knochel² have described the use of S₂Cl₂ to achieve functionalized aryl and heteroaryl disulfides from functionalized zinc organometallics. All the reactions were carried out at –80 °C, producing within ten minutes the expected disulfide in 62–99% yield.

(B) An equilibrated equimolecular mixture of S₂Cl₂ and DABCO (1,4-diazobicyclo[2.2.2]octane) has been used for treatment of N-substituted 2,5-dimethylpyrroles **1** giving pentathiepinopyrroles **2** in moderate yields. Further reaction of **2** with the same mixture at room temperature has resulted in an extensive reaction cascade, to give bis(dithiolo)pyrrole **3** in high yield.¹⁰

(C) Chiral benzopolysulfides are rarely described in the literature. Sato and co-workers⁵ have reported the synthesis of axially chiral benzopentathiepins by treatment of dithiastannole with S_2Cl_2 .

(D) Reaction of a diol with S_2Cl_2 resulted in the first example of a stable and fully characterized cyclic dialkoxo disulfide under mild conditions.¹¹

(E) S_2Cl_2 was reacted with 1,7-s-hydrindacenedione dioximes leading to the first example of bis[1,2,3]dithiazolo-s-indacene.¹² In this example, S_2Cl_2 has also been found as a chlorinating agent.

(F) Treatment of 1,5-cyclooctadiene with S_2Cl_2 , followed by reaction with sulfuryl chloride (SO_2Cl_2) provides high yields of 2,6-dichloro-9-thiabicyclo[3.3.1]nonane in a robust and convenient manner. This product may be used as connector and as a chiral scaffold through nucleophilic substitution of chloride.¹³

(G) S_2Cl_2 is a very effective reagent for the preparation of nitrogen-substituted thiosulfinyl compounds ($R_2N)_2S=S$. When the substituted 1,2-ethylenediamine (**1**) containing electron-withdrawing groups on the nitrogen atoms was treated with *n*-BuLi in Et_2O and then with S_2Cl_2 , compound **2**, a new heterocyclic system, was obtained in 57% yield. The reaction in THF gave sulfoxide **3** in 27% yield.¹⁴

(H) The reaction of aldehyde hydrazones or phenyldiazomethane with S_2Cl_2 in the presence of DBU (1,8-diazabicyclo[5.4.0]undec-7-ene) or Et_3N gave 1,3,4-thiadiazoles in good to moderate yields. The azines **4a** and **4b** were obtained as side products.¹⁵

References

- (1) Tan, R. X.; Jensen, P. R.; Williams, P. G.; Fenical, W. *J. Nat. Prod.* **2004**, *67*, 1374.
- (2) Korn, T. J.; Knochel, P. *Synlett* **2005**, 1185.
- (3) Zysman-Colman, E.; Harpp, D. N. *J. Org. Chem.* **2003**, *68*, 2487.
- (4) Sugihara, Y.; Noda, K.; Nakayama, J. *Tetrahedron Lett.* **2000**, *41*, 8913.
- (5) Sato, R.; Ohta, H.; Yamamoto, T.; Nakajo, S.; Ogawa, S.; Alam, A. *Tetrahedron Lett.* **2007**, *48*, 4991.
- (6) Aebischer, D.; Brzostowska, E. M.; Mahendran, A.; Greer, A. *J. Org. Chem.* **2007**, *72*, 2951.
- (7) Braverman, S.; Pechenick, T.; Gottlieb, H. E. *Tetrahedron Lett.* **2003**, *44*, 777.
- (8) Koutentis, P. A.; Rees, C. W. *J. Chem. Soc., Perkin Trans. I* **2002**, 315.
- (9) Dodd, R. E.; Robinson, P. L. *Experimental Inorganic Chemistry*, 2nd ed.; Elsevier Publishing Company: New York, **1957**, 218.
- (10) Amelichev, S. A.; Aysin, R. R.; Konstantinova, L. S.; Obruchnikova, N. V.; Rakitin, O. A.; Rees, C. W. *Org. Lett.* **2005**, *7*, 5725.
- (11) Zysman-Colman, E.; Nevins, N.; Eghbali, N.; Snyder, J. P.; Harpp, D. N. *J. Am. Chem. Soc.* **2006**, *128*, 291.
- (12) Macho, S.; Miguel, D.; Gómez, T.; Rodríguez, T.; Torroba, T. *J. Org. Chem.* **2005**, *70*, 9314.
- (13) Díaz, D. D.; Converso, A.; Sharpless, B.; Finn, M. G. *Molecules* **2006**, *11*, 212.
- (14) Yoshida, S.; Sugihara, Y.; Nakayama, J. *Tetrahedron Lett.* **2007**, *48*, 8116.
- (15) Okuma, K.; Nagakura, K.; Nakajima, Y.; Kubo, K.; Shioji, K. *Synthesis* **2004**, 1929.