Properties of N-S bond (Sulfenamide)

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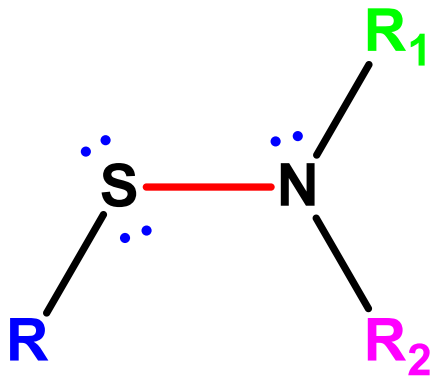
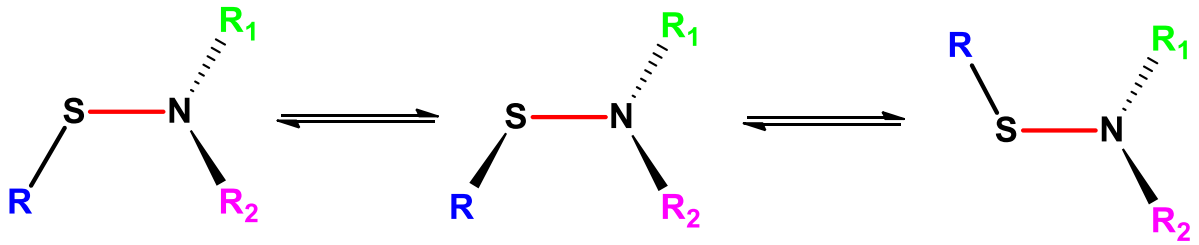
The Chemistry of Sulfenamides

- Structure
- Preparation
- Reaction
- Applications

Structure of Sulfenamide



Sulfenamides (also spelled sulphenamides) are a class of organosulfur compounds characterized by the general formula $RSNR_1R_2$, where R , R_1 and R_2 are H, alkyl, or aryl.



The S-N bond is a chiral axis. Torsional barriers can be quite large and vary from 12-20 kcal/mol.

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Preparation of Sulfenamide

(1) use of sulfur reagents RSX(X = Cl, Br, OR, NR_2, $S0_2Ar$, SCN);

(2) use of disulfides RSSR, in which the oxidation state of sulfur is lower by one unit;

(3) use of thiols RSH, in which the oxidation state of sulfur is lower by two units.

Preparation of Sulfenamide

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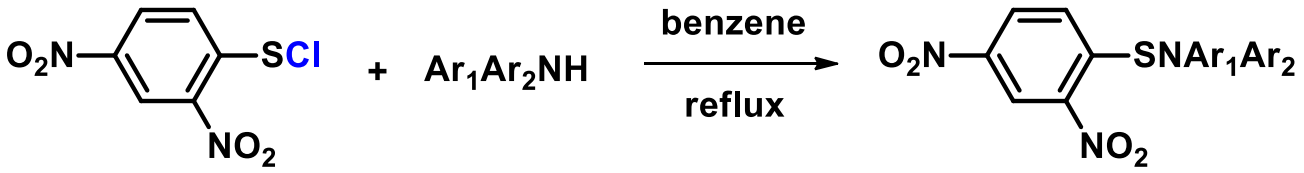
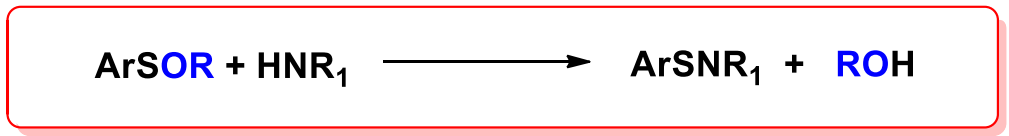
Typical example



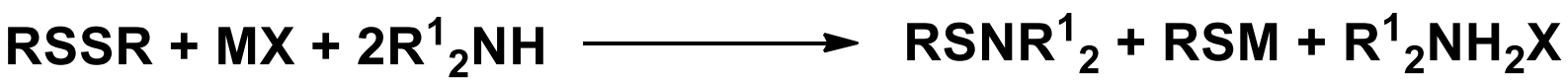


(R, R_1 = alkyl; Ar = aryl)

Tetrahedron Lett. **1984,** 25(13), 1337
*J. Org. Chem.***1985,** 50, 2205
J. Chem. Soc. *C.* **1971**, 3867

Preparation of Sulfenamide

(2) use of disulfides RSSR, in which the oxidation state of sulfur is lower by one unit;



MX = $AgNO_3$, AgOAc, $HgCl_2$

Unlike sulfenyl halides, the disulfide reaction can be used with amines containing *hydroxyl groups and C-C double bonds*.

*J. Org. Chem.***1977**, 42, 967.

Preparation of Sulfenamide

(3) use of thiols RSH, in which the oxidation state of sulfur is lower by two units.

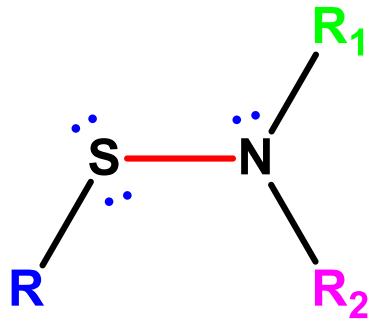
1) $ArSH + R^1R^2NH \xrightarrow[DMSO\ 60°C\ \text{in air}]{CuI\text{-}bpy\ 5mol\%} ArS\text{-}NR^1R^2$

2) $RSH + R^1N_3 \longrightarrow RSNHR^1$

Formation of disulfides is the primary competing reaction.

Eur. J. Org. Chem. **2010**, 2670
J. Org. Chem. **1970**,35,2979

Reactions of sulfenamide



- The S-N bond in sulfenamide are labile in a variety of ways. The sulfur atom tends to be the more *electrophilic center* of the S-N bond.
- Sulfenamides are subject to attack by nucleophiles at sulfur and electrophiles at nitrogen.

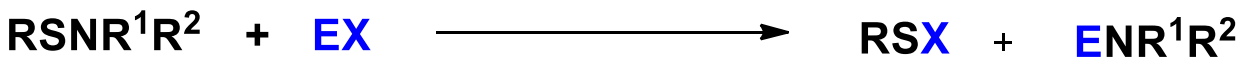
A. Reactions with Electrophiles

B. Reactions with Nucleophiles

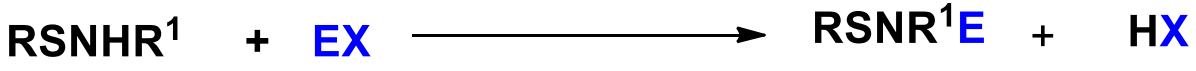
C. Thermal and Photochemical Reactions

D. Oxidation and Reduction Reactions

Reactions of sulfenamide with Electrophiles



EX=HCl, Benzoyl chloride, Sulfuryl chloride

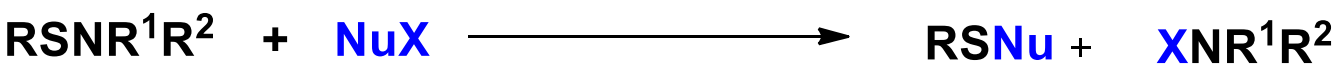


EX=Acid Anhydride,Acyl isocyanates

The reaction of sulfenamides with electrophiles involves the *coordination of the electrophile with nitrogen* and *subsequent nucleophilic attack on sulfur.*

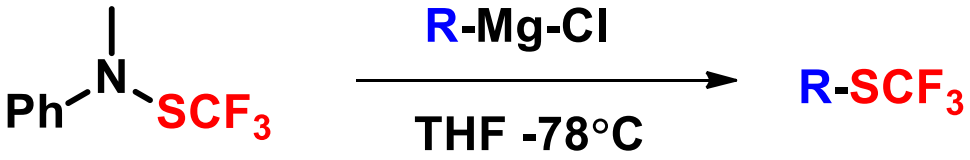
J. *Org. Chem.* **1970,** 35, 3012**.**
Synthesis **1982**, 949.
Gen.Chem. USSR (Engl. Transl.) **1979**, 49(6), 1250

Reactions of sulfenamide with Nucleophiles



Nu=amines, thiols, alkyl-magnesium halides

Typical example



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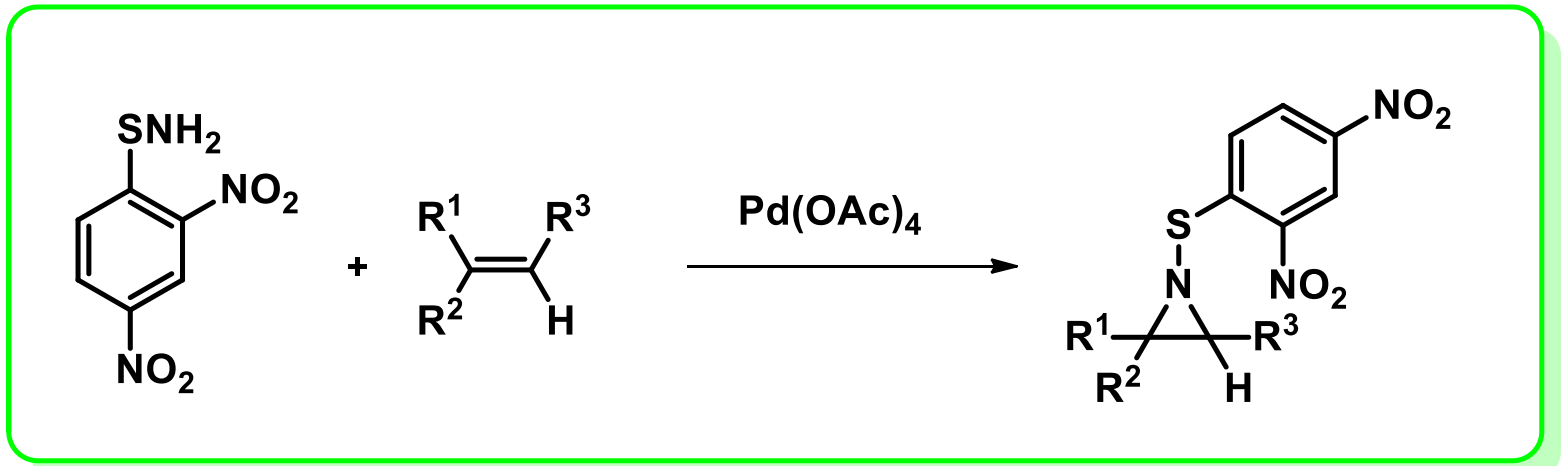
Angew. Chem. Int. Ed. **2012**, 51, 10382

Thermal Reactions of sulfenamide

(a) Homolytic cleavage of the S-N bond to give amino and sulfenyl radicals

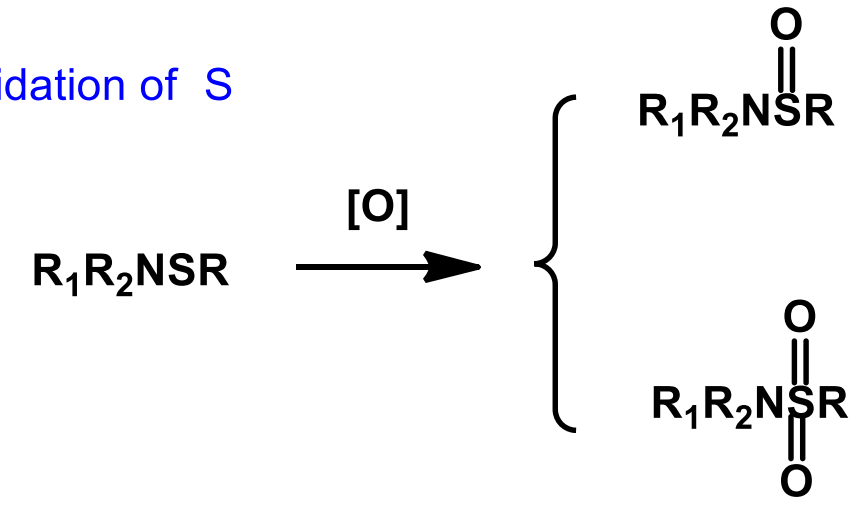
(b) Rearrangement to produce *o*- and *p*-aminodiphenyl sulfides



Chem. Rev. **1989**, Vol. 89, No.4 690
J. Chem. Soc.Perkin Trans. 1981, 2615.

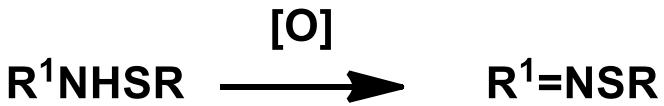
Oxidation and Reductions of sulfenamide

Oxidation of S



Oxidation of sulfenamides can occur at nitrogen or at sulfur.

Oxidation of N



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Applications of Sulfenamide

1) Sulfenamides in the Rubber Industry

2) Sulfenamides in Agriculture

3) Medicinal Applications of Sulfenamides

4) Miscellaneous Applications

5) Sulfenamides as Protecting Groups in Synthesis

Thank you