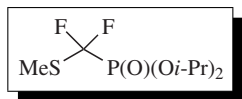


## Diisopropyl Methylsulfanyldifluoromethylphosphonate



[327156-97-8] C<sub>8</sub>H<sub>17</sub>F<sub>2</sub>O<sub>3</sub>PS (MW 262.25)  
 InChI = 1/C8H17F2O3PS/c1-6(2)12-14(11,13-7(3)4)8(9,10)  
 15-5/h6-7H,1-5H3  
 InChIKey = CXJGLDDSOYUAPU-UHFFFAOYAL

(source of phosphonodifluoromethylcarbanion and phosphonodifluoromethyl radical)

*Alternate Names:* phosphonic acid, [difluoro(methylthio)methyl]-, bis(1-methylethyl) ester.

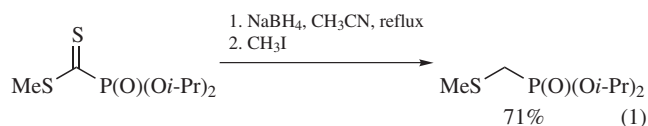
*Physical Data:* bp 66–72 °C at 0.8 mmHg, colorless oil.

*Solubility:* sol in most organic solvents.

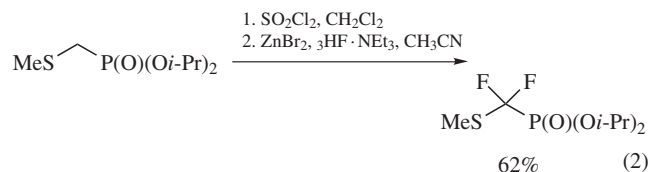
*Form Supplied in:* not commercially available.

*Preparative Methods:* the reagent is prepared in two steps from diisopropyl methylsulfanylmethylphosphonate.

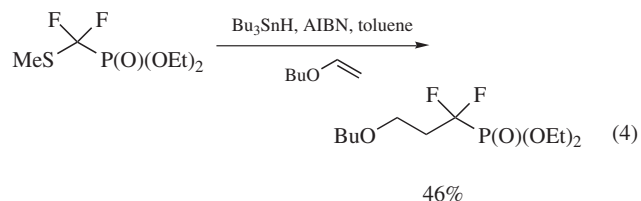
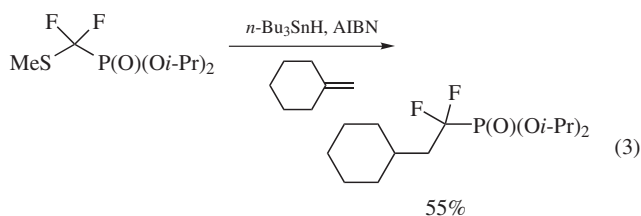
**Preparation.** Sodium diisopropylphosphonate generates *S*-methyl diisopropoxyphosphinyldithioformate when treated with carbon disulfide and methyl iodide.<sup>1</sup> The reduction of this compound with *Sodium Borohydride* followed by trapping of the thiolate with methyl iodide leads to diisopropyl methylsulfanylmethylphosphonate (eq 1).<sup>2</sup>



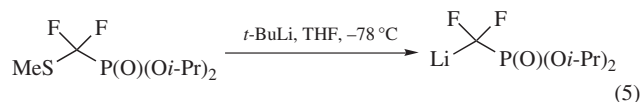
The phosphonate is then converted into diisopropyl methylsulfanyldichloromethylphosphonate upon treatment with *Sulfuryl Chloride*<sup>3</sup> or *N-Chlorosuccinimide*<sup>4</sup> and the latter is treated with hydrogen fluoride/triethylamine/zinc bromide to afford diisopropyl methylsulfanyldifluoromethylphosphonate (eq 2).



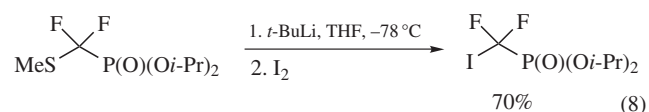
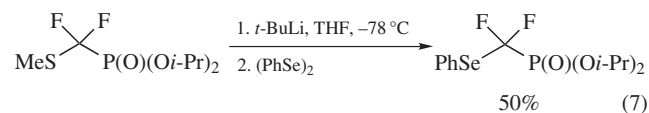
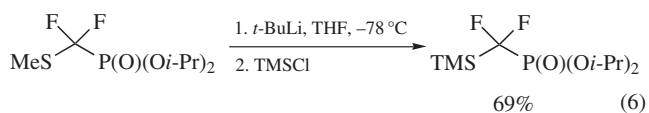
**Radical Addition to Alkenes.** Diisopropyl methylsulfanyldifluoromethylphosphonate is a precursor of phosphonodifluoromethyl radicals. The radical addition product is generated when diisopropyl methylsulfanyldifluoromethylphosphonate is treated with *Tributyltin Hydride* in the presence of *AIBN* (eq 3).<sup>5</sup> A similar reaction is also observed with the analogous diethyl methylsulfanyldifluoromethylphosphonate (eq 4).



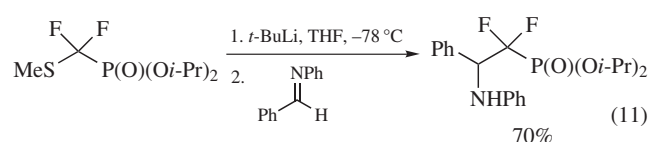
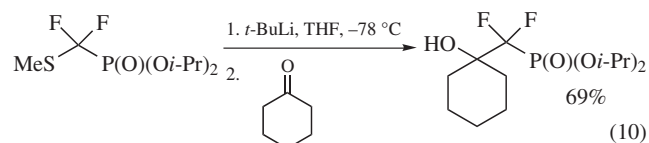
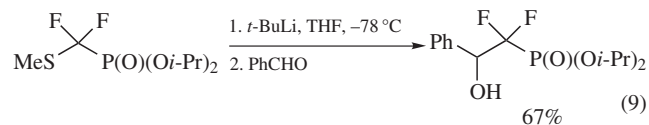
**1,2-Additions.** Diisopropyl methylsulfanyldifluoromethylphosphonate is a precursor of phosphonodifluoromethyl carbanion. Treatment of the phosphonate with *tert-BuLi* in THF at –78 °C leads to the formation of lithium diisopropyl difluoromethylphosphonate (eq 5).<sup>6</sup>

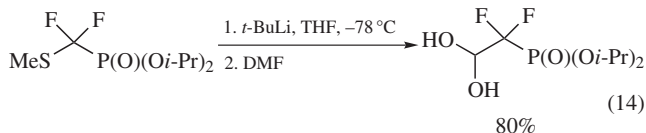
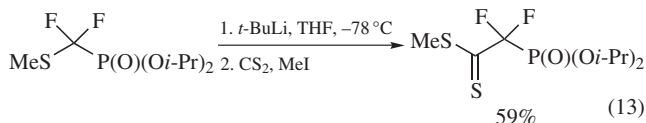
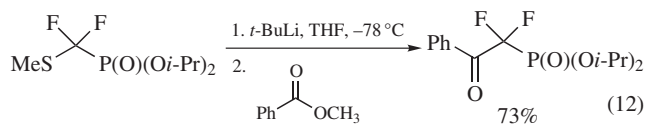


This anion can be trapped with a wide range of electrophiles such as trimethylsilyl chloride (eq 6), diphenyl disulfide or diselenide (eq 7), and iodine (eq 8).

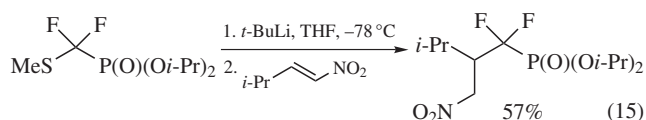


Moreover, this anion undergoes efficient 1,2-addition reactions with aldehydes (eq 9), ketones (eq 10), imines (eq 11), esters (eq 12), carbon disulfide (eq 13), and DMF (eq 14).

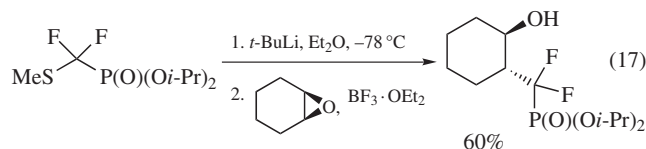
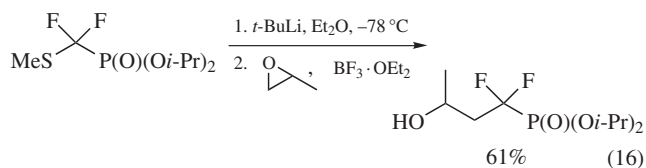




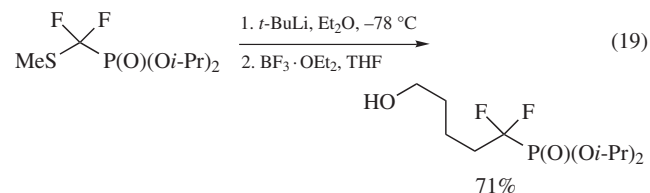
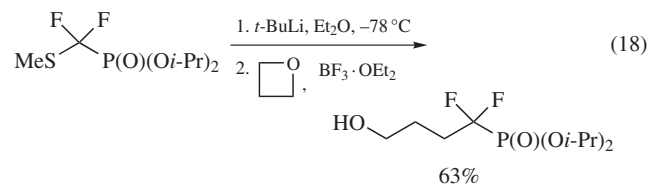
**Conjugate Additions.** Lithium phosphonodifluoromethyl anion undergoes conjugate addition reactions with  $\alpha,\beta$ -unsaturated nitro derivatives (eq 15).<sup>6</sup>



**Opening of Cyclic Ethers.** This anion is sufficiently nucleophilic to open epoxides in the presence of **Boron Trifluoride Etherate** (eqs 16–17).<sup>7</sup>



Furthermore, the opening reactions of oxetane and tetrahydrofuran proceed nicely under these reaction conditions to give primarily the corresponding alcohols (eqs 18 and 19).



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