行政院國家科學委員會補助專題研究計畫成果報告

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自由基在有機合成上的運用

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計畫類別：v **個別型計畫**　　□**整合型計畫**
計畫編號：NSC89－2113－M－002－013
執行期間：88 **年** 8 **月** 1 **日至** 89 **年** 7 **月** 31 **日**

計畫主持人：蔡蘊明
共同主持人：

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- □**赴國外出差或研習心得報告一份**
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- □**國際合作研究計畫國外研究報告書一份**

執行單位：國立台灣大學化學系

中　華　民　國八十九年十月十三日

行政院國家科學委員會專題研究計畫成果報告

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NSC Project Reports

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一、中文摘要

矽基酮與 NPTS 在酸的催化下可於其α位植入一苯硫基

關鍵詞：矽基酮、α苯硫基

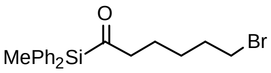
Abstract

The reactions of acylsilanes with *N*-(phenylthio)succinimide in the presence of *p*-toluenesulfonic acid in acetonitrile give α-sulfenylated acylsilanes in good yields. Aldehydes with α-alkyl substituent afford moderate yields of α-sulfenylated products under the same conditions.

Keywords: imides; silicon and compounds; sulfides.

二、緣由與目的

α-Sulfenylated carbonyl compounds are useful intermediates in organic synthesis.[1] Preparation of these compounds often involves S_N2 displacement of α-halogenated carbonyl compounds.[1a] Direct sulfenylation methods are also available;[1a,c] however, these methods usually require basic conditions. Recently, we needed to prepare α-sulfenylated acylsilane **2** from bromoacylsilane **1**.[2,3] Due to the presence of a bromo functional group, we tried to avoid using basic conditions.[4] We found that *N*-(phenylthio)succinimide (**3**)[5] could be used to convert acylsilanes to α-sulfenylated acylsilanes under acidic conditions.[6,7]



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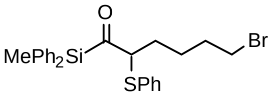

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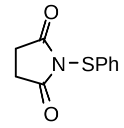

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三、研究報告應含的內容

Our results were shown in Table 1. The reaction of acylsilane **1** (entry 1) with one equivalent of imide **3** and 0.1 equivalent of *p*-toluenesulfonic acid in dichloromethane at room temperature overnight gave sulfide **2** in excellent yield (92%). Surprisingly, under the same reaction condition (entry 2), acylsilane **4**[2] afforded 10% of sulfide **5**. The difference between acylsilanes **4** and **1** is a single methylene unit. We found that this type of reaction is faster in a more polar solvent such as acetonitrile. When acylsilane **4** was treated with imide **3** (1 equiv) in the presence of catalytic amount of *p*-toluenesulfonic acid (0.1 equiv) in acetonitrile for 8 h (entry 3), we obtained an 80% yield of sulfide **5**. The reaction condition used in entry 3 turned out to be quite useful for analogous acylsilanes **6** and **8** (entries 4 and 5). However, for shorter acylsilanes such as **10** (entry 6), no reaction occurred by using 0.1 equivalent of *p*-

toluenesulfonic acid. In the presence of one equivalent of *p*-toluenesulfonic acid, propanoylsilane **10** reacted with imide **3** in acetonitrile for 5 h to afford 90% yield of sulfide **11**.

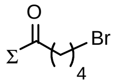
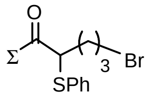
Ethanoylsilane **12** (entry 8) was the least reactive one that we have studied. Under the condition described above for the preparation of sulfide **11** (entry 7), we observed no reaction for ethanoylsilane **12**. Reaction occurred when we used borontrifluoride etherate; however, bis-sulfenylation became competitive. As shown in entry 8, the reaction of ethanoylsilane **12** with imide **3** in the presence of borontrifluoride etherate (0.5 equiv) in acetonitrile for 6 h proceeded in about 60% conversion. The monosulfide **13** and bis-sulfide **14** were present in a 3/2 ratio, respectively.

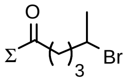
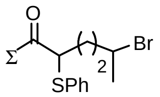
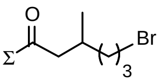
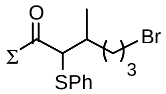
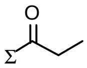
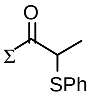
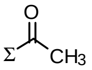
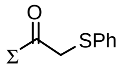
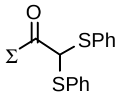
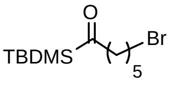
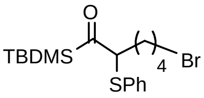
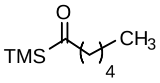
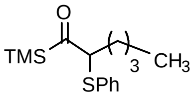
The α-sulfenylation reactions are not limited to acylmethyldiphenylsilanes. As shown in entry 9 (Table 1), bromoacylsilane **15**[2] with a bulky *t*-butyldimethylsilyl group (TBDMS) underwent α-sulfenylation with imide **3** (2.2 equiv) in the presence of *p*-toluenesulfonic acid (0.1 equiv) in acetonitrile (6 h) to give sulfide **16** in 83% yield. Under similar reaction condition, acyltrimethylsilane **17**[8] (entry 10) afforded sulfide **18**[4a] in good yield (86%).

When we applied this method to aldehydes and ketones, only α-substituted aldehydes were sulfenylated in mild yields. As shown in Table 2, a dismal 19% yield of sulfide **20**[9] (entry 1) was obtained by the reaction of straight chain hexanal (**19**) with imide **3** in the presence of borontrifluoride etherate (1 equiv) at room temperature in acetonitrile for 21 h. With the presence of an α-methyl substituent, aldehyde **21** (entry 2) led to 68% of sulfide **22** in 3 h under similar condition. All the ketones that we have studied reacted poorly as shown in entries 3 and 4. Sulfenylation occurred preferentially at the more substituted side of the unsymmetric ketones with low yields.

The reactivity pattern observed in these sulfenylation reactions correlates well with the enol-content of the carbonyl compounds.[10] It was reported recently that the enol-content of acylsilanes is higher than aldehydes and ketones.[11] In this study, the acylsilanes show the highest reactivity towards imide **3** under acidic conditions. Among the acylsilanes, ethanoylsilane **12** is the least reactive. Presumably, acylsilane **12** is the least enolizable acylsilane that we have studied. Ketones are known to have lower enol content than aldehyde.[10] Here, we found that the ketones are poor substrates in this reaction.

Table 1 α-Sulfenylation of acylsilanes with *N*-phenylthiosuccinimide (**3**)[a]

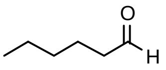
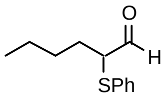
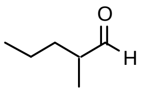
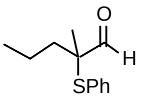
entry	substrate $\Sigma = SiPh_2Me$	imide **3** (equiv)	acid (equiv)	solvent	time (h)	product (% yield) $\Sigma = SiPh_2Me$
1	**1**	1	TsOH (0.1)	CH_2Cl_2	15	**2** (92)
2	 **4**	1	TsOH (0.1)	CH_2Cl_2	15	 **5** (10)
3	**4**	1	TsOH (0.1)	CH_3CN	8	**5** (80)

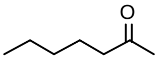
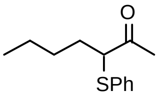
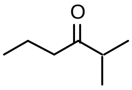
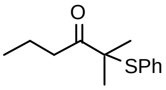
4	 **6**	1	TsOH (0.1)	CH_3CN	6	 **7** (92)
5	 **8**	1	TsOH (0.1)	CH_3CN	6	 **9** (88)
6	 **10**	2.2	TsOH (0.1)	CH_3CN	6	no reaction
7	**10**	1	TsOH (1)	CH_3CN	5	 **11** (90)
8	 **12**	1	BF_3•OEt_2 (0.5)	CH_3CN	6	 **13**  **14** **13** : **14** : **12** = 1 : 0.6 : 1[b]
9	 **15**	2.2	TsOH (0.1)	CH_3CN	6	 **16** (83)
10	 **17**	1.2	TsOH (0.1)	CH_3CN	6	 **18** (86)

[a] All reactions were performed at room temperature.

[b] Products were not isolated, and the ratio was determined by ^{1}H NMR analysis.

Table 2 α-Sulfenylation of aldehydes and ketones with *N*-phenylthiosuccinimide (**3**)[a]

entry	substrate	imide **3** (equiv)	acid (equiv)	time (h)	product (%yield)
1	 **19**	1.0	BF_3•OEt_2 (1.0)	21	 **20** (19)
2	 **21**	1.0	BF_3•OEt_2 (1.0)	3	 **22** (68)

3	 **23**	2.0	TsOH (1.0)	7	 **24** (24)
4	 **25**	1.0	BF_3•OEt_2 (1.0)	14	 **26** (22)

[a]These reactions were performed in acetonitrile at room temperature.

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