Electrolytic Partial Fluorination of Organic Compounds. 42.[1] Marked Solvent Effects on Regioselective Anodic Monofluorination of 4-Oxo-2-pyrimidyl Sulfides

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Regioselective anodic monofluorination of 4-oxo-2-pyrimidyl sulfides was investigated under various electrolytic conditions. Anodic fluorination was successfully carried out using $Et_4NF{\cdot}4HF$ in dimethoxyethane (DME) to provide the corresponding α-fluorinated products in good yields. In contrast, acetonitrile (MeCN) was not suitable for the anodic fluorination due to the severe anode passivation during the electrolysis. A mixed solvent of DME and MeCN was found to be also effective for the fluorination, and the product yield increased with an increase of the ratio of DME to MeCN. The superiority of DME can be explained mainly in terms of the suppression of the anode passivation and enhancement of the nucleophilicity of the fluoride ions. Such marked solvent effects on the anodic fluorination were discussed in detail.

Introduction

Recently, selective anodic fluorination of organic compounds has been studied extensively by several groups,[2,3] and it was shown that anodic fluorination is a highly efficient new tool for synthesizing various fluoroorganic compounds since the fluorination reaction can be conducted under mild conditions using relatively simple equipment. However, limited examples of selective anodic fluorination of heterocycles have been reported, but in many cases both the yield and the selectivity are rather low except for our studies.[4]

On the other hand, the chemistry of fluorinated pyrimidines has been receiving much attention in recent years[5] since fluorinated pyrimidines have a potentiality of anticancer activity exemplified by 5-fluorouracil derivatives, which are clinically used.[6] In addition, sulfur-containing analogues such as 2-thiouracil also play a vital role in many biological processes and are used as intermediates for drug synthesis.[7] Our continuous interest in selective anodic fluorination of organic compounds[8] together with the significance of these compounds have prompted us to develop new and better synthesis of heterocyclic compounds having fluorine atom(s) in side-chain or bonded to the heterocyclic ring.

In this work, anodic fluorination of 5-methyl- and 6-methyl-4-oxo-2-pyrimidyl-sulfides **1** and **2** was attempted under various electrolytic conditions. It was found that a highly regioselective monofluorination of **1** and **2** could be achieved using $Et_4NF{\cdot}4HF$ as a supporting electrolyte and fluoride ion source in dimethoxyethane (DME). Using these conditions the corresponding α-fluorinated products were obtained in good yields. We also studied solvent effects on the anodic fluorination using dimethoxyethane (DME) and acetonitrile (MeCN).

Results and Discussion

Oxidation Potentials of 4-Oxo-2-pyrimidyl Sulfides. At first, oxidation potentials of 4-oxo-2-pyrimidyl sulfides having the overall structure of **1** and **2** were measured by cyclic voltammetry. An anhydrous acetoni-

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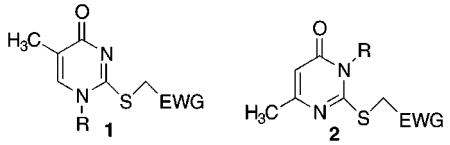
Table 1. Oxidation Potentials (Peak Potentials, E_p^{ox}) of 4-Oxo-2-pyrimidyl Sulfides[a]



substrate			E_p^{ox}
no.	R	EWG	(V vs SSCE[b])
1a	H	COOEt	1.90
1b	H	$COCH_3$	2.08
1c	H	H	1.90
1d	COPh	COOEt	2.09
1e	COPh	$COCH_3$	2.00
1f	COPh	H	1.82
1g	CH_3	$COCH_3$	1.95
2a	H	COOEt	2.10
2b	H	$COCH_3$	2.05
2c	H	H	1.91
2d	COPh	COOEt	2.30
2e	COPh	$COCH_3$	2.01
2f	COPh	H	1.80
2g	CH_3	$COCH_3$	2.02
2h	CH_3	H	1.94

[a] Substrate (1 mmol) in 0.1 M $Bu_4N{\cdot}BF_4$/MeCN. Sweep rate: 100 mV/s. [b] The potential of SSCE is almost same as that of SCE.

Table 2. Anodic Monofluorination of Ethyl α-[(1-Benzoyl-5-methyl-4-oxo-2-pyrimidyl)thio]acetate (1d) under Various Electrolytic Conditions

run	supporting electrolyte	solvent	charge passed (F/mol)	yield[a] (%) of **3d**
1	$Et_4NF{\cdot}4HF$	MeCN	4	5[b]
2	$Et_4NF{\cdot}4HF$	DME	9	73 (58)[c]
3	$Et_4NF{\cdot}3HF$	MeCN	4	4[b]
4	$Et_3N{\cdot}3HF$	MeCN	10	0[b]
5	$Et_4NF{\cdot}3HF$	DME	11	55
6	$Et_3N{\cdot}5HF$	MeCN	12	2[b]
7	$Et_3N{\cdot}5HF$	DME	11	42

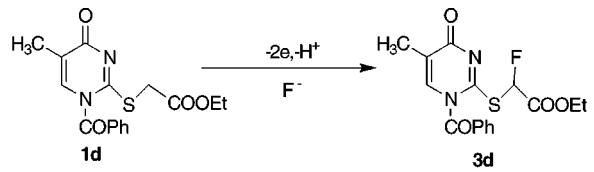
[a] Calculated on the basis of ^{19}F NMR. [b] A large amount of **1d** was recovered. [c] Isolated yield.

trile solution containing $Bu_4NF{\cdot}BF_4$ (0.1 M), platinum electrodes, and a saturated NaCl calomel electrode (SSCE) as a reference electrode are used in this study. All these compounds showed irreversible waves in cyclic voltamograms. Their first peak oxidation potentials were listed in Table 1. Interestingly, the oxidation potentials of 6-methyl derivatives **2** were higher than those of their corresponding 5-methyl derivatives **1** except for **2b** and **2f**. However, the reason is not clear.

Anodic Fluorination of 4-Oxo-2-pyrimidyl Sulfides. Anodic fluorination of ethyl α-[(1-benzoyl-5-methyl-4-oxo-2-pyrimidyl)thio]acetate (**1d**) as a model compound was carried out at a constant current in MeCN or DME containing various supporting fluoride salts, using an undivided cell equipped with platinum plate electrodes. The results are summarized in Table 2.

As shown in Table 2, the anodic fluorination greatly depended on both the electrolytic solvent and supporting fluoride salts. Although MeCN has been commonly used as the anodic fluorination solvent so far, MeCN was not suitable at all mainly due to severe anode passivation caused by polymer film formation on the anode surface (runs 1, 3, 4, and 6). In this case, a large amount of the starting **1d** was recovered. In contrast, the use of a DME as a solvent generally provided good to moderate yield of α-fluorinated product **3d**. However, a large amount of electricity was required since DME is easily oxidized and

Scheme 1



Scheme 2

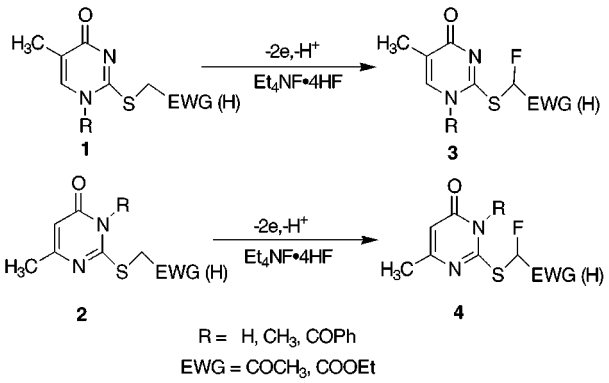


Table 3. Anodic Monofluorination of 4-Oxopyrimidyl Sulfides 1 and 2 in $Et_4NF{\cdot}4HF$/DME

run	substrate no.	charge passed (F/mol)		yield[a] (%)
1	**1a**	13	**3a**	4[b,c]
2	**1b**	16	**3b**	0[b]
3	**1c**	15	**3c**	0[b]
4	**1d**	9	**3d**	75 (58)
5	**1e**	5.5	**3e**	70 (60)
6	**1f**	7.5	**3f**	77 (68)
7	**1g**	14	**3g**	0[b]
8	**2a**	17	**4a**	4[b,d]
9	**2b**	13	**4b**	2[b,e]
10	**2c**	16	**4c**	0[b]
11	**2d**	10	**4d**	75 (62)
12	**2e**	5	**4e**	74 (67)
13	**2f**	6.5	**4f**	78 (70)
14	**2g**	16	**4g**	0[b]
15	**2h**	17	**4h**	0[b]

[a] Calculated on the basis of ^{19}F NMR, and the values in the parentheses show the isolated yield. [b] Most of the starting material was recovered. [c] **3a**: ^{19}F NMR −87.66 (d, J = 51.16 Hz); MS m/z 246 (M^+). [d] **4a**: ^{19}F NMR −87.66 (d, J = 51.09 Hz); MS m/z 246 (M^+). [e] **4b**: ^{19}F NMR −88.23 (d, J = 48.98 Hz); MS m/z 216 (M^+).

1d has a high oxidation potential (+2.09 V vs SSCE). Among the fluoride salts used, $Et_4NF{\cdot}4HF$ was the most effective (run 2). The use of $Et_4NF{\cdot}3HF$ and $Et_3N{\cdot}5HF$ resulted in the formation of **3d** in moderate yield (runs 5 and 7). On the other hand, $Et_3N{\cdot}3HF$ in CH_3CN was not suitable for fluorination (run 4). Following optimization, the best fluorination conditions were extended to other 4-oxo-2-pyrimidyl sulfide derivatives (Scheme 2). The results are summarized in Table 3.

The fluorination was also greatly affected by both an electron-withdrawing groups (EWG) at the position α to the sulfur atom and a *N*-substituent group of **1** and **2**.

N-Benzoyl derivatives of **1d**,**e**,**f** and **2d**,**e**,**f** underwent anodic monofluorination regardless of the presence of an EWG α to the sulfur. In these cases, a fluorine atom was selectively introduced α to the sulfur atom. Heterocyclic fluorination did not occur. In sharp contrast, *N*-unsubstituted derivatives of **1a**,**b**,**c** and **2a**,**b**,**c** gave extremely low yields or no formation of the fluorinated products mainly due to the protonation of the starting material.

Table 4. Dependence of the Yield of 4f on the Ratio of DME/MeCN

ratio of DME/MeCN	yield, %
0	0
0.1	10
0.2	18
0.3	26
0.5	41
0.8	70
1	78

N-Methyl derivatives, **1g** and **2g**,**h** did not provide any fluorinated products. Instead, almost all of the starting materials were recovered although a large excess amount of electricity was passed. Since *N*-methyl derivative **1g** and **2g**,**h** are basic, **1g** and **2g**,**h** should be protonated by the strongly acidic solution. The resulting salt was not oxidized at the anode but rather reduced at the cathode (namely proton reduction) to generate the starting material. The starting material would be immediately protonated again and the cycle continued. Such a scenario would explain the large consumption of electricity in a reaction where no apparent electrolysis occurred. In fact, it was confirmed that **1g** and **2g**,**h** formed the corresponding salts with strong acids such as picric acid.

Solvent Effects on Anodic Fluorination. Anodic partial fluorination of organic substrates has been usually accomplished in MeCN solution containing fluoride ions. However, such electrolytic solutions very often cause severe anode passivation (formation of nonconductive polymer film on the anode).[9] Moreover, desired fluorinated products were not always obtained in good yields due to a side acetamidation reaction.[10] In our previous studies, we found that DME was much more suitable than MeCN for the anodic fluorination of various heterocyclic sulfides.[11,12] As shown in the present study, the yields of the fluorination products in MeCN were negligible in contrast to those in DME.

To clarify the real role of DME in the anodic fluorination process, we examined the anodic fluorination of 1-benzoyl-5-methyl-2-methylthio-4-pyrimidinone (**1f**) as the model compound in a mixed solvent of DME and MeCN at various ratios containing $Et_4NF{\cdot}4HF$. The results are summarized in Table 4.

Although the desired monofluorinated product **3f** was not formed in MeCN, the yield of **3f** increased markedly when DME was added into the MeCN containing $Et_4NF{\cdot}4HF$. As shown in Figure 1, with an increase in the ratio of DME to MeCN, the yield increased continuously, and 78% yield of **3f** was obtained when DME was used solely.

Such a marked solvent effect of DME can be explained as follows. Although MeCN electrolytic solution containing fluoride salts cause anodic passivation, this anode passivation was efficiently suppressed by the addition of DME to MeCN.

Furthermore, the fluoride ion nucleophilicity seems to be enhanced by DME since DME may strongly solvate the cations of the fluoride salts to make the anions more reactive.[13] DME has a much higher donor number (23.9) than MeCN (14.1). Furthermore, the enhancement of the nucleophilicity of fluoride ions was confirmed by ^{19}F NMR spectroscopy of the fluoride salt, $Et_4NF{\cdot}4HF$, by the measurements carried out in DME, MeCN, and their mixture. As shown in Figure 2, the signal due to $Et_4NF{\cdot}4HF$ shifted almost linearly to a higher magnetic field with an increase in the ratio of DME to MeCN. It was found that the signal due to $Et_4NF{\cdot}4HF$ in DME appeared at about a 1 ppm higher magnetic field than that in MeCN. This suggests that the fluoride ions of $Et_4NF{\cdot}4HF$ in DME would be more negative (i.e., more nucleophilic) than those in MeCN. Consequently, a reactive fluoride ion released by DME easily attacks the anodically generated cationic intermediate as shown in Scheme 3. As shown in Figure 2, the fluoride ion nucleophilicity should be enhanced almost linearly with an increase in the ratio of DME to MeCN, which was consistent with our results as shown in Figure 1.

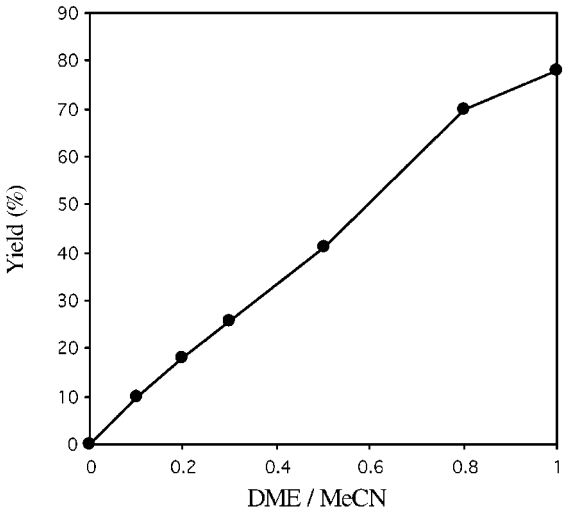


Figure 1. Dependence of the yield of **4f** on the ratio of DME/MeCN.

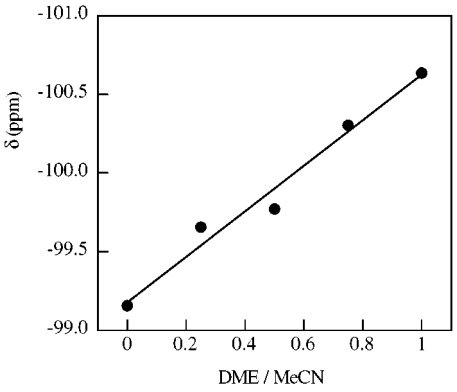


Figure 2. Dependence of the chemical shift of fluoride ions on the ratio of DME to MeCN.

It was found that fluorination of DME itself took place simultaneously during the anodic fluorination of sulfides when DME was used as a solvent.[11] That seems to be one of the reasons for a large excess amount of electricity required.

In summary, we have successfully carried out highly regioselective anodic monofluorination of 4-oxo-2-pyrim-

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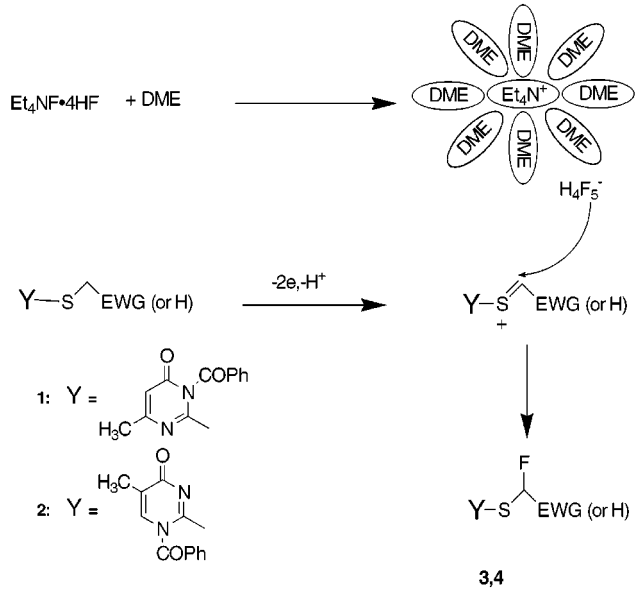
Scheme 3



idyl sulfides in DME containing $Et_4NF·4HF$. In addition, we have also disclosed the role of DME in the anodic fluorination of the heterocyclic sulfides. These new findings should be highly useful for further study on selective anodic fluorination of various organic substances.

Experimental Section

Caution! $Et_4NF·4HF$ and $Et_3N·5HF$ were obtained from Morita Chemical Co. Ltd. (Japan). They are toxic and may cause serious burns if they come in contact with unprotected skin. $Et_4NF·3HF$ and $Et_3N·3HF$ are much less aggressive. However, proper safety precautions should be taken at all times.[14] It is therefore recommended to provide hand protection.

Synthesis of *N*-Benzoyl Derivatives of 4-Oxo-2-pyrimidyl Sulfides. General Procedure. To a stirred mixture of 4-oxo-2-pyrimidyl sulfides[15] **1** or **2** (20 mmol) and benzoyl chloride (24 mmol) in dry benzene (50 mL) was added dropwise dry pyridine (24 mmol) with a syringe. The mixture was stirred at 80 °C for 2 h and then cooled to room temperature. The solvent was evaporated under reduced pressure, and the residue was purified by silica gel column chromatography using benzene as an eluent to give the corresponding *N*-benzoyl derivative.

Ethyl α-[(1-benzoyl-5-methyl-4-oxo-2-pyrimidyl)thio]-acetate (1d): 53% yield; mp 49 °C, ^{1}H NMR: δ 1.16 (t, 3 H, J = 7.25 Hz), 2.05 (s, 3 H), 3.83 (s, 2 H), 4.11 (q, 2 H, J = 7.25 Hz), 7.45 (t, 2 H, J = 7.59 Hz), 7.60 (t, 1 H, J = 7.25 Hz), 8.1 (d, 2 H, J = 7.25 Hz), 8.36 (s, 1 H). HRMS *m/z* Calcd for $C_{16}H_{16}N_2O_4S$ 332.0831, found 332.0787. Anal. Calcd for $C_{16}H_{16}N_2O_4S$: C, 57.82; H, 4.85; N, 8.43; S, 9.65. Found: C, 57.60; H, 4.75; N, 8.13; S, 9.55.

1-[(1-Benzoyl-5-methyl-4-oxo-2-pyrimidyl)thio]-2-propanone (1e): 61% yield; yellow oil, ^{1}H NMR: δ 2.33 (s, 3 H), 2.50 (s, 3 H), 3.95 (s, 2 H), 7.53 (t, 2 H, J = 7.25 Hz), 7.67 (t, 1 H, J = 7.59 Hz), 8.15 (d, 2 H, J = 7.25 Hz), 8.43 (s, 1 H). HRMS *m/z* Calcd for $C_{15}H_{14}N_2O_3S$ 302.0725, found 302.0701. Anal. Calcd for $C_{15}H_{14}N_2O_3S$: C, 59.59; H, 4.67; N, 9.27; S, 10.60. Found: C, 59.79; H, 4.65; N, 9.07; S, 10.53.

1-Benzoyl-5-methyl-2-methylthio-4-pyrimidinone (1f): 60% yield; mp 59 °C;, ^{1}H NMR: δ 2.15 (s, 3 H), 2.54 (s, 3 H),, 7.52 (t, 2 H, J = 7.25 Hz), 7.6 (t, 1 H, J = 7.59 Hz), 8.17 (d, 2 H, J = 7.25 Hz), 8.44 (s, 1 H). HRMS *m/z* Calcd for $C_{13}H_{12}N_2O_2S$ 260.0619, found 260.0618. Anal. Calcd for: $C_{13}H_{12}N_2O_2S$: C, 59.98; H, 4.65; N, 10.76; S, 12.32. Found: C, 59.86; H, 4.65; N, 10.76; S, 12.22.

Ethyl α-[(3-benzoyl-6-methyl-4-oxo-2-pyrimidyl)thio]-acetate (2d): 60% yield; mp 43 °C; ^{1}H NMR: δ 1.17 (t, 3 H, J = 7.25 Hz), 2.43 (s, 3 H), 3.86 (s, 2 H), 4.17 (q, 2 H, J = 7.25 Hz), 6.76 (s, 1 H), 7.45 (t, 2 H, J = 7.25 Hz), 7.60 (t, 1 H, J = 7.59 Hz), 8.1 (d, 2 H, J = 7.25 Hz); HRMS *m/z* Calcd for $C_{16}H_{16}N_2O_4S$ 332.0831, found 332.0808. Anal. Calcd for $C_{16}H_{16}N_2O_4S$: C, 57.82; H, 4.85; N, 8.43; S, 9.65. Found: C, 57.62; H, 4.73; N, 8.33; S, 9.53.

1-[(3-Benzoyl-6-methyl-4-oxo-2-pyrimidyl)thio]-2-propanone (2e): 70% yield; yellow oil; ^{1}H NMR: δ 2.33 (s, 3 H), 2.48 (s, 3 H), 3.95 (s, 2 H), 6.83 (s, 1 H), 7.51 (t, 2 H, J = 7.25 Hz), 7.66 (t, 1 H, J = 7.59 Hz), 8.14 (d, 2 H, v). HRMS *m/z* Calcd for $C_{15}H_{14}N_2O_3S$ 302.0725, found 302.0700. Anal. Calcd for $C_{15}H_{14}N_2O_3S$: C, 59.59; H, 4.67; N, 9.27; S, 10.60. Found: C, 59.75; H, 4.66; N, 8.88; S, 10.55.

3-Benzoyl-6-methyl-2-methylthio-4-pyrimidinone (2f): 63% yield; mp 56 °C; ^{1}H NMR: δ 2.35 (s, 3 H), 3.31 (s, 3 H), 6.85 (s, 1 H), 7.37 (t, 2 H, J = 7.25 Hz), 7.5 (t, 1 H, J = 7.59 Hz), 8.19 (d, 2 H, J = 7.25 Hz). HRMS *m/z* Calcd for $C_{13}H_{12}N_2O_2S$ 260.0619, found 260.0621. Anal. Calcd for: $C_{13}H_{12}N_2O_2S$: C, 59.98; H, 4.65; N, 10.76; S, 12.32. Found: C, 59.87; H, 4.59; N, 10.77; S, 12.20.

Anodic Fluorination of 4-Oxo-2-pyrimidyl Sulfides. A typical procedure for the anodic fluorination of 2-sulfenyluracil derivatives is as follows. Anodic oxidation of **1** (1 mmol) was carried out with platinum-plate electrodes (2 × 2 cm^2) in 0.3 M $Et_4NF·4HF$ and using DME and/or MeCN (15 mL) in an undivided cell under nitrogen atmosphere at room temperature. Constant current (5 mA/cm^2) was passed until the starting material **1** was almost consumed (checked by TLC or GC-MS). After electrolysis, the electrolytic solution was passed through a short column filled with silica gel using ethyl acetate as an eluent to remove fluoride salts. The eluent was evaporated under reduced pressure, and the residue was further purified by column chromatography on silica gel using hexane/ethyl acetate (5:1) as an eluent. The results are shown in Tables 2−4.

Ethyl α-fluoro-α-[(1-benzoyl-5-methyl-4-oxo-2-pyrimidyl)thio]acetate (3d): colorless oil;^{1}H NMR: δ 1.31 (t, 3 H, J = 7.25 Hz), 2.20 (s, 3 H), 4.30 (q, 2H, J = 7.25 Hz), 7.00 (d, 1 H, J = 50.5 Hz), 7.53 (t, 2 H, J = 7.25 Hz), 7.66 (t, 1 H, J = 7.59 Hz), 8.18 (d, 2 H, J = 7.25 Hz), 8.52 (s, 1 H). ^{19}F NMR: δ −88.55 (d, J = 50.50 Hz); MS *m/z* 350 (M^+), 304 (M^+ − EtOH), 277 (M^+ − COOEt), 258 (M^+ − F − COOEt); HRMS *m/z* Calcd for $C_{16}H_{15}FN_2O_4S$ 350.0737, found 350.0699. Anal. Calcd for $C_{16}H_{15}FN_2O_4S$: C, 54.85; H, 4.32; F, 5.42; N, 8.00; S, 9.10. Found: C, 54.80; H, 4.20; F, 5.13; N, 7.72; S, 8.80.

1-[(1-Benzoyl-5-methyl-4-oxo-2-pyrimidyl)thio]-1-fluoro-2-propanone (3e): yellow oil; ^{1}H NMR: δ 2.07 (s, 3 H), 2.42 (s, 3 H), 6.72 (d, 1 H, J = 49.5 Hz), 7.50 (t, 2 H, J = 7.25 Hz), 7.66 (t, 1 H, J = 7.59 Hz), 8.13 (d, 2 H, J = 7.25 Hz), 8.51 (s, 1 H); ^{19}F NMR: δ −89.80 (d, J = 49.50 Hz); MS *m/z* 320 (M^+), 258 (M^+ − CH_3COF); HRMS *m/z* Calcd for $C_{15}H_{13}FN_2O_3S$ 320.0631, found 320.0629. Anal. Calcd for $C_{15}H_{13}FN_2O_3S$: C, 56.24; H, 4.09; F, 5.93; N, 8.74; S, 10.01. Found: C, 56.11; H, 3.89; F, 5.89; N, 8.73; S, 9.86.

1-Benzoyl-2-(fluoromethylthio)-5-methyl-4-pyrimidinone (3f): mp 50 °C; ^{1}H NMR: δ 2.2 (s, 3 H), 6.0 (d, 1 H, J = 50.81 Hz), 7.26 (t, 2 H, J = 7.25 Hz), 7.66 (t, 1 H, J = 7.59 Hz), 8.18 (d, 2 H, J = 7.25 Hz), 8.52 (s, 1 H); ^{19}F NMR: δ −114.02 (t, J = 50.81 Hz); MS *m/z* 278 (M^+); HRMS *m/z* Calcd for $C_{13}H_{11}FN_2O_2S$ 278.0525, found 278.0524. Anal. Calcd for $C_{13}H_{11}FN_2O_2S$ C, 56.11; H, 3.98; F, 6.83; N, 10.07; S, 11.52. Found: C, 56.18; H, 3.81; F, 6.55; N, 9.97; S, 11.61.

Ethyl α-fluoro-α-[(3-benzoyl-6-methyl-4-oxo-2-pyrimidyl)thio]acetate (4d): yellow oil;^{1}H NMR: δ 1.33 (t, 3 H, J = 7.25 Hz), 2.56 (s, 3 H), 4.31 (q, 2 H, J = 7.25 Hz), 6.97 (s, 1 H), 7.1 (d, 1H, J = 50.50 Hz), 7.52 (t, 2H, J = 7.25 Hz), 7.67 (t, 1H, J = 7.59 Hz), 8.18 (d, 2H, J = 7.25 Hz); ^{19}F NMR: δ −88.40 (d, J = 50.5); MS *m/z* 350 (M^+), 304 (M^+ − EtOH), 277 (M^+ − COOEt), 258 (M^+ − F − COOEt); HRMS *m/z* Calcd for $C_{16}H_{15}FN_2O_4S$ 350.0737, found 350.0698. Anal. Calcd for

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$C_{16}H_{15}FN_2O_4S$: C, 54.85; H, 4.32; F, 5.42; N, 8.00; S, 9.10. Found: C, 54.92; H, 4.44; F, 5.11; N, 7.74; S, 8.71.

1-[(3-Benzoyl-6-methyl-4-oxo-2-pyrimidyl)thio]-1-fluoro-2-propanone (4e): mp 44 °C, ^{1}H NMR: δ 2.03 (s, 3 H), 2.20 (s, 3 H), 6.80 (d, 1 H, J = 49.50 Hz), 6.97 (s, 1 H), 7.46 (t, 2 H, J = 7.25 Hz), 7.64 (t, 1 H, J = 7.59 Hz), 8.16 (d, 2 H, J = 7.25 Hz). ^{19}F NMR: δ −89.10 (d, J = 49.50 Hz); MS m/z 320 (M^+), 258 ($M^+ - CH_3COF$); HRMS m/z Calcd for $C_{15}H_{13}FN_2O_3S$ 320.0631, found 320.0627. Anal. Calcd for $C_{15}H_{13}FN_2O_3S$: C, 56.24; H, 4.09; F, 5.93; N, 8.74; S, 10.01. Found: C, 56.20; H, 3.99; F, 5.79; N, 8.71; S, 9.93.

3-Benzoyl-2-(fluoromethylthio)-6-methyl-4-pyrimidinone (4f): mp 51 °C; ^{1}H NMR: δ 2.56 (s, 3 H), 6.1 (d, 2 H, J = 49.5 Hz), 6.93 (s, 1 H), 7.52 (t, 2 H, J = 7.25 Hz), 7.66 (t, 1 H, J = 7.59 Hz), 8.17 (d, 2 H, J = 7.25 Hz); ^{19}F NMR: δ −114.10 (t, J = 49.5 Hz); MS m/z 278 (M^+); HRMS m/z Calcd for $C_{13}H_{11}FN_2O_2S$ 278.0525, found 278.0522. Anal. Calcd for $C_{13}H_{11}FN_2O_2S$ C, 56.11; H, 3.98; F, 6.83; N, 10.07; S, 11.52. Found: C, 56.16; H, 3.83; F, 6.58; N, 9.77; S, 11.62.

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Supporting Information Available: Copies of ^{1}H NMR spectra of **2e** and **4d**. This material is available free of charge via the Internet at http://pubs.acs.org.

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