

This article was downloaded by:

On: 28 January 2011

Access details: *Access Details: Free Access*

Publisher *Taylor & Francis*

Informa Ltd Registered in England and Wales Registered Number: 1072954 Registered office: Mortimer House, 37-41 Mortimer Street, London W1T 3JH, UK



## Phosphorus, Sulfur, and Silicon and the Related Elements

Publication details, including instructions for authors and subscription information:

<http://www.informaworld.com/smpp/title~content=t713618290>

### Dabco/SOCl<sub>2</sub>, Mild, and Convenient Reagent for the Preparation of Symmetrical Carboxylic Acid Anhydrides

Foad Kazemi<sup>a</sup>; Ali Reza Kiasat<sup>a</sup>

<sup>a</sup> Shahid Chamran University, Ahvaz, Iran

Online publication date: 27 October 2010

**To cite this Article** Kazemi, Foad and Kiasat, Ali Reza(2003) 'Dabco/SOCl<sub>2</sub>, Mild, and Convenient Reagent for the Preparation of Symmetrical Carboxylic Acid Anhydrides', *Phosphorus, Sulfur, and Silicon and the Related Elements*, 178: 10, 2287 — 2291

**To link to this Article:** DOI: 10.1080/713744563

**URL:** <http://dx.doi.org/10.1080/713744563>

PLEASE SCROLL DOWN FOR ARTICLE

Full terms and conditions of use: <http://www.informaworld.com/terms-and-conditions-of-access.pdf>

This article may be used for research, teaching and private study purposes. Any substantial or systematic reproduction, re-distribution, re-selling, loan or sub-licensing, systematic supply or distribution in any form to anyone is expressly forbidden.

The publisher does not give any warranty express or implied or make any representation that the contents will be complete or accurate or up to date. The accuracy of any instructions, formulae and drug doses should be independently verified with primary sources. The publisher shall not be liable for any loss, actions, claims, proceedings, demand or costs or damages whatsoever or howsoever caused arising directly or indirectly in connection with or arising out of the use of this material.

## DABCO/SOCl<sub>2</sub>, MILD, AND CONVENIENT REAGENT FOR THE PREPARATION OF SYMMETRICAL CARBOXYLIC ACID ANHYDRIDES

*Foad Kazemi and Ali Reza Kiasat*  
*Shahid Chamran University, Ahvaz, Iran*

(Received March 25, 2003)

*Various types of carboxylic acids undergo rapid dehydration with 1,4-diazabicyclo[2.2.2]octane, dabco/thionyl chloride, under mild reaction conditions to afford symmetrical acid anhydrides in high isolated yields.*

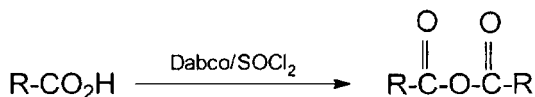
**Keywords:** Carboxylic acid; symmetrical anhydrides; thionyl chloride; dabco

Carboxylic acid anhydrides are among the most important class of reagents used in organic synthesis.<sup>1,2</sup> They are frequently the preferred reactive acid derivative for preparation of esters, amides, and peptides.<sup>2</sup> Availability of symmetrical acid anhydrides is quite important for many transacylation applications because their acylation precludes the formation of by-products due to attack at the second acyl carbonyl group of unsymmetrical anhydrides.<sup>2,3</sup>

Generally, carboxylic acid anhydrides are prepared by reacting sodium, potassium, and especially thallium salts of carboxylic acids with powerful acylating agents, such as acid chlorides<sup>3,4</sup> or acid anhydrides,<sup>3,5</sup> or reacting carboxylic acids with dehydrative coupling agents such as thionyl chloride,<sup>6</sup> ketene,<sup>7</sup> phosgene,<sup>8</sup> phosphorus pentoxide,<sup>9</sup> dicyclohexylcarbodiimide,<sup>10</sup> N,N-carbonyldimidazole,<sup>7</sup> isocyanate,<sup>11</sup> ethoxyacetylene,<sup>7</sup> bromotriphenylphosphonium bromide,<sup>12</sup> N-phenylphosphoramidochloridate,<sup>12</sup> diphenylphosphorochloridate,<sup>12</sup> bis (trichloromethyl) carbonate,<sup>8</sup> or trichloroacetonitrile/PPh<sub>3</sub>.<sup>3</sup> However, many of these methods met with some limitations, including low yields, laborious procedures, expensive or not readily accessible reagents, unstable or special reagents, harsh reaction conditions, necessary presence of a phase transfer catalyst, or tedious work-up. Consequently,

Address correspondence to Foad Kazemi, Chemistry Department, College of Science, Shahid Chamran University, Ahvaz, Iran.

it seems that there is a still great demand for new and efficient methods. In our development of new methods for functional group transformation,<sup>13</sup> we especially are interested in developing the application of modified form of thionyl chloride in organic synthesis.<sup>13h-j</sup> In this line, very recently, we have found that aldoximes undergo rapid dehydration using  $\text{Na}_2\text{SO}_3/\text{SOCl}_2$ ,<sup>14j</sup> and dabco/ $\text{SOCl}_2$ <sup>13i</sup> under mild reaction conditions to afford the corresponding nitriles. Now we report on conditions whereby various types of symmetrical anhydride can be conveniently synthesized from the corresponding carboxylic acids under mild nonaqueous reaction conditions by dabco/thionyl chloride.



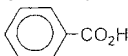
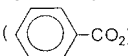
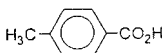
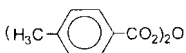
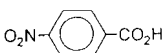
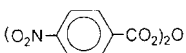
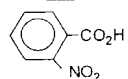
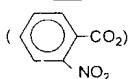
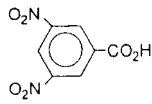
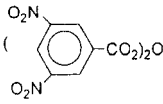
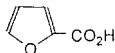
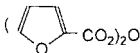
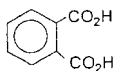
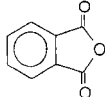
## RESULTS AND DISCUSSION

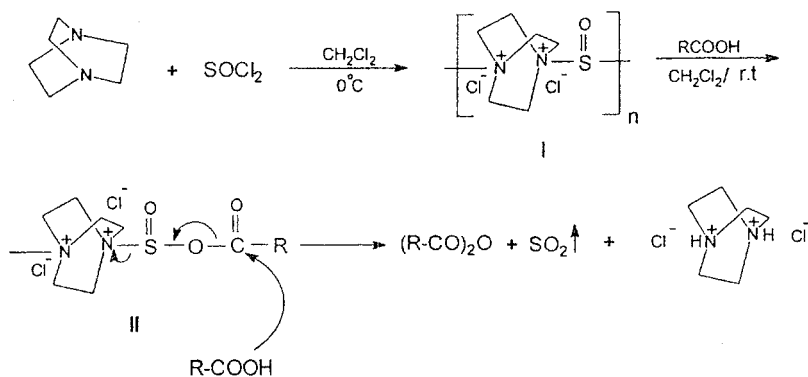
The reagent was prepared easily in essentially quantitative yield as a white solid by the reaction of thionyl chloride with stiochiometric amount of dabco in dichloromethane at 0°C. Since this white complex was sensitive to moisture, it was used directly in its crude form suspended in anhydrous dichloromethane. The obtained reagent can be used efficiently as dehydrative coupling agent for synthesis of symmetrical anhydride from the carboxylic acids. The plausible mechanism for the successful application of this reagent as dehydrating agent in symmetrical anhydride synthesis is as follows. At first, (I) is probably formed; this kind of mechanism has been proposed in the reaction of thionyl chloride and polyvinylpyrrolidone,<sup>13h</sup> N-methyl pyrrolidone,<sup>14</sup> or N,N-dimethylformamide.<sup>15</sup> Representative carboxylic acids were treated with (I) in  $\text{CH}_2\text{Cl}_2$  at room temperature. The reaction proceeded, probably via O-substituted carboxylic acid (II), which turns to symmetrical carboxylic anhydride with the nucleophilic addition of carboxylic acid followed by elimination of sulfur dioxide as shown in Scheme 1.

Several controlled reactions were carried out in order to establish the optimal reaction conditions. It revealed that simple stirring of benzoic acid (1 equiv.) and 3 equiv. of dabco/ $\text{SOCl}_2$  (1:1) in  $\text{CH}_2\text{Cl}_2$  effected the formation of benzoic anhydride in 80% isolated yield within 45 min.

The procedure turned out to be general for a range of structurally diverse carboxylic acids. Aliphatic and aromatic carboxylic acids were dehydrated easily and afforded the corresponding anhydrides in high isolated yields. The scope and generality of this process is illustrated with several examples and the results are summarized in Table I. The structure of all the products were settled from their analytical and

**TABLE I** Conversion of Carboxylic Acids to Anhydrides Using Dabco Thionyl Chloride

Entry	Substrate	Product	Time (min)	Yield (%)
1	$\text{CH}_3(\text{CH}_2)_3\text{CO}_2\text{H}$	$(\text{CH}_3(\text{CH}_2)_3\text{CO}_2)_2\text{O}$	35	80
2	$\text{CH}_3(\text{CH}_2)_{16}\text{CO}_2\text{H}$	$(\text{CH}_3(\text{CH}_2)_{16}\text{CO}_2)_2\text{O}$	40	85
3			45	80
4			45	75
5			45	85
6			45	75
7			50	82
8			50	87
9			60	80

<sup>a</sup>Molar ratio of reagent to substrate was 3:1 and performed at rt.<sup>b</sup>Yields refer to pure isolated products.<sup>c</sup>Products were characterized by comparison of their physical data, IR, and NMR spectra with known samples.**SCHEME 1**

spectral (IR,  $^1\text{H}$  NMR) data and by direct comparison with authentic samples.

It is noteworthy that no evidence for the formation of carboxylic acid chlorides as by-product of the reaction was observed and the products were obtained in pure form after aqueous basic work-up without further purification. It was found that the yield of reaction products in the absence of dabco was very low.

The reaction of phthalic acid as a dicarboxylic acid compound proceeded under the same reaction conditions to afford the expected cyclic anhydride, phthalic anhydride in 80% isolated yield.

Compared to some previously reported reagents with major or minor drawbacks, several noteworthy features of this system are apparent. These are the easy work-up procedure, availability of the reagent, operational simplicities, and use of inexpensive reagent.

## CONCLUSION

We believe this procedure using dabco/ $\text{SOCl}_2$  presents a useful and convenient alternative to the existing methods for dehydration coupling of carboxylic acids. Further application of this dehydrative system in organic synthesis are currently under investigation.

## EXPERIMENTAL

### General

IR spectra were recorded on a Shimadzo 450 spectrophotometer; and  $^1\text{H}$ NMR spectra in  $\text{CDCl}_3$  on a Bruker Avance DPX instrument (250 MHz). Carboxylic acids, dabco, and thionyl chloride were purchased from Fluka and Merck. Products were characterized by comparison of their physical data, IR and  $^1\text{H}$  NMR spectra with authentic samples. The purity determination of the products and reaction monitoring were accomplished by TLC on silica gel polygram SILG/UV 254 plates.

### General Procedure for the Preparation of Dabco/Thionyl Chloride Complex and Its Application in Conversion of Carboxylic Acid to Anhydrides

To a stirred solution of dabco (3 mmol, 0.336 g) in anhydrous  $\text{CH}_2\text{Cl}_2$  (3 ml) at  $0^\circ\text{C}$  freshly distilled thionyl chloride was added slowly (3 mmol, 0.357 g) to give a white precipitate. The reaction mixture was stirred for

about 5 min to effect the complete reaction of thionyl chloride and dabco. To the reaction mixture, carboxylic acid (1 mmol) was slowly added and stirred at room temperature for 30–50 min. Progress of the reaction was monitored by TLC. On completion of the reaction, the reaction mixture was basified with a dilute solution of  $\text{NaHCO}_3$  (10%) and extracted with  $\text{CH}_2\text{Cl}_2$  (15 ml). The organic layer was dried over anhydrous sodium sulfate and the solvent evaporated under reduced pressure to afford the TLC and  $^1\text{H}$ NMR pure products in 75–90% isolated yields.

## REFERENCES

- [1] M. A. Ogliaruso and J. F. Wolfe, *Synthesis of Carboxylic Acids, Esters and Their Derivatives* (John Wiley & Sons, New York, 1991), pp. 198–217.
- [2] W. K. Fife and Z. D. Zhang, *Tetrahedron Lett.*, **27**, 4933 (1986).
- [3] J. Kim and D. O. Jang, *Synth. Commun.*, **31**, 395 (2001).
- [4] P. Rambacher and S. Make, *Angew. Chem.*, **80**, 487 (1968).
- [5] S. R. Sandler and W. Karo, *Organic Functional Group Preparations* (New York, 1972), pp. 12, vol. III.
- [6] J. M. Adduci and R. S. Ramirez, *Org. Prep. Proced. Int.*, **2**, 321 (1970).
- [7] Y. Kita, S. Akai, N. Ajimura, et al., *J. Org. Chem.*, **51**, 4150 (1986).
- [8] R. Kocz, J. Roestamadji, and S. Mobashery, *J. Org. Chem.*, **59**, 2913 (1994).
- [9] S. G. Burton and P. T. Kaye, *Synth. Commun.*, **19**, 3331 (1989).
- [10] F. M. F. Chen and N. L. Benoiton, *Synthesis*, 710 (1979).
- [11] K. S. Keshavamurthy, D. Y. Vankar, and D. N. Dhar, *Synthesis*, 506 (1982).
- [12] R. Mestres and C. Palomo, *Synthesis*, 218 (1981).
- [13] a) F. Kazemi, A. R. Kiasat, and S. Ebrahimi, *Phosphorus, Sulfur, and Silicon*, **176**, 135 (2001); b) F. Kazemi and A. R. Kiasat, *Synthetic Commun.*, **32**, 2255 (2002); c) F. Kazemi, A. R. Kiasat, and S. Ebrahimi, *Synthetic Commun.*, **32**, 2483 (2002); d) F. Kazemi, A. R. Kiasat, and S. Ebrahimi, *J. Chem. Research(S)*, 176 (2002); e) B. Tamami and A. R. Kiasat, *Synthetic Commun.*, **28**, 1275 (1998); f) B. Tamami and A. R. Kiasat, *J. Chem Research*, 454 (1998); g) B. Tamami and A. R. Kiasat, *Synthetic Commun.*, **30**, 235 (2000); h) B. Tamami and A. R. Kiasat, *J. Chem. Research*, 444 (1999); j) F. Kazemi and A. R. Kiasat, *Ind. J. Chem. B*, 2003; g) A. R. Kiasat, F. Kazemi, and F. Khosravian, *Phosphorus, Sulfur, and Silicon*, 2003.
- [14] F. Hiashi and J. Nishi, *J. Polymer Science A*, 701 (1986).
- [15] M. S. Newman and P. K. Sujeeth, *J. Org. Chem.*, 4367 (1978).