

SYNLETT

Spotlight 82

This feature focuses on a reagent chosen by a postgraduate, highlighting the uses and preparation of the reagent in current research

Trifluoromethanesulfonic (triflic) Anhydride

Compiled by Sandipan Sarkar

Born in Kolkata, West Bengal, India, in 1975, he completed his M.Sc. in organic chemistry at the University of Calcutta, Kolkata, India, and joined the Department of Chemistry, Bose Institute, Kolkata, India, as a Junior Research Fellow in 2000. Currently he is working as a Senior Research Fellow (C.S.I.R.) towards a Ph.D. under the supervision of Professor Manas Chakrabarty. His research involves the reaction and synthesis of bioactive or potentially bioactive condensed heterocycles and also dry reactions mediated by montmorillonite clay.



Department of Chemistry, Bose Institute, 93/1 A. P. C. Road
Kolkata-700009, India
Fax 91-33-23506790; E-mail: ssarkar0123@yahoo.com

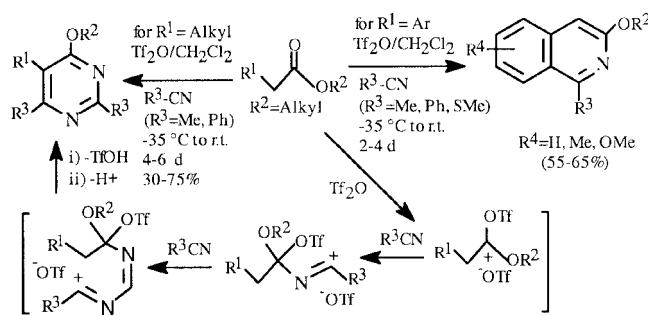
Introduction

Trifluoromethanesulfonic (triflic) anhydride [$(CF_3SO_2)_2O$; Tf_2O] has proved to be a versatile reagent in organic synthesis over the last few decades.^{1–3} Due to the excellent leaving group properties of the triflate group, Tf_2O finds its use in the conversion of various compounds to triflates which can be transformed into other useful products. Detailed studies have established triflates to be some 2×10^4 to 2×10^5 times more reactive than the comparable tosylates.¹

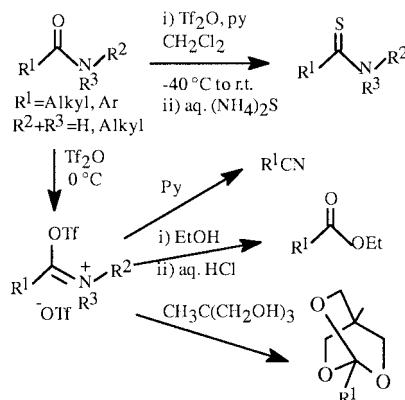
Abstract

(A) The reaction of aliphatic esters with aliphatic and aromatic nitriles in presence of Tf_2O affords 4-alkoxy pyrimidines. This reaction proceeds through the intermediacy of alkoxy (trifloxy) carbonium ions⁶ and leads to isoquinolines in case of arylacetic acid esters.⁷ A similar reaction with ketones offers a broad scope for the preparation of functionalised pyrimidines.⁸

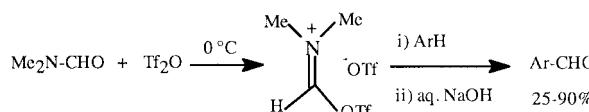
The anhydride is best prepared by distillation of triflic acid from excess P_2O_5 .⁵ Stang found that yields can be considerably increased by using P_2O_5 premixed with an equal volume of celite. The pure anhydride is a colourless liquid that is stable for long periods, insoluble in water, does not fume in air and hydrolyses slowly over several days at room temperature. The liquid boils at 81 °C at 760 torr pressure. The reagent is also commercially available.



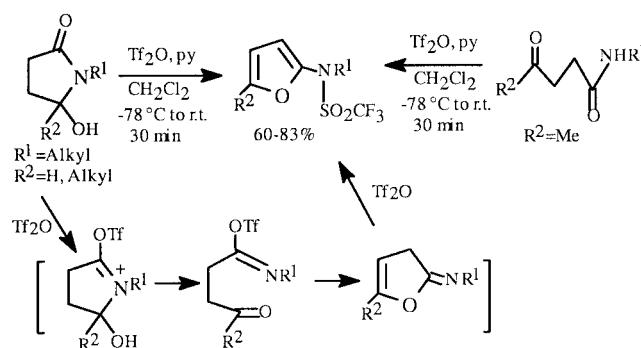
(B) The iminium and iminotriflates derived from the treatment of secondary and tertiary amides has opened up broad avenues for transformations of the amide functionality. These salts are versatile reagents that can react with various N-, O- and S-nucleophiles, thereby transforming amide group into other functionalities.⁹



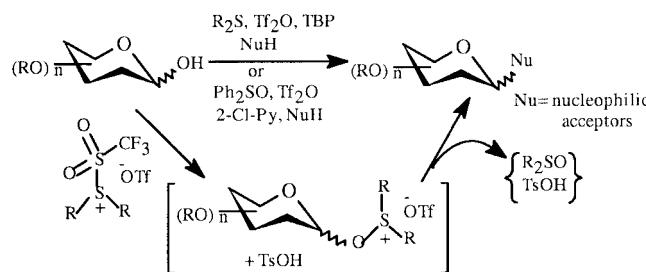
(C) Tf₂O has been utilised as a mild activation reagent in Vilsmeier–Haack formylation. Less nucleophilic aromatics can be formylated with DMF/Tf₂O.¹⁰



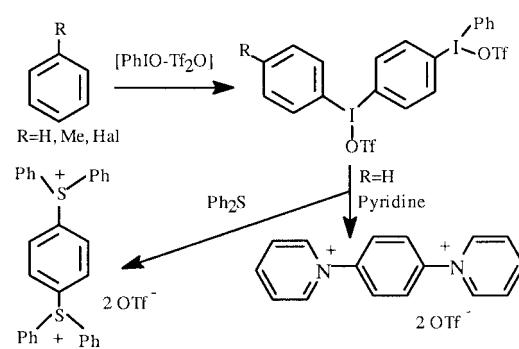
(D) α -Trifluoromethylsulfonamido furans, an important class of compounds, have recently been prepared by Tf₂O-mediated cyclisation of ketoamides and 5-hydroxy substituted pyrrolidinones.¹¹



(E) Tf₂O is used extensively in carbohydrate chemistry, frequently for glycosylation. Recently a novel sulfide- and sulfoxide-mediated dehydrative glycosylation technique employing Tf₂O has been developed.¹²



(F) In hypervalent iodine chemistry, PhIO-Tf₂O finds its use in the preparation of 1,4-disubstituted benzene derivatives. The extreme reactivity of the above complex even towards non-activated benzene derivatives affords (*p*-phenylene)bis(aryliodonium) ditriflates. This subsequently leads to the products.¹³



References

- Stang, P. J.; Hanack, M.; Subramanian, L. R. *Synthesis* **1982**, 85.
- Ritter, K. *Synthesis* **1993**, 735.
- Baraznekok, I. L.; Nenajdenko, V. G.; Balenkova, E. S. *Tetrahedron* **2000**, *56*, 3077.
- Su, T. M.; Sliwinski, W. F.; Schleyer, P. V. R. *J. Am. Chem. Soc.* **1969**, *91*, 5386.
- (a) Gramstad, T.; Hazeldine, R. N. *J. Chem. Soc.* **1956**, 173. (b) Gramstad, T.; Hazeldine, R. N. *J. Chem. Soc.* **1957**, 4069.
- Martínez, A. G.; Ferández, A. H.; Álvarez, R. M.; Vilchez, M. D.; Gutiérrez, M. L.; Subramanian, L. R. *Tetrahedron* **1999**, *55*, 4825.
- Martínez, A. G.; Ferández, A. H.; Vilchez, M. D.; Gutiérrez, M. L.; Subramanian, L. R. *Synlett* **1993**, 229.
- Martínez, A. G.; Ferández, A. H.; Jiménez, F. M.; Martínez, P. J. M.; Martin, C. A.; Subramanian, L. R. *Tetrahedron* **1996**, *52*, 7973.
- (a) Amidines: Charlette, A. B.; Grenon, M. *Tetrahedron Lett.* **2000**, *41*, 1677. (b) Thiazolidines: Charlette, A. B.; Chua, P. J. *Org. Chem.*; **1998**, *63*, 908. (c) Esters: Charlette, A. B.; Chua, P. *Synlett*; **1998**, 163. (d) Cyclic ortho esters: Charlette, A. B.; Chua, P. *Tetrahedron Lett.*; **1997**, *38*, 8499. (e) Thioamides: Charlette, A. B.; Grenon, M. *J. Org. Chem.*; **2003**, *68*, 5792.
- Martínez, A. G.; Álvarez, R. M.; Barcina, J. O.; Cerezo, S. M.; Vilar, E. T.; Fraile, A. G.; Hanack, M.; Subramanian, L. R. *J. Chem. Soc., Chem. Commun.* **1990**, 1571.
- (a) Padwa, A.; Rashatasakhon, P.; Rose, M. *J. Org. Chem.* **2003**, *68*, 2609. (b) Padwa, A.; Rashatasakhon, P.; Rose, M. *J. Org. Chem.* **2003**, *68*, 5139.
- (a) Garcia, B. A.; Gin, D. Y. *J. Am. Chem. Soc.* **2000**, *122*, 4269. (b) Nguyen, H. M.; Chen, Y.; Duron, S. G.; Gin, D. Y. *J. Am. Chem. Soc.* **2001**, *123*, 8766. (c) Honda, E.; Gin, D. Y. *J. Am. Chem. Soc.* **2002**, *124*, 7343.
- (a) Kitamura, T.; Furuki, R.; Nagata, K.; Taniguchi, H.; Stang, P. J. *J. Org. Chem.* **1992**, *57*, 6810. (b) Kitamura, T.; Furuki, R.; Nagata, K.; Zheng, L.; Taniguchi, H. *Synlett* **1993**, 193. (c) Kitamura, T.; Furuki, R.; Taniguchi, H.; Stang, P. J. *Mendeleev Commun.* **1991**, 148.