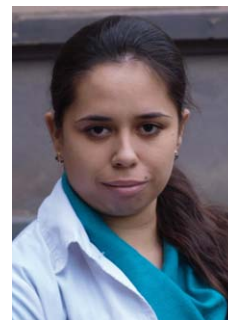


SYNLETT Spotlight 460

Cetylpyridinium Chloride

Compiled by Oksana Paley



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

Oksana Paley was born in Ukraine in 1990. She obtained her M.Sc. degree in analytical chemistry from the Uzhgorod National University, Ukraine, in 2011. She is currently working towards her Ph.D. at the Uzhgorod National University under the supervision of Dr. Yaroslav Studenyak. Her research interests focus on studying the formation of ionic associates of surfactants.

Chemical Faculty, Uzhgorod National University, Fedynets St. 53, 88000 Uzhgorod, Ukraine
E-mail: oksanapaley@mail.ru

Introduction

Cetylpyridinium chloride (CPC; IUPAC name: 1-hexadecylpyridinium chloride) is a cationic quaternary ammonium salt with a molar mass of 339.99 g/mol and a melting point of 77 °C (80–83 °C for its monohydrate form). These beige flakes are insoluble in acetone, acetic acid, and ethanol but can be solved in water.

CPC is commercially available and can be synthesized by the reaction of cetyl chloride with pyridine^{1a} and by alkylation of pyridine with cetyl dichlorophosphate.^{1b} If swallowed or inhaled, it is toxic, and it is irritating to the eyes, respiratory system, and skin. However, it is also an antiseptic that kills bacteria and other microorganisms.²

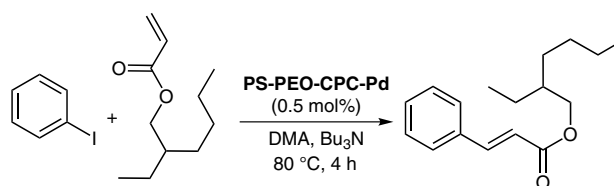
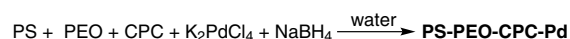
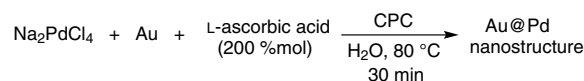
Therefore, it is effective in preventing dental plaque and in reducing gingivitis.³ CPC is widely used in industrial and commercial formulations, including disinfectants, cosmetics, and pharmaceuticals. Hence, its accurate determination is necessary.⁴

The application of CPC in organic synthesis and analytical chemistry includes use as a phase-transfer catalyst,⁵ modification of surface of sorbents,⁶ synthesis of mesoporous materials,⁷ preparation of nanoparticles,⁸ formation of turbid gels,⁹ determination of anionic surfactants¹⁰/mercury¹¹/thallium,¹² and the detection of 2,4,6-trinitrotoluene.¹³ CPC shows an inhibitory action on the corrosion of mild steel.¹⁴

Abstracts

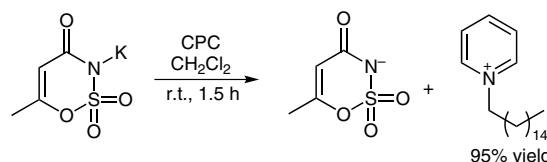
(A) Synthesis of Nanostructures

A facile method for the synthesis of Au@Pd nanostructures with controlled sizes and morphologies using gold nanospheres as seeds and CPC as a surfactant was reported. The use of CPC is critical to generate a Au@Pd nanostructure with a flower-like morphology.^{8b} Palladium nanoparticles stabilized by polystyrene (PS)-co-poly(ethyleneoxide) (PEO) and cetylpyridinium chloride were shown to be a very good catalyst in Heck reactions and the heterocyclization of *N*-methylsulfonyl *o*-iodoaniline with phenylacetylene to form substituted indoles.^{8c}



(B) Cetylpyridinium–Acesulfame Complex

Novel complex compounds, which shown great antimicrobial activity and also can find potential application as feeding deterrents, were synthesized from potassium acesulfame, saccharine, and cyclamate on CPC in non-aqueous media.¹⁵



SYNLETT 2014, 25, 0599–0600

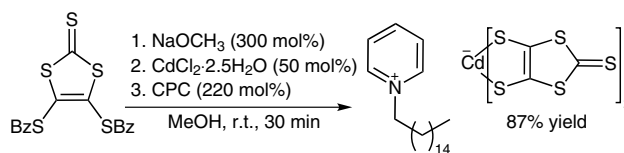
Advanced online publication: 13.01.2014

DOI: 10.1055/s-0033-1340488; Art ID: ST-2013-V0467-V

© Georg Thieme Verlag Stuttgart · New York

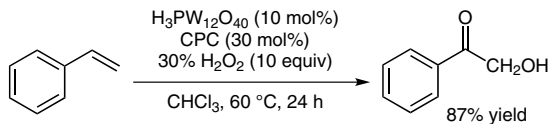
(C) Reactions with Complex Metal-Containing Anions

Li and co-workers constructed a Langmuir–Blodgett film from the complex of cetylpyridinium–cadmium(1,3-dithiole-2-thione-4,5-dithiolate), which was synthesized from 4,5-bis(benzoylthio)-1,3-dithiole-2-thione, sodium methylate, cadmium chloride, and CPC at room temperature.^{16a} CPC also reacts with beryllium- and cobalt-complex anions.^{16b,c}



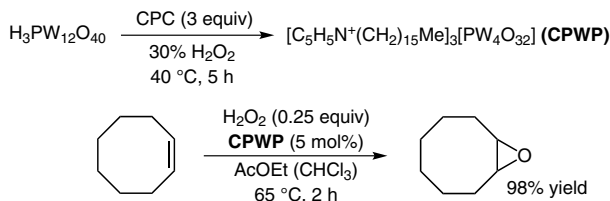
(D) Synthesis of Acyloins

Various acyloins were obtained in good yields and high regioselectivities by ketohydroxylation of 1-aryl-1-alkenes with H₂O₂, catalyzed by the 12-tungstophosphoric acid–cetylpyridinium chloride system.¹⁷



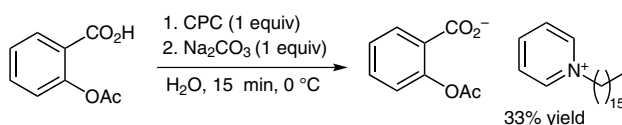
(E) Epoxidation of Alkenes

The epoxidation of alkenes was successfully catalyzed by a recyclable and environmentally benign catalytic system consisting of CPWP, H₂O₂, and solvent. CPWP was synthesized by the action of CPC on tungstophosphoric acid in a solution of hydrogen peroxide.¹⁸



(F) Modification of Drugs

Novel compounds were designed by the reaction of CPC with drugs, including aspirin,^{19a} sulfathiazole,^{19b} and triclosan,^{19c} to obtain synergistic effects of the two ionic components.



References

- (1) (a) Karrer, P.; Kahnt, F. W.; Epstein, R.; Jaffe, W.; Ishii, T. *Helv. Chim. Acta* **1938**, *21*, 223. (b) Narender, T.; Madhur, G.; Reddy, K. P.; Sarkar, S.; Dharamsheela; Tripathi, R. K.; Sarkar, J. *Synlett* **2011**, 1687.
- (2) Sreenivasan, P. K.; Haraszthy, V. I.; Zambon, J. J. *Lett. Appl. Microbiol.* **2012**, *56*, 14.
- (3) Asadoorian, J.; Williams, K. B. *J. Dent. Hyg.* **2008**, *82*, 42.
- (4) (a) Mohamed, G. G.; Ali, T. A.; El-Shahat, M. F.; Al-Sabagh, A. M.; Migahed, M. A.; Khaled, E. *Anal. Chim. Acta* **2010**, *673*, 79. (b) He, X.-L.; Wang, Y.-Q.; Ling, K.-Q. *Talanta* **2008**, *74*, 821.
- (5) (a) Sauda H., Hagiya K., EP 2474517, **2012** (b) Shinde, M. M.; Bhagwat, S. S. *Colloid. Surface. Physicochem. Eng. Aspects* **2011**, *380*, 201. (c) Li, W.; Zhang, W.; Ma, X.; Wang, P.; Du, M. *Appl. Cat. A: Gen.* **2012**, *210*, 419.
- (6) (a) Krajišnik, D.; Daković, A.; Malenović, A.; Djekić, L.; Kragović, M.; Dobričić, V.; Milić, J. *Micropor. Mesopor. Mat.* **2013**, *167*, 94. (b) Keledi, G.; Hari, J.; Pukanszky, B. *Nanoscale* **2012**, *4*, 1919.
- (7) Modak, A.; Mondal, J.; Aswal, V. K.; Bhaumik, A. *J. Mater. Chem.* **2010**, *20*, 8099.
- (8) (a) Xiao, J.; Qi, L. *Nanoscale* **2011**, *3*, 1383. (b) Kim, D. Y.; Kang, S. W.; Choi, K. W.; Choi, S. W.; Han, S. W.; Im, S. H.; Park, O. O. *CrystEngComm* **2013**, *15*, 7113. (c) Beletskaya, I. P.; Kashin, A. N.; Litvinov, A. E.; Tyurin, V. S.; Valetsky, P. M.; van Koten, G. *Organometallics* **2006**, *25*, 154.
- (9) Ramakanth, I.; Ramesh, N.; Patnaik, A. *J. Mater. Chem.* **2012**, *22*, 17842.
- (10) Qiaohong, H.; Hengwu, C. *Fresenius J. Anal. Chem.* **2000**, *367*, 270.
- (11) (a) He, X.-L.; Wang, Y.-Q.; Ling, K.-Q. *Talanta* **2007**, *72*, 747. (b) Tavallali, H.; Shaabanpur, E.; Vahdati, P. *Spectrochim. Acta A, Mol. Biomol. Spectrosc.* **2012**, *89*, 216.
- (12) Parakudyil, A. S.; Pillaiand, A. K.; Mathew, S. B. *Anal. Methods* **2011**, *3*, 1546.
- (13) Liu, H.; Lin, D.; Sun, Y.; Yang, L.; Liu, J. *Chem. Eur. J.* **2013**, *19*, 8789.
- (14) Khamis, A.; Saleh, M. M.; Awad, M. I. *Corros. Sci.* **2013**, *66*, 343.
- (15) (a) Hough-Troutman, W.; Smiglak, M.; Grin, S.; Reichert, W. M.; Mirska, I.; Jodynis-Liebert, J.; Adamska, T.; Nawrot, J.; Stasiewicz, M.; Rogers, R.; Pernak, J. *New J. Chem.* **2009**, *33*, 26. (b) Pernak, J.; Wasiski, K.; Praczyk, T.; Nawrot, J.; Cieniecka-Rosonkiewicz, A.; Walkiewicz, F.; Materna, K. *Sci. China Chem.* **2012**, *55*, 1532.
- (16) (a) Li, H.-Q.; Zhao, S.-M.; Wang, M.; Tan, G.-Z.; Yu, X.-D.; Xu, Y.; Liu, S.-G.; Liu, Y.-Q.; Li, Y.-F. *Phosphorus, Sulfur Silicon Relat. Elem.* **1997**, *131*, 83. (b) Burzlaff, H.; Lange, J.; Spengler, R. *Acta Cryst.* **1995**, *51*, 190. (c) Deng, F.-G.; Hu, B.; Sun, W.; Chen, J.; Xia, C.-G. *Dalton Trans.* **2007**, 4262.
- (17) Zhang, Y.; Shen, Z.; Tang, J.; Zhang, Y.; Kong, L.; Zhang, Y. *Org. Biomol. Chem.* **2006**, *4*, 1478.
- (18) (a) Ding, Y.; Zhao, W.; Hua, H.; Ma, B. *Green Chem.* **2008**, *10*, 910. (b) Gao, S.; Xi, Z. In *Mechanisms in Homogeneous and Heterogeneous Epoxidation Catalysis*; Oyama, S. T., Ed.; Elsevier: Amsterdam, Boston, **2008**, 432.
- (19) (a) Bica, K.; Rijkssen, C.; Nieuwenhuyzen, M.; Rogers, R. D. *Phys. Chem. Chem. Phys.* **2010**, *12*, 2011. (b) Seter, M.; Thomson, M. J.; Stoimenovski, J.; MacFarlane, D. R.; Forsyth, M. *Chem. Commun.* **2012**, *48*, 5983. (c) Zhang B., WO 2012/012049, **2012**.