

Sulfonated octa-substituted Co(II) phthalocyanines immobilized on silica matrix as catalyst for Thiuram E synthesis

Vashurin A., Marfin Y., Tarasyuk I., Kuzmin I., Znoyko S., Goncharenko A., Rumyantsev E.
Kazan Federal University, 420008, Kremlevskaya 18, Kazan, Russia

Abstract

© 2018 John Wiley & Sons, Ltd. Silica nanoparticles were obtained during the work according to two different sol-gel methods. In first one Schtrober's technique and series of cobalt phthalocyanine metal complexes varying in peripheral substituents were used. Second method was performed using the same complexes but differed in applying surface-active substance (SAS) and two precursors - tetraethoxysilane (TEOS) and aminopropyltrimethoxysilane (APTMO). All obtained hybrid materials were analyzed via SEM, the size of single particle was studied, which in all cases was about 200 nm. In order to investigate hybrid's characteristics laser diffraction and liquid nitrogen adsorption methods were applied. Distinction in pore's specific volume of differently-obtained nanoparticles was found. Catalytic activity of all obtained materials were tested in conversion of N,N-diethylcarbomodithiolate to thiuram E. Effect of peripherally substituted phthalocyanines and morphology of matrixes were manifested on catalytic activity of the hybrids.

<http://dx.doi.org/10.1002/aoc.4482>

Keywords

cobalt complexes, heterogeneous catalysis, phthalocyanine, silica, sol-gel synthesis

References

- [1] Z. Skrott, M. Mistrik, K. K. Andersen, S. Friis, D. Majera, J. Gursky, T. Ozdian, J. Bartkova, Z. Turi, P. Moudry, M. Kraus, M. Michalova, J. Vaclavkova, P. Dzubak, I. Vrobel, P. Pouckova, J. S, M. Andrea, A. Kutt, J. Li, J. Mattova, C. Driessen, Q. P. Dou, J. Olsen, M. Hajduch, B. Cvek, R. J. Deshaies, J. Bartek, *Nat. Chem.* 2017, 552, 194.
- [2] G. D. Thorn, R. A. Ludwig, *The dithiocarbamates and related compounds*, New York, Elsevier Publishing Co., Amsterdam 1981.
- [3] A. Z. Halimehjani, L. M. A. Hasani, Alaei, *Tetrahedron Lett.* 2016, 57, 883.
- [4] M. Destarac, D. Charmot, X. Franck, S. Z. Zard, *Macromol. Rapid Commun.* 2000, 21, 1035.
- [5] E. R. T. Tiekink, *Appl. Organomet. Chem.* 2008, 22, 533.
- [6] O. S. Urgut, I. I. Ozturk, C. N. Banti, N. Kourkoumelis, M. Manoli, A. J. Tasiopoulos, S. K. Hadjikakou, *Inorg. Chim. Acta* 2016, 443, 141.
- [7] P. K. Gessner, *Disulfiram and Its Metabolite, Diethyldithiocarbamate*, Springer, UK, London 1992.
- [8] L. I. Victoriano, *Coord. Chem. Rev.* 2000, 196, 383.
- [9] S. Reinhardt, N. Stoye, M. Luderer, F. Kiefer, U. Schmitt, K. Lieb, K. Endres, *Sci. Rep.* 2018, 8, 1329.
- [10] D. Derouet, Q. N. Tran, *Eur. Polym. J.* 2007, 43, 1806.

- [11] J. Aragonés, C. López-Rodríguez, A. Corbí, P. Gómez del Arco, M. López-Cabrera, M. O. de Landázuri, *J. Biol. Chem.* 1996, 271, 924.
- [12] R. Golding, C. Harris, K. Jessop, W. Tennant, *Aust. J. Chem.* 1972, 25, 2567.
- [13] X.-S. Li, M.-R. Ke, M.-F. Zhang, Q.-Q. Tang, B.-Y. Zheng, J.-D. Huang, *Chem. Commun.* 2015, 51, 4704.
- [14] X.-S. Li, B.-Y. Zheng, X.-H. Peng, S.-Z. Li, J.-W. Ying, Y. Zhao, J.-D. Huang, *J. Yoon, Coord. Chem. Rev.* 2017. <https://doi.org/10.1016/j.ccr.2017.08.003>
- [15] Z. Weiyu, Z. Jiacheng, C. Yong, C. Aijun, S. Fu'an, H. Mingyang, X. Hixiang, *Appl. Catal. Gen.* 2017, 542, 191.
- [16] T. Keleş, D. Akyüz, Z. Büyüklöğlü, *J. Electroanal. Chem.* 2017, 804, 53.
- [17] A. Vashurin, S. Pukhovskaya, A. Semeikin, O. Golubchikov, *Macroheterocycles* 2012, 5, 72.
- [18] A. Vashurin, V. Maizlish, S. Pukhovskaya, A. Voronina, I. Kuzmin, N. Futerman, O. Golubchikov, O. Koifman, *J. Porphyrins Phthalocyanines* 2015, 19, 573.
- [19] A. I. Zvyagina, A. A. Shiryaev, A. E. Baranchikov, V. V. Chernyshev, Y. Y. Enakieva, O. A. Raitman, A. A. Ezhov, I. N. Meshkov, D. A. Grishanov, O. S. Ivanova, G. Yu, Gorbunova, V. V. Arslanova, *New J. Chem.* 2017, 41, 948.
- [20] A. Vashurin, A. Filippova, S. Znoyko, A. Voronina, O. Lefedova, I. Kuzmin, V. Maizlish, *J. Porphyrins Phthalocyanines* 2015, 19, 983.
- [21] A. A. Voronina, I. A. Kuzmin, A. S. Vashurin, G. P. Shaposhnikov, S. G. Pukhovskaya, O. A. Golubchikov, *Russ. J. Gen. Chem.* 2014, 84, 1777.
- [22] I. A. Tarasyuk, I. A. Kuzmin, Y. S. Marfin, A. S. Vashurin, A. A. Voronina, *Synth. Met.* 2016, 217, 189.
- [23] A. A. Voronina, I. A. Tarasyuk, Y. S. Marfin, A. S. Vashurin, E. V. Rummyantsev, *J. Non Cryst. Solids* 2014, 406, 5.
- [24] N. Karousis, J. Ortiz, K. Ohkubo, T. Hasobe, S. Fukuzumi, Á. Sastre-Santos, N. Tagmatarchis, *J. Phys. Chem. C* 2012, 116, 20564.
- [25] R. Cao, R. Thapa, H. Kim, X. Xu, M. Gyu Kim, Q. Li, N. Park, M. Liu, J. Cho, M. K. Debe, R. Cao, J.-S. Lee, M. Liu, J. Cho, K. Sasaki, V. R. Stamenkovic, J. Greeley, Y. Liang, K. Gong, F. Du, Z. Xia, M. Durstock, L. Dai, G. Wu, K. L. More, C. M. Johnston, P. Zelenay, Z.-S. Wu, X. Li, B. N. Popov, T. Kawahara, H. Yanagi, J. Suntivich, S. N. S. Goubert-Renaudin, X. Zhu, A. Wieckowski, Z. Chen, D. Higgins, A. Yu, L. Zhang, J. Zhang, F. Jaouen, R. Chen, H. Li, D. Chu, G. Wang, W. Li, A. Yu, D. C. Higgins, B. G. Llanos, Z. Chen, R. Jasinski, C. Bezerra, A. A. Gewirth, M. S. Thorum, H. Meier, U. Tschirwitz, E. Zimmerhackl, W. Albrecht, G. Zeitler, A. A. Tanaka, C. Fierro, D. Scherson, E. B. Yeager, S. Gupta, D. Tryk, I. Bae, W. Aldred, E. Yeager, U. I. Kramm, I. Herrmann-Geppert, P. Bogdanoff, S. Fiechter, W. Li, J. Wu, D. C. Higgins, J.-Y. Choi, Z. Chen, F. Jaouen, A. M. Serventi, M. Lefèvre, J. P. Dodelet, P. Bertrand, M. Lefèvre, J. P. Dodelet, P. Bertrand, U. I. Koslowski, I. Abs-Wurmbach, S. Fiechter, P. Bogdanoff, C. J. Chang, Z.-H. Loh, C. Shi, F. C. Anson, D. G. Nocera, K. M. Kadish, J. P. Collman, S. Rywkin, C. M. Hosten, J. R. Lombardi, R. L. Birke, H. Michel, J. Behr, A. Harrenga, A. Kannt, J. L. Bahr, M. Lefèvre, J.-P. Dodelet, Y. Liang, F. Jaouen, Z. Shi, J. Zhang, *Nat. Commun.* 2013, 4.
- [26] A. Fashina, E. Amuhaya, *Spectrochim. Acta Part A Mol. Biomol. Spectrosc.* 2015, 140, 256.
- [27] W. Stöber, A. Fink, E. Bohn, *J. Colloid Interface Sci.* 1968, 26, 62.
- [28] C. J. Brinker, G. W. Scherer, *Sol-gel science: the physics and chemistry of sol-gel processing*, Academic Press, San Diego, CA 1990.
- [29] J. H. Weber, D. H. Busch, *Inorg. Chem.* 1965, 4, 472.
- [30] A. Filippova, A. Vashurin, S. Znoyko, I. Kuzmin, M. Razumov, A. Chernova, G. Shaposhnikov, O. Koifman, *J. Mol. Struct.* 2017, 1149, 17.
- [31] A. Vashurin, V. Maizlish, I. Kuzmin, S. Znoyko, A. Morozova, M. Razumov, *J. Porphyrins Phthalocyanines* 2017, 21, 37.
- [32] A. Weissberger, E. Proskauer, J. Riddick, *Organic solvent: physical properties and methods of purification*, Inter. Science Publishers Inc, New York 1955.
- [33] Y. Karjakin, I. Angelov, *Pure chemical substances*, Khimia, Moscow 1974.
- [34] Y. S. Marfin, A. S. Vashurin, E. V. Rummyantsev, S. G. Puhovskaya, *J. Sol-Gel Sci. Technol.* 2013, 66, 306.
- [35] V. N. Nemykin, A. E. Polshyna, S. A. Borisenkova, V. V. Strelko, *J. Mol. Catal. A: Chem.* 2007, 264, 103.
- [36] E. M. Tyapochkin, E. I. Kozliak, *J. Mol. Catal. A Chem* 2005, 242, 1.
- [37] A. Vashurin, I. Kuzmin, V. Mayzlish, M. Razumov, O. Golubchikov, *J. Serb. Chem. Soc.* 2016, 81, 1025.
- [38] J. C. Bricker, L. Laricchia, *Top. Catal.* 2012, 55, 1315.
- [39] A. Andreev, V. Ivanova, L. Prahov, *J. Mol. Catal. A: Chem.* 1995, 95, 197.
- [40] I. Chatti, A. Chorbel, P. Grange, J. M. Colin, *Catal. Today* 2002, 75, 113.
- [41] H. Liu, E. Min, *Green Chem.* 2006, 8, 657.
- [42] G. Das, B. Sain, S. Kumar, M. O. Garg, G. M. Dhar, *Catal. Today* 2009, 141, 152.
- [43] E. P. Barrett, L. G. Joyner, P. P. Halenda, *J. Am. Chem. Soc.* 1951, 73, 373.