



COPPER-CATALYZED C-H ACTIVATION REACTIONS UNDER NON-CONVENTIONAL TECHNIQUES

M. J. Moran, K. Martina, G. Cravotto

Department of Drug Science and Technology, University of Turin, Via Pietro Giuria 9, 10125, Turin. mariajesus.moranplata@unito.it

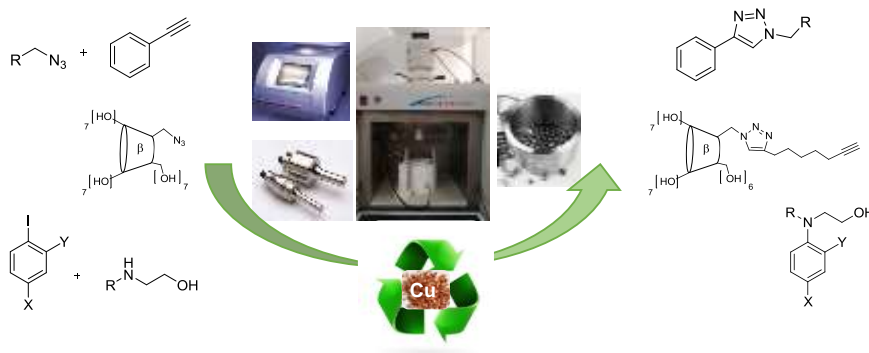
The use of environmentally benign enabling technologies such as microwave and ultrasound irradiation either alone or combined (CMUI) and mechanochemistry in solvent-free conditions, represent an important improvement in chemical processes. Besides energy and time saving, more efficient and selective chemical transformations have been observed [1].

In synthetic organic chemistry, one of the most direct way to pursue Green Chemistry is the use of truly efficient catalytic reactions. The application of non-conventional techniques has been successfully applied in copper heterogeneous catalysis. In the last decade this approach gained more and more attention due to important advantages: (1) compared to other transition-metal, copper catalysts are inexpensive, readily available, insensitive to air, and can be easily handled. (2) are extremely versatile and effective in different reaction types.

We reported the optimization of several Cu-catalyzed alkyne-azide cyclization in presence of copper powder, wires and solid supported copper. In all cases non conventional conditions can strongly promote heat and mass transfer, allowing to minimize energy consumption, reduce the reaction time and increase product yield and selectivity.

In this vein, click chemistry [2] and green chemistry walk hand in hand on a pathway of rigorous principles that help to safeguard the health of our planet against negligent and uncontrolled production. In the present work, CMUI strongly promotes CuAAC [3] with low catalyst loading, or copper powder as a source of Cu(I). Besides, ultrasound-assisted procedure has been successfully applied in the synthesis of solid supported Cu(I) and Pd(II) catalysts [4], obtaining cross-linked chitosan derivatives (CS-Cu, CS-Pd). The in situ polymerization in water under sonochemical conditions was extremely fast and efficient.

Solvent-free click cycloaddition [5], as well as Ullman [6] reactions, gave good results under mechanochemical activation of copper powder. Cyclodextrins [7] decoration could be easily achieved by microwave irradiation.



References

- [1] Z. Chun, T. Conghui, J. Ning, *Chemical Society Reviews*, 2012, 41, 3464; C. Sambigioglio, S. P. Marsden, A. J. Blacker, P. C. McGowan, *Chemical Society Reviews*, 2014, 43, 3525; M. B. Gawande, A. Goswami, F. Felpin, T. Asefa, X. Huang, R. Silva, X. Zou, R. Zboril, R. S. Varma, *Chemical Reviews*, 2016, 116, 3722.
- [2] P. Cintas, K. Martina, B. Robaldo, D. Garella, L. Boffa and G. Cravotto, *Chemical Communications*, 2007, 72, 1014; P. Cintas, A. Barge, T. Tagliapietra, L. Boffa, G. Cravotto, *Nature Protocols*, 2010, 5(3), 607.
- [3] G. Cravotto, V. V. Fokin, D. Garella, A. Binello, L. Boffa, A. Barge, *Journal of Combinatorial Chemistry*, 2010, 12, 13.
- [4] K. Martina, S. E. S. Leonhardt, B. Ondruschka, M. Curini, A. Binello, G. Cravotto, *Journal of Molecular Catalysis A: Chemical*, 2011, 334, 60.
- [5] L. Rinaldi, K. Martina, F. Baricco, L. Rotolo, G. Cravotto, *Molecules*, 2015, 20, 2837.
- [6] K. Martina, L. Rinaldi, F. Baricco, L. Boffa, G. Cravotto, *Synlett*, 2015, 26, 2789.
- [7] A. Barge, M. Caporaso, G. Cravotto, K. Martina, P. Tosco, S. Aime, C. Carrera, E. Gianolio, G. Pariani, D. Corpillo, *Chemistry – A European Journal*, 2013, 19, 12086.