

AperTO - Archivio Istituzionale Open Access dell'Università di Torino

**Power Ultrasound in Organic Synthesis: From Reformatsky and Barbier Reactions to Click Chemistry**

**This is the author's manuscript**

*Original Citation:*

*Availability:*

This version is available <http://hdl.handle.net/2318/1663915> since 2018-03-26T22:29:06Z

*Terms of use:*

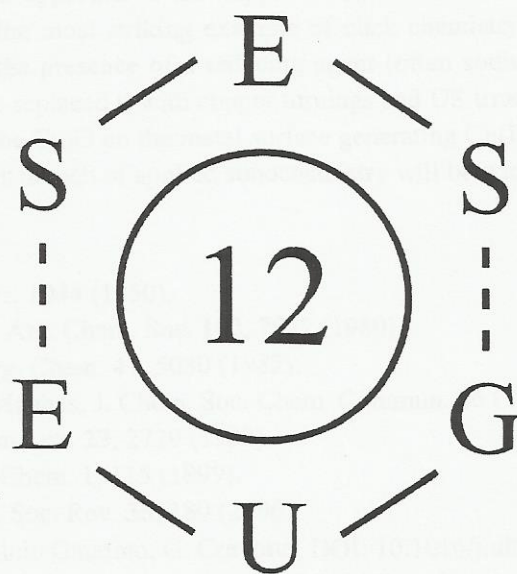
Open Access

Anyone can freely access the full text of works made available as "Open Access". Works made available under a Creative Commons license can be used according to the terms and conditions of said license. Use of all other works requires consent of the right holder (author or publisher) if not exempted from copyright protection by the applicable law.

(Article begins on next page)

12<sup>th</sup> Meeting of the  
European Society of Sonochemistry

Program and  
Book of Abstracts



May 30 - June 03, 2010  
Chania • Crete • Greece

## PL-4: Power Ultrasound in Organic Synthesis: From Reformatsky and Barbier Reactions to Click Chemistry

G. Cravotto<sup>a</sup>, S. Tagliapietra<sup>a</sup>, E. Calcio Gaudino<sup>a</sup>, P. Cintas<sup>b</sup>

<sup>a</sup>Dipartimento di Scienza e Tecnologia del Farmaco, Università di Torino, Via P. Giuria 9 - 10125 Torino - Italy.  
Fax: +39 011670.7687; Tel: +39 011670.7684; E-mail: giancarlo.cravotto@unito.it

<sup>b</sup>Departamento de Química Orgánica e Inorgánica, Universidad de Extremadura, Avenida de Elvas s/n,  
E-06071 Badajoz, Spain. E-mail: pecintas@unex.es

Synthetic protocols involving metals and organometallic reagents are the favourite domain in sonochemistry. The field was pioneered sixty years ago by Renaud [1], who reported that certain organometallics could be quickly prepared in undried solvents using a simple cleaning bath. Luche described the facile sonochemical preparation of organolithium and Grignard reagents and their Barbier-type coupling with carbonyls [2]. The same group studied a variety of sonochemical organometallic reactions involving Ni, Li, Zn and Cu. Han and Boudjouk dramatically increased the yields and rates of Reformatsky reactions under sonication [3], a finding that was subsequently exploited to prepare  $\beta$ -lactams from ethyl bromoacetate and a diaryl Schiff base [4]. Among several other examples that could be cited, the sonochemical variation of the Zn-mediated Simmons-Smith cyclopropanation of alkenes deserves attention [5]. US has been recognised as a key technique for green and sustainable synthetic processes [6], allowing the use of non-activated metals and crude reagents as well as aqueous media [7]. In the case of large scale and high-throughput applications, US-flow reactors are definitely required [8]. We thoroughly studied Pd-catalyzed reactions promoted by US or the combined use of US and MW irradiations [9, 10] (i.e. Suzuki-Miyaura [11] and Heck reactions [12]). We recently described a sonochemical approach to the copper-catalyzed azide-alkyne cycloaddition (CuAAC) [13], the reaction recognized as the most striking example of click chemistry. The most common catalyst system employs a Cu(II) salt in the presence of a reducing agent (often sodium ascorbate) to generate the required Cu(I) catalyst *in situ*. We replaced it with copper turnings and US irradiation smoothly activated the redox between the Cu metal and the Cu<sub>2</sub>O on the metal surface generating Cu(I) species [14]. State-of-the-art techniques and perspectives of this branch of applied sonochemistry will be widely discussed.

### References

- [1] P. Renaud, Bull. Soc. Chim. Fr. 1044 (1950).
- [2] J.-L. Luche, J. C. Damiano, J. Am. Chem. Soc. **102**, 7927 (1980).
- [3] B. H. Han; P. Boudjouk, J. Org. Chem. **47**, 5030 (1982).
- [4] A. K. Bose, K. Gupta, M. S. Manhas, J. Chem. Soc. Chem. Commun. 86 (1984).
- [5] O. Repic, S. Vogt, Tetrahedron Lett. **23**, 2729 (1982).
- [6] P. Cintas, J.-L. Luche, Green Chem. **1**, 115 (1999).
- [7] G. Cravotto, P. Cintas, Chem. Soc. Rev. **35**, 180 (2006).
- [8] P. Cintas, S. Mantegna, E. Calcio Gaudino, G. Cravotto, DOI: 10.1016/j.ultsonch. 2009.12.003.
- [9] A. Barge, S. Tagliapietra, L. Tei, P. Cintas, G. Cravotto, Curr. Org. Chem. **12**, 1588 (2008).
- [10] G. Cravotto, M. Beggiato, G. Palmisano, J.M. Lévêque, W. Bonrath, Tetrahedron Lett. **46**, 2267 (2005).
- [11] G. Cravotto, G. Palmisano, S. Tollari, G.M. Nano, A. Penoni, Ultrason. Sonochem. **12**, 91 (2005).
- [12] G. Palmisano, W. Bonrath, L. Boffa, A. Barge, G. Cravotto, Adv. Synth. Catal. **349**, 2338 (2007).
- [13] G. Cravotto, V. V. Fokin, D. Garella, A. Binello, A. Barge, J. Comb. Chem. **12**, 13 (2010).
- [14] P. Cintas, A. Barge, T. Tagliapietra, L. Boffa, G. Cravotto, Nature Prot. **5**, 607 (2010).