We intend to present an oral communication.

Supercritical microfluidics (SCμF) synthesis of ZnO nanoparticles (NPs) with improved excitonic luminescence

Yann Roig, Samuel Marre, Thierry Cardinal, Cyril Aymonier

CNRS, Université de Bordeaux, ICMCB
87 Avenue du Dr Albert Schweitzer, 33608 Pessac Cedex, France
aymonier@icmcb-bordeaux.cnrs.fr

ZnO is a known wide band gap semi-conductor, which has been extensively studied for years for its applications in solar cells, catalysis, optoelectronics or piezoelectric applications.[1] The photoluminescence spectra of ZnO NPs generally exhibit two main peaks attributed to the excitonic recombination and to the presence of defects. Liquid phase synthesis of ZnO leads to well control nanoparticles but rather large amount of defects, mostly incompatible with several applications such as UV-LEDs. Oppositely, high excitonic luminescent ZnO particles are obtained through gas phase physical techniques. However, these methods exhibit poor control over particle size and size distribution. Therefore, supercritical fluids turn out be ideal solvent systems for such synthesis.[2] Additionally, new continuous processes based on microreactors offer several advantages over macroscale chemical processes such as control of hydrodynamics, enhancement of mass and heat transfer, reproducibility, rapid screening of parameters and low reagent consumption during optimization.[3] The recent combination of supercritical fluids with microfluidics in high pressure / high temperature microreactors[4] has been successfully applied to the synthesis of high quality nanomaterials.[5]

In this communication, we present the use of supercritical microreactors based on silica capillary tubings for obtaining high excitonic emission luminescent ZnO nanoparticles (NPs), taking benefits of both liquid and gas phase chemistry in supercritical microfluidics (SCμFs). However, handling solids in microsystems is still challenging due to potential NPs deposition and aggregation leading to microchannels clogging.[4] Thus, we present a mean to overcome this limitation in the case of ZnO NPs elaboration by acting on both hydrodynamics and chemistry. The influence of several operating parameters (p, T, flow rates, surfactant nature and ratio...) on ZnO NPs material characteristics (size, morphology) and photoluminescence properties will be discussed.

[1] (a) Tsukazaki, A.; Ohtomo, A.; Onuma, T.; Ohtani, M.; Makino, T.; Sumiya, M.; Ohtani, K.; Chichibu, S. F.; Fuke, S.; Segawa, Y.; Ohno, H.; Koinuma, H.; Kawasaki, M. *Nature materials*. **2005**, *4*, 42-6. (b) , N. T.; Aw, K. C.; Gao, W.; Wright, B. E. *Thin Solid Films*. **2009**, *518*, 362-365.

[2] F. Cansell, C. Aymonier, *J. Supercrit. Fluids*, **2009**, *47*, 508-516.

[3] (a) S. Marre, K. F. Jensen, Chemical Society Reviews 2010, 39, 1183, (b) Tsukazaki, A.; Ohtomo, A.; Onuma, T.; Ohtani, M.; Makino, T.; Sumiya, M.; Ohtani, K.; Chichibu, S. F.; Fuke, S.; Segawa, Y.; Ohno, H.; Koinuma, H.; Kawasaki, M. *Nature materials*. **2005**, *4*, 42-6, (c) , N. T.; Aw, K. C.; Gao, W.; Wright, B. E. *Thin Solid Films*. **2009**, *518*, 362-365.

[4] S. Marre, A. Adamo, S. Basak, C. Aymonier, K. F. Jensen, Industrial & Engineering Chemistry Research 2010, 49, 11310.

[5] (a) S. Marre, J. Park, J. Rempel, J. Guan, M. G. Bawendi, K. F. Jensen, Advanced Materials 2008, 20, 4830, (b) S. Marre, J. Baek, J. Park, M. G. Bawendi, K. F. Jensen, Jala 2009, 14, 367, (c) J. Baek, P. M. Allen, M. G. Bawendi, K. F. Jensen, Angewandte Chemie-International Edition 2011, 50, 627.

[6] R.L. Hartman, J.R. Naber, N. Zaborenko, S.L. Buchwald, K.F. Jensen, *Organic Process Research & Development* **2010**, 1347-1357.