A low temperature wet-chemistry toolbox for the green and up-scalable synthesis of inorganic nanostructures for catalysis

Silvia Gross, Dept. of Chemical Sciences, University of Padova, Padova, Italy;
Federico Spolaore, Dept. of Chemical Sciences, University of Padova, Padova, Italy;
Nicola Dengo, Dept. of Chemical Sciences, University of Padova, Padova, Italy;
Stefano Diodati, Dept. of Chemical Sciences, University of Padova, Padova, Italy;
Francesca Tajoli, Dept. of Chemical Sciences, University of Padova, Padova, Italy
Marina Franca, Dept. of Chemical Sciences, University of Padova, Padova, Italy

Control on shape, morphology, size and crystallinity of inorganic nanomaterials are major requirements in the fields of catalysis and photocatalysis. In this context, the paradigms of green and sustainable chemistry are currently raising a sharply growing interest in all fields of inorganic materials chemistry [1]. In this framework, resorting to sustainable, green and easy scalable wet-chemistry, typically aqueous-based, synthesis routes is a convenient approach to produce nanostructures for catalytic and photocatalytic applications. In particular, inorganic chemistry represents an exciting playground for the design and optimisation of green chemistry-inspired routes which can also be implemented on a larger scale, which is a relevant aspect for industrial applications of catalysts. The controlled exploration of experimental parameters discloses exciting perspectives in orienting, *inter alia*, the morphogenesis and the final structure and shape of the crystalline materials. In this framework, we have explored and optimised different low temperature (T< 150°C) and sustainable wet chemistry and colloidal routes [1, 2] and developed an efficient and versatlite synthetic toolbox (see Figure 1) The toolbox encompasses (i) hydrothermal routes [3], (ii) very low (0°C) temperature precipitation, (iii) continuous flow synthesis, (iv) seeded-growth) and combinations thereof, to prepare different inorganic functional nanomaterials ranging from metal and metal alloys nanoparticles for gas exhaust after-treatment, metal oxides for possible oxidation catalysis reactions, zinc sulphide and metal titanates for photocatalytic applications. These syntheses have been recently extended to the preparation of further sulphides and mixed oxides. Common factors of all these approaches are the low temperature of processing, the easy procedure, the

reproducibility, the possibility to up-scale the optimised route, the achievement of highly crystalline and size-controlled nanostructures.

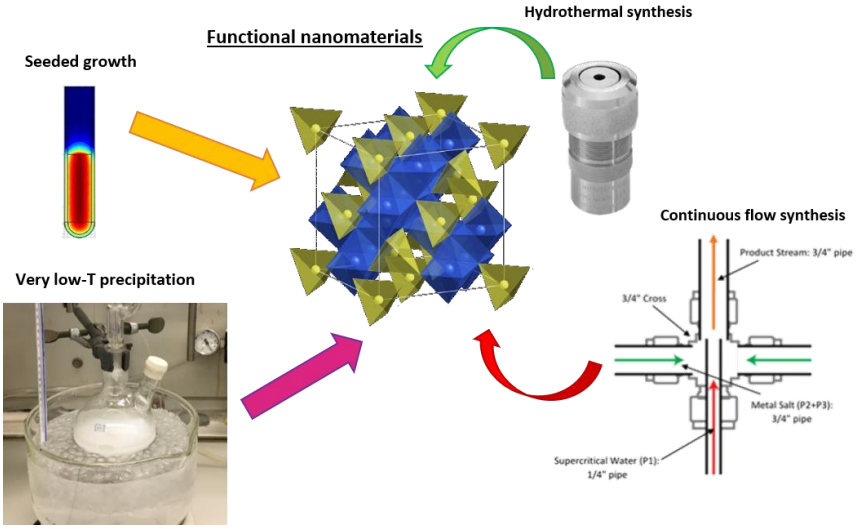

Figure 1- Synthetic toolbox for low temperature synthesis of inorganic nanostructures

[1] S. Diodati, P. Dolcet, M. Casarin, S. Gross; Chem. Rev. 2015, 115, 11449–11502
[2] P. Dolcet, S. Diodati, M. Casarin, S. Gross; J. Sol-Gel Sci Technol. 2015, 73, 591-604
[3] P. Dolcet, S. Diodati, F. Zorzi, P. Voepel, C. Seitz, B. Smarsly, S. Mascotto, F. Nestola, S. Gross; Green Chem. 2018, 20, 2257-2268