Colloidal nanocrystals to advance studies in CO_2 conversion

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Storage of intermittent renewable energy in chemical bonds is an important research area to build a more sustainable society. Artificial photosynthesis mimics the natural photosynthesis by converting sunlight, water and carbon dioxide into value-added chemicals (such as fuels for transportation like hydrogen or hydrocarbons but also useful chemicals like ethylene, which is a feedstock for petrolchemicals). Many scientific challenges still exist for the technological implementation of water splitting and CO_2 photoelectrochemical devices. Our goal is to address some of these challenges by tailor-making material platforms based on atomically-defined colloidal nanocrystals (NCs). [1]

In this talk, I will briefly outline the activities of the group regarding visible-light absorbing metal oxide NCs and stabilization schemes for quantum dots. However, main focus will be on NCs for the conversion of CO_2 into value-added chemicals. In our first work, we have exploited the material tunability afforded by colloidal chemistry to build unambiguous structure/properties between Cu NCs of different sizes (8nm to 60nm) and shapes (cubes and spheres) and their behaviour as electrocatalysts for CO_2 reduction. An unexpected selectivity trend was found, with 44nm nanocubes showing an impressive CO_2 conversion efficiency to ethylene, which is one of the highly desirable products (Figure 1). [2] I will discuss our recent stability studies by HR-TEM and theoretical calculations, which are elucidating the mechanims behind such a behaviour. Furthermore, our results with more complex hybrid systems comprising Cu NCs as building blocks (metastable Cu-based alloys and NC/metal organic hybrids [3]) will be briefly discussed as examples of multifunctional platforms to tune selectivity in the CO_2 conversion reaction. The synthetic challenges of such materials and our strategies to access them in a programmable manner will be highlighted.

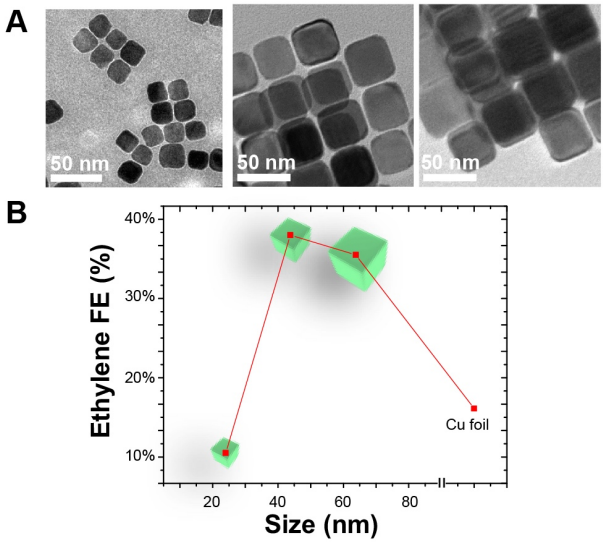

Fig. 1 Colloidal Cu nanocrystals as electrocatalysts for CO_2 reduction: (A) TEM images of Cu cubes with an average edge length of 24, 44, 63 nm and (B) corresponding faradaic efficiencies towards ethylene. [2]

1) C. Gadiyar *et al*., *J. Phys. D: Appl. Phys.*, **2017**, *50*, 074006.
2) A. Loiudice, *Angew. Chem. Int. Ed.*, **2016**, *55*, 5789.
3) I. Luz, *Chem. Mater.*, **2016**, *28*, 3839.