Jean-Cyrille HIERSO

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Biography

Having a PhD from Université Paul Sabatier, Toulouse, Jean-Cyrille HIERSO is now full professor of Chemistry since 2009, at the Institute of Molecular Chemistry at the Université de Bourgogne, Dijon. He has interest in the fields of organometallic chemistry, ligand design, homo- and heterogeneous catalysis, chemical physics and material sciences. In 2011 he was awarded the National Prize for Coordination Chemistry from the French Chemical Society (SCF) and at the end of 2012 he was elected Member of the French Professors Academy "Institut Universitaire de France" (IUF). He has been nominated Junior Distinguished Member of the SCF in 2015. Topics developed in his group concern catalytic C–H bond functionalization, C–C and C–heteroatom bond formation, and sp3-C-based nanochemistry with applications in transition metal reactivity, especially palladium, gold and ruthenium.

Engineering Nanodiamonds from Gas Phase or Solution: Applications in Ammonia and Dihydrogen Sensing and Catalysis

Diamondoids (aka molecular nanodiamonds) are cage hydrocarbon molecules that can be described as fully hydrogen-terminated nanometer-sized diamonds. Adamantane and diamantane are the smallest diamondoids, and their selective functionalization can be achieved with high efficiency at various positions of the hydrocarbon cage [1]. We reported the mild physical vapor deposition of such functionalized nanodiamonds, which provides robust nano- and microstructured self-assembly of organic micro and nanocrystals [2]. Then, a bottom-up construction of hybrid organic–inorganic nanocomposites with a coated metal surface as ultrathin nanolayer on phosphine-functionalized nanodiamonds was stepwisely achieved from the gas phase by the low-temperature chemical vapor deposition (45 °C) of an organometallic complex over the self-assembled diamondoid scaffold [3]. Palladium nanolayered composites can be used to detect toxic NO2 and NH3 gases. NO2 detection down to 50 ppb and NH3 detection at 25 ppm concentration with fast response and recovery processes at 100 °C was demonstrated [4].

Other functionalization of adamantane and diamantane, including the introduction of sulfur functions [5], opened the way to the synthesis in solution of dense networks of metal nanoparticles. The control of the growth of sub-2-nm gold nanoparticles is achieved by the formation of well-defined networks, assembled in a single step reaction by employing bifunctional bis-adamantanedithiol (BAd-SH) or diamantanedithiol (DAd-SH). These are serving both as bulky surface stabilizers and short-sized rigid linkers. Uniformly small gold NPs (1.3 ± 0.2 nm to 1.6 ± 0.3 nm) embedded in insoluble frameworks are organized alongside short interparticular distances ranging from 1.9 to 2.7 nm. These were used for highly selective heterogeneous gold-catalyzed enyne cyclization to five-membered diene [5], while this reaction suffers from serious selectivity troubles in homogeneous catalysis. The control over the selectivity results from atoms cooperation at the gold surface that we analyzed in joint experimental and theoretical studies combining XPS, NMR and DFT. Further applications of such recoverable nanocatalysts in networks extend to ruthenium-catalyzed selective alkyne hydrogenation [6] and ammonia-borane solvolysis for high rate H2 production [7,8].

Keywords:

Nanocomposite; Nanodiamonds; Organometallic; Interface; Reactivity

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